



Economic Analysis of Watermelon-Based Production Systems In Ebonyi State, Nigeria

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Abstract

The research was on the economic analysis of watermelon based production systems in Ebonyi State, Nigeria. A multistage random sampling technique was used in the selection of hundred farmers from the selected local governments. Well-structured questionnaire was used to obtain information on socio-economic characteristics and other relevant variables. The study data were analyzed by descriptive statistics, budgetary and stochastic frontier production function. The results showed that 80.0% of watermelon farmer in the study area were female in which 78.6% of them were married and 33.5% did not have any formal education. Watermelon was predominantly grown as sole crop by 42.5% while 57.5% of farmers engaged in intercropping. Budgetary analysis revealed that watermelon intercropping with cassava had higher gross margin (N265, 638.00/ha) than sole watermelon (N322, 824.00/ha). The benefit/cost ratio (BCR) of sole watermelon (2.33:1) was greater than watermelon cassava intercropping system (2.21:1). Yield level was positive and significantly ($p \leq 0.01$) influenced by labour input. The level of education was significant and found to contribute positively to technical efficiency while farming experience was found to reduce technical efficiency. Inadequate credit facilities (79%), pest and disease (75.2%), inadequate fertilizer (65.4%), labour shortage (66.7%), high transportation cost (55.1%) and seed procurement (34.5%) were the prominent constraints to watermelon production in the study area.

Keywords: watermelon-based farm, budgetary analysis, stochastic production function.

1. Introduction

Watermelon (*Citrullus lanatus*) is one of the most widely cultivated crops in the world at large and the global production in 2002 reached 89.9 million mega grams (FAO, 2003; Huh *et al.*, 2008). China was reported to be leading country in production of watermelon followed by Turkey, United States, Iran and Republic of Korea (Huh *et al.*, 2008; Wehner and Maynard, 2003). Watermelon is one of the most popular and widely grown cucurbitaceous fruit vegetables in tropical and subtropical countries of the world. Its global consumption is greater than that of any other cucurbits and account for 6.8% of the world area devoted to vegetable production (Goreta *et al.*, 2005 and Miles, 2004). 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. According to Okeke *et al.*, (2020); Adeoye *et al.*, (2007) and Oguntola (2006), watermelon is the most preferred among five other exotic vegetables examined in Abakaliki Metropolis of Ebonyi State, Nigeria. Watermelon contains 60% more lycopene than tomato. Lycopene in the human diet is associated with prevention of heart attacks and certain cancers. Rind of watermelon contains an important natural compound called citrulline, an amino acid that the human body makes from food. Citrulline is found in high concentration in liver, and is involved with athletic ability and functioning of the immune system (Ajibefun *et al.*, 2002). It is a good source of fiber which is important for keeping digestive tract operating properly by preventing constipation, hemorrhoids and diverticular disease. In Nigeria, though there are no official figures recorded for watermelon production, the crop has a wide distribution as a garden crop, while as a commercial vegetable production; its cultivation is confined to the drier savanna region of Nigeria (Anon, 2005). Recent report indicated that exotic vegetables production generate higher profit, provided more employment and



income to the farmers than those of indigenous vegetables, knowledge of availability of aggregated farm level resources and differences in their productivities are essential in order to enhance productive capacity of the smallholder farmers (Ajewole and Folayan, 2008). This will indicate the direction of resource use adjustment and allocation (Ogundari and Ojo, 2005). Efficiency measurement is very important because it leads to resource savings, efficiency gains are also important since efficient farms are more likely to generate higher income and thus stand a better chance of surviving (Bravo-Uretar and Rieger, 1991).

Against this background, it is necessary to evaluate the performance of this crop in sole and mixtures, and the factors affecting the productivity in order to determine the profitability of the production. Therefore, this study was undertaken to determine economic efficiency of water melon based system in Ebonyi State. The study specifically examined socio economic characteristics of the farmers, compare costs and returns structure across the cropping systems, determine the factor affecting production level and technical efficiency of resource use, and identify the constraints faced by watermelon farmers in the study area. This study will serve as a guide to prospective investors on watermelon production investment decisions.

2. Methodology

2.1 Study area

The study was carried out in Ebonyi State, which lies within the tropical zone in the rain forest region of southwestern part of Nigeria. It is located between latitude 6°15'N and longitude 8°05'E of Greenwich meridian of equator (FECAL, 2004). Abakaliki and Ohaozara local Government areas of Ebonyi State were purposively selected for the study. The areas are peculiar for rice production and a large percentage of the inhabitants are farmers. The population figure of Abakaliki and Ohaozara are 102,979 and 118,226 respectively (NBS, 2006).

2.2 Sampling technique

A multistage sampling technique was used in selecting one hundred (100) respondents from the two Local Governments. Based on *a priori* information, two local Government areas (Abakaliki and Ohaozara) with highest density of watermelon farmers were selected using purposive sampling technique. The second stage was the random selection of forty percent of producers from each local government areas based on the total number of watermelon farmers. In all, a total number of hundred questionnaires were distributed to the selected respondents in which 98 questionnaires were processed for the analysis.

2.3 Data collection

Data were collected using structured questionnaire on farmers output, production input variables (farm size, labour used, fertilizer, cost of seed, chemicals, transportation cost, harvesting cost, depreciation and rent). Also included in the data collection were the socio-economic characteristics of the farmers (age, education, farming experience, household size, credit availability, gender and marital status). All data on resource use, production cost and outputs were converted to per hectare equivalent.

2.4 Method of data analysis

Data were analyzed using descriptive and quantitative statistical techniques. Farm budget analysis was constructed to estimate the production cost, revenue and gross margin accruable to the farmers. The equation used in estimating the various parameters were defined below:

$$GM = TR - TVC \quad (1)$$

$$TC = TFC + TVC \quad (2)$$



$$NP = TR - TC \quad (3)$$

Where:

TC = total cost, TFC = total fixed cost, TVC= total variable cost, GM = Gross margin, TR = Total revenue, NP = Net profit

Depreciation on tools was calculated by the straight-line method as follows:

Depreciation = (cost of purchase - salvage value)/useful life.

2.5 Stochastic frontier

The model was employed to examine factors influencing output of watermelon among farmers in the study area and the technical efficiency of resources employed. The main strength of the model is that it deals with stochastic noise and permits statistical test of hypothesis pertaining to production structure and degree of efficiency. Efficient transformation of inputs into output is characterized by the production function, which shows the maximum output obtainable from various input vectors. The stochastic production function is defined as:

$$Q = f (X_i\beta) \exp (V_i - U_i) \dots\dots\dots(4)$$

Where:

Q = Quantity of Watermelon output

X_i = Vector of input quantities

β = vector of parameters to be estimated

Exp = exponential function

V_i = random variables

U_i = non negative random variables which are account for technical inefficiency in production.

The random errors, V_i, are assumed to be independently and identically distributed and independent of U_i's. V capture variations in output due to factors outside the control of the farmer like fluctuations in input prices, farm size. The U's are also assumed to be independently and identically distributed (Meeusen and Van den Broeck, 1977 and Aiger *et al.*, 1977). U's are factors under farmers control, it follows half normal distribution and it is a non-negative random variable called technical inefficiency effect associated with the technical efficiency of watermelon production. It captures the variation in output due to age, household size, farming experience, extension visit and level of education. Technical efficiency (TE) of an individual farmer is defined as the ratio of the observed output to the corresponding frontier output, conditional on the levels of inputs used by the farmer. Thus the technical efficiency of farmer i in the context of the stochastic frontier production function (1) is:

$$TE_i = Y_i/Y_i^* = f (X_i; \beta) \exp (V_i - U_i)/f (X_i\beta) \exp (V_i) \dots\dots\dots(5)$$

$$TE = \exp (-U_i) \dots\dots\dots (6)$$

Where Y_i is the actual output and Y_i* is the frontier output (potential output). The value of the technical efficiency lies between zero and one. The most efficient farmer will have value one, whereas the less efficient farmers will have their efficiencies lying between zero and one.

3. Results

3.1 Socio-economic characteristics of respondents

The result of the analysis (Table-1) showed that most of the respondents were female (80.0%) while only 20.0% were male. This indicates dominance of female folk in watermelon production. Eighty percent of respondents were less than 50 years old revealing presence of young and middle aged individuals who are known to be active and innovative. They are also likely to be opened to new ideas. Furthermore, majority of the farmers (78.6%) were married and are therefore expected to be stable and settled career wise. About thirty four percent of the



respondents did not have any formal education, 28.6% attended primary school, and 25.0% had secondary school education while 12.9% had tertiary education. This shows low level of literacy in the study area. The result also indicated that 47.2% of the respondents had been in the practice of watermelon production for more than 5 years, 40.4% of them had grown water melon between 6-10 years while 12.4% had grown water melon between 11-15 years. The mean years of water melon production experience was 6 years. This further shows that water melon production is a newly introduced profession of the people in the study area. The mean household size was 6.

This indicates that the household size of respondents were relatively large. Credit facilities were not enjoyed by 74.0% of respondents. This may be due to the absence of micro financial institution in the area. Agricultural extension services reached 59.8% of the farmers in the study area. This will enable the farmers to have access to improved technologies involved in production of the crop.

Table 1. Socio-economic characteristics of respondents.

Personal characteristics	Categories	Percentage
Sex	Male	20.0
	Female	80.0
Age	Below 30	13.4
	30-40	36.0
	41-50	30.6
	51-60	17.8
	Above 60	2.2
Marital status	Single	21.4
	Married	75.5
	Separated	3.1
Educational Qualification	No formal Education	33.5
	Primary	28.6
	Secondary	25.0
	Tertiary education	12.9
Experience	1-5 years	47.2
	6-10 years	40.4
	11-15 years	12.4
Household size	1-3	16.9
	4-6	46.1
	7-9	27.0
	Above 10	10
Access to loan	Yes	26.0
	No	74.0
Extension visit	Yes	59.8
	No	40.2

3.2 Cropping practices employed by farmers

Watermelon was predominantly grown as sole crop by (42.5%) while 57.5% of farmers engaged in intercropping. Watermelon was intercropped with cassava, maize, yam and okra in the study area. About 43.2% intercropped with cassava, 24.3% with maize, 30.1% with yam and 2.4% with okra. The reasons given for intercropping watermelon with other crops were improved income (60%), increased fertility (20%), prevention against crop failure (15%) and for maximum use of land (5%) as shown in Table 2. Although Sugarbaby was the most grown



varieties of watermelon in the area. Majority, (82%) preferred variety Sugarbaby. This was attributed to the following: marketability, sweetness, size and storability. With respect to the method of seed planting, it was discovered that direct seeding method was the most popular technique adopted by most of the sampled farmers. About 47.2% of the farmers had between 1-2ha, 30.3% had less than 1 ha and only 1.5% had more than 6 hectares. This shows that most of the farmers operated small scale enterprise. The Table also shows that majority of the respondents relied on hired labour (50.8%) for their farm operation while 35.6% depend on self and hired labour. Majority of the farmers carried out an average of two weedings in water melon production. This is because watermelon suppresses weed growth after full establishment. Moreover, more than 79.8% percent of the farmers did their weeding manually while about 13.5% combined chemical weeding with manual weeding (Table 2).

Table 2. Cropping practices adopted by farmers.

Characteristics	Categories	Percentage
Cropping system	Sole cropping	42.8
	Watermelon intercropping	57.2
Intercrop system	Watermelon – cassava	43.2
	Watermelon – maize	24.3
	Watermelon – yam	30.1
	Watermelon – okra	2.4
Reasons for intercropping	Improve income	60
	Increase fertility	20
	Prevention against crop failure	15
	Maximum use of land	5
Watermelon variety	Sugarbaby	82.0
	Kaolack	16.0
	F1 Koloss	1.0
	Charlton gray	1.0
Method of seed planting	Direct seedling	97.8
	Transplanting	2.2
Farm size	Below 1 ha	30.3
	1-2 ha	47.2
	5-6 ha	21.0
	Above 6 ha	1.5
Cost structure	Hired labour	50.8
	Self and hired	35.6
	Self	13.6
Number of weeding	1	18.3
	2	75.6
	3	6.1
Weeding methods	Manual	79.8
	Chemical	6.7
	Chemical and manual	13.5

3.3 Costs and returns structure

The estimates of the budgetary analysis for sole and watermelon intercrop are presented in Table 3. The average gross margin generated by sole watermelon farms was N 322, 824.00 per hectare which was lower than N265,

638.00 per hectare recorded on farms that intercropped watermelon with cassava. Also, the net margin was higher by about N57, 186.00 per hectare for farms that intercropped watermelon with cassava. Similar trends (higher income with intercropping) were also observed by Aihonsu (2002) and this may probably be the reason why watermelon-cassava intercrop was popular with the farmers. However, the benefit to cost ratio of sole watermelon (2.33) was higher than that of the intercropping system (2.21). In term of the cost structure, hired labour accounted for almost 90 percent of total variable cost for both sole watermelon and intercrop enterprises, while seed, fertilizer and chemical accounted for the rest. This probably indicates high labour requirement of agricultural practices. Watermelon production is profitable based on the fact that an average farm in the area investigated recorded over 100 percent returns on investment.

Table 3. Average cost and profitability per hectare of watermelon production.

Variables	Sole watermelon farm		Watermelon-cassava farm	
	Amount ₦/ha	% of VC/TVC	Amount ₦/ha	% of VC/TVC
Revenue				
Value of watermelon output	394,000.00	100	220,000	43.2
Value of other crops	-	-	265,108.69	56.8
Total Revenue (TR)	394,000.00	100	485,108.69	100
Variable cost				
Seed	7,000	3.6	16,000.00	6.6
Fertilizer	12,000	6.0	12,000	4.5
Chemicals	2,100.00	0.72	2,100.00	0.54
Hired labour	149,982.00	89.71	191,470.69	88.4
Total variable cost	171,082.00	100	219,470.69	100
Gross margin/ha	222,918.00		265,638.00	
Fixed cost				
Rent on land	2,000		2,000	
Depreciation	1,333		1,333	
Total fixed cost	3,333		3,333	
Total cost (TC)	174,415.00		222,803.69	
Net margin/ha	219,585.00		262,305.00	
B/C ratio	1:2.33		1:2.21	

3.4 Factors that influences output and technical efficiency of watermelon farmers

The result of the estimated production frontier and technical efficiencies were presented in Table 4. The result showed that estimated coefficient of labour input was positive and significant at 1% level. This means that the output will increase as the level of these independent variables increases. This conforms to the findings of Adebayo (2006), Ajibefun and Abdulkadri (2004),

Ajibefun *et al.*, (2002), and Ogundele and Okoruwa (2006). They showed that hired labor contributed positively to farm productivity in the dry savannah and humid forest agro-ecological zones of Nigeria. For technical inefficiency effect, the coefficient of household size variable showed a positive relationship and was not significant. This suggests that increase in household size may increase technical inefficiency in the study area. The coefficient of education showed a negative relationship with the predicted technical inefficiency effect and was significant at 5% level. This implies that increase in years of schooling reduces technical inefficiency or improves efficiency. This agrees with the findings of Adetiba (2005) ; Ajibefun and Abdulkadri (2004) and Kehinde (2005). They confirmed that education was key to enhanced productivity among farming households in the humid forest, dry savannah and moist savannah agro-ecological zones of Nigeria. The positive coefficient of experience which was significant at 10% level indicates that any increase in years of experience increases



inefficiency. This indicates that more experienced farmers tend to be less efficient in watermelon production in the study area. This conforms to the findings of Ajewole and Folayan (2008). They reported similar trend in dry season leaf vegetable production among small holders in Ekiti State, Nigeria. The coefficient of extension visit was also negative though not statistically significant. This implies that farmers that received more extension visit tend to be more efficient. The positive coefficient of age also indicates that older farmers tend to be less efficient in the production of watermelon.

However, Table 5 summarized the TE distribution of the studied farmers. There were variation in the level of efficiency among the farmers ranging from a very low 27.56% to 59.1% with a mean efficiency of 34%. However, 14.4% of farmers had TE of 40% and above.

Table 4. Estimate of the stochastic production function.

Variables	Parameters	Coefficient	t-value
Frontier production function			
Constant	β_0	0.21	4.62**
Ln seed quantity	β_1	-0.52	-3.04
Ln chemical quantity	β_2	-0.01	-1.20
Ln fertilizer quantity	β_3	-0.37	-7.84
Ln farm size	β_4	1.24	7.33
Ln Labour input	β_5	0.10	4.89***
Technical inefficient function			
Constant	σ_0	0.34	8.9**
Age	σ_1	0.12	1.32
Household size	σ_2	0.12	0.08
Farming experience	σ_3	0.21	2.54*
Extension visit	σ_4	-0.22	-0.41
Level of education	σ_5	-0.81	3.21**
Variance parameters			
Sigma square	σ^2	0.98	6.56
Gamma	Γ	0.52	-3.11
Log likelihood	Lif	-0.75	

***, **, * Significant at 1%, 5% and 10%

**significant at 0.01

Table 5. Distribution of technical efficiencies.

Efficiency	No. of farmers	Percentage
20-29.99	27	27.0
30-39.99	55	55.0
40-49.99	13	13.0
50-59.99	5	5.0
Total	100	
Mean	34	
Minimum	27.56	
Maximum	59.1	



3.5 Constraints to watermelon production

Constraints to watermelon production in the study area are shown in Table 6. Inadequate credit ranked first among the constraints. This is closely followed by pest and disease problem. There are also problems of inadequate supply of inputs like fertilizer and seed among other constraints faced in the study areas.

Table-6. Constraints to watermelon production.

Constraints	Percentage
Inadequate credit	79
Pest and disease problem	75.2
Inadequate fertilizer	65.4
Labour shortage	66.9
Inadequate transportation	55.1
Seed procurement	34.5
Marketing problem	37.5
Pilfering	33.0
Inadequate technical know how	24.9

4.0 Conclusions and Recommendations

The study has shown that watermelon production is profitable in the study area. The study further revealed that the production level was significantly influenced by labour input while level of reduction was identified as significantly contributing towards increased farmer’s efficiency. Based on the findings from the study, the following recommendations are made: More research on watermelon should be encouraged especially in the areas of disease and pest control. This will solve the problem of infestation during the growing period; and farmers should organize themselves into groups through which they can get access to production inputs.

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