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Cost-Benefit Analysis of Watermelon Production in Ibarapa North and Ibarapa Central of Oyo State, Nigeria

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Abstract - The study was carried out to investigate the cost-benefit analysis of watermelon production in Ibarapa north and Ibarapa central local government areas of Oyo State. A multistage random sampling technique was adopted in the selection of 140 farmers from the chosen areas. Primary data were used with the aid of well-structured questionnaire to obtain information on socio-economic characteristics and other relevant variables. The data were analysed by descriptive statistics, budgetary, costs and returns analysis and stochastic frontier production function. The mean age of the watermelon farmers were 53years which seems to be a dominance of farmers age that has adverse implication for increasing watermelon production. 83.4% of the farmers were males and 82% were married with little formal education. The budgetary analysis revealed that watermelon production in these areas were profitable. The Gross margin analysis shows that a net profit of #910,214.475 was realized by the watermelon farmers in the study areas. The benefit cost ratio (BCR) of watermelon was 5.743. The findings revealed that majority of the watermelon farmers adopted sole cropping system (71.43%) while just 28.57% intercrop with other crops. Those that adopted intercropping system intercrop with Cassava (62.5%), Maize (15%), Tomato (12.5%) and Pepper (10%). The influence of labour inputs on watermelon leads to a positively and significantly production yield level, the size of the farm and the quantity of fertilizer used were found significant (1%) which had a positive sign to increase the output of watermelon.
Keywords: cost-benefit analysis, multistage, net profit, output, watermelon

1. Introduction

Watermelon (*Citrullus lanatus*) is grown in more than 96 countries worldwide. Watermelon is a tender, warm season vegetable belonging to the family Cucurbitaceae and is one of the most widely cultivated crops in the world at large. According to FAO (2011) statistics, China is the world's leading producer of watermelon. The top twenty leading producers of watermelon produced a collective volume of approximately 92.7 million metric tonnes in 2011, of which China produced 75%. Turkey, Iran and Brazil commanded a production share (of the 20 leading producers) of 4.7%, 3.5% and 2.4% respectively in 2011. Nigeria produced more watermelons in 2011 (139,223 tons) than the leading fresh produce African exporter, Kenya, which produced 66,196 tons and South Africa that produced 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 (Zohary and Hopf, 2000). The global consumption of the crop is greater than that of any other cucurbit. The estimated total production of watermelon in Nigeria in 2003 was 175.34 metric tons (Project Coordinating Unit and Federal Ministry of Agriculture Crop Production Data, PCU/FMARD, 2004).

In Nigeria, watermelon production has increased significantly in the last one decade with the major production areas being in the Sahel, Sudan and Guinea agro-ecological zones. In recent times, its cultivation has extended down to the forest belts of southwestern Nigeria. However, the northern fringes of the Sudan and Sahel savanna ecological zones and the shores of the Lake Chad remain the major production areas (NIHORT, 2000). It is enjoyed by many people across the world as fresh fruit and is mainly cultivated in the tropical countries. Watermelon is good for all human consumption and livestock needs as it contains most of the basic daily nutritional requirements of the body and other essential nutrients that prevents human health problems. It is thirst-quenching and contains vitamins C and A in the form of disease-fighting beta-carotene. Watermelon is rich in carotenoids, some of the carotenoids of which include lycopene, phytofluene, phytoene, beta-carotene, lutein and neurosporene. Lycopene and beta-carotene work in conjunction with other plant chemicals not found in vitamin/mineral supplements. Potassium is also available in it which is believed to help in the control of blood pressure and possibly prevention of stroke (De Lannoy, 2001). Lycopene is what gives watermelon its rich, red colour and is associated with reduced risk of developing muscular degeneration, prostate challenges, and a variety of other degenerative conditions. Beta carotene is another powerful antioxidant that can help to

protect body cells against damage by free radicals (Kim, 2008). Watermelon seeds are excellent sources of protein (both essential and non-essential amino acids) and oil. The largest production of the crop comes from the northern part of Nigeria where suitable agro-ecology is found. The potentials of watermelon as a cash producing crop are enormous for farmers, especially those residing near the urban areas (Adekunle *et al*., 2007).

2. Methodology

2.1 The Study Area

This study was carried out in Oyo State which lies within the tropical zone in the rain forest region of south western part of Nigeria. Ibarapa North and Ibarapa Central Local Government areas of Oyo State were purposively selected for the study. This location enjoys the wet and dry seasons, average annual rainfall is estimated at 1,278mm, while sunshine hours ranges from 2.4 hours in August to 7 hours in February, average temperature of 27^0C. Based on the prevailing climatic and soil characteristics, three vegetation zones are identified in the areas, these are Forest, Savanna and Derived savanna. The forest zone with high relative humidity favours the cultivation of tree crops such as cocoa, kolanut, citrus, oil palm, arable crops (like yam, cassava, maize and rice) as well as fruit crops (like cashew, mango, grape, guava and watermelon). The derived savanna has a mixture of forest and savanna vegetations. The population Figure of Ibarapa North and Ibarapa Central are 306,795 and 102,979 respectively (NPC, 2006).

2.2 Sampling technique

Multistage sampling techniques were used in selecting the respondents. Based on apriori information, the two local Government areas with highest density of watermelon farmers were selected using purposive sampling technique. The second stage was the random selection of 70 producers from each local government area making a total number of 140 watermelon farmers.

2.3 Analytical techniques

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, the socioeconomic characteristics of the farmers (like age, education, farming experience, household size, credit availability, gender, cost, revenue in watermelon production and marital status) were included in data collection. All data on resource use, production cost and outputs were converted to per hectare equivalent. The Gross Margin analysis which is the difference between total revenue and total variable costs was used to determine the costs and returns to watermelon production in the study areas. While the Cobb Douglas function was used in input factor analysis in watermelon production. The choice of Cobb Douglas was based on its widely acknowledged fitness to agricultural production (Barman and Chaudhury 2000; Barman et al., 2002; Onyenweaku and Nwaru, 2005, Ogbonna et al 2009).

2.4 Gross Margin Analysis

The costs and returns of watermelon production was estimated using the gross margin analysis as follows;

GM = TR-TVC

Where GM = Gross margin in naira/ha

TR = Total revenue in naira/ ha (i.e. Unit Price X Quantity)

TVC = Total variable cost in Naira/ha

2.5 Cobb Douglas function

The Cobb Douglas function used in the factor analysis of watermelon production in the study areas were specified in the logarithmic form as:

$InY_i = \ln \beta_o + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \varepsilon_i$

Where Y = Gross return, measured in N/ ha

X_1 = Cost of planting material, measured in N/ha

X_2 = Cost of fertilizer (NPK 15:15:15), measured in N /ha

X_3 = Cost of agrochemicals, measured in N/ha

X_4 = Cost of labour, measured in N/ha

β = Constant

ε_i = Error terms

3. Results and Discussion

3.1 Socio-economics characteristics of respondents

The result of the analysis (Table-1) below showed that most of the respondents were male (84.3%) while only 15.7% were female. This indicated dominance of male farmers which has adverse implication for increasing watermelon productivity. 74.3 % of the respondents were less than 60 years old revealing the presence of old, young and little middle-aged individuals who are known to be innovative and active to new ideas. Majority of the farmers (82.14%) were married, (15.71%) were widowed and (2.14%) were single. This indicated that married farmers are stable in farming. About (35.7%) had technical/vocational education, (25.7%) attended Secondary school, (22.9%) attended primary school and (15.7%) had tertiary education. This revealed that farmers had educational knowledge and skills with little formal education. 40.7% of the respondents indicated that farmers had been in the practice of watermelon production between 1-10 years, 25.7% of them had grown watermelon between 11-20 years, 16.4% had grown watermelon between 21-30 years, 15.7% had grown watermelon between 31-40 years and 1.4% had grown watermelon above 40 years. The mean years of watermelon production experience was 6 years. This revealed that watermelon production is a newly introduced profession of the people in the study areas. The mean household size was 10. This indicated that the household size of respondents was relatively large. Credit facilities were enjoyed since all the respondents were active members of cooperative society. This is due to the presence of micro financial institution in the study areas. 62.1 % of the respondents indicated that the farm size is between 1.0-4.0 hectare, 21.4% of the farm size is between 4.1-8.0 hectare and 16.4% of the farm size is above 8.0 hectare. This revealed that watermelon production is a newly introduced profession of the people in the study areas.

Table 1: Socio-economics characteristics of watermelon farmers

Variables	Frequency	Percentage
Age		
21-30	2	1.4
31-40	19	13.6
41-50	37	26.4
51-60	46	32.9
61-70	30	21.4
Above 70	6	4.3
Gender		
Male	118	84.3
Female	22	15.7
Marital Status		
Single	3	2.14
Married	115	82.14
Widowed	22	15.71
Education		
Primary	32	22.9
Secondary	36	25.7
Technical/Vocational	50	35.7
Tertiary	22	15.7
Family size		
1-10	65	46.43
11-20	55	39.29
21-30	17	12.14
Above 30	3	2.14
Faming experience		
1-10	57	40.7
11-20	36	25.7
21-30	23	16.4
31-40	22	15.7
41-50	2	1.4
Membership of cooperative		
Yes	140	100
No	Nil	Nil
Farm size		
1.0-4.0	87	62.1
4.1-8.0	30	21.4
8.1-12.0	8	5.7
12.1-16.0	7	5.0
Above 16.0	8	5.7

3.2 Maximum Likelihood Estimates of the Parameters for the Stochastic analysis

1. The results of Maximum Likelihood Estimates (MLE) for the production frontier are presented in the table 2 below. The estimated parameter of sigma-squared (σ^2) of watermelon was 0.002989 (significant at 5%). The value is large and significantly different from zero. This indicated a good fit of the model and the correctness of the specified distributional assumptions of the composite error term. Also, the estimated gamma (γ) parameter of watermelon farmers is 0.9999 and is highly significant at 5% level of significance. This means that the variations in the watermelon output of the farmers in the study area are due to the differences in their technical efficiencies. This result is consistent with the findings of Yao and Liu, (1998); Seyoum *et. al*., (1998); Ajibefun *et. al.*, (2002); Ajibefun and Aderinola, (2004). Among the watermelon farmers, the coefficients of the variables that were significant includes farm size (at 1%) and fertilizer (at 1%) while the other variable labour quantity was not significant at all known levels of significance. By implication, the above findings revealed that the major productive inputs that greatly impact on the watermelon output in the study areas were the quantity of fertilizer used on the watermelon farms as well as the size of the farms. Farm size had the highest coefficient, with a value of 0.5849 and by implication farm size exists as the most important inputs that have impact on watermelon output of the farmers in the study areas. Both farm size and fertilizer quantity had positive signs while labour quantity had a negative sign. The economic implication of the signs is that any increase in the quantity of fertilizer as well as in the size of the farm land will lead to an increase in the output of watermelon, while an increase in the quantity of labour will lead to a decline in the output of watermelon in the study areas. Negative coefficient on a variable might indicate an excessive utilization of such a variable. In economic terms, any attempt to increase the quantity of fertilizer as well as size of the farm for watermelon production will be tantamount to raising the level of the watermelon farmers in the study areas. Also, to allow for the proposition of a better watermelon output status, the farmers must engage the size of farm lands that they can actively supervised into watermelon production, control cost incurred on labour and chemical inputs.

Table 2: Maximum Likelihood Estimates of the Parameters for the Stochastic analysis

Variable	Coefficients	Standard error	t-value
Production Function Model			
Constant (β_0)	0.03369	0.0008097	41.61***
Farm size (β_1)	0.5849	0.0005658	1033.76***
Fertilizer (β_2)	0.3042	0.0006203	490.41***
Labour (β_3)	-0.0000334	0.0002544	-0.13
Inefficiency Model			
Constant (δ_0)	0.6652	0.4336	1.52
Age (δ_1)	0.005083	0.001536	3.31***
Family size (δ_2)	0.001859	0.002442	0.76
Farming experience (δ_3)	0.004030	0.001270	3.17***
Extension contact (δ_4)	-1.07772	0.42817	-2.52***
Education (δ_5)	0.0002936	0.004845	0.06
Variance of Parameters			
Sigma squared (σ^2)	0.002989	0.0000802	37.27
Gama (γ)	0.9999	0.00000314	318439.49
Log Likelihood Function	380.242		
X_c^2	4.95e+07		
$X^2_{(0.05, 3)}$	7.815		

*** = Significant at 1%

Table 3: Costs and Returns per Hectare of the Respondents

ITEMS	COSTS (₦)
Watermelon yield (Number of Pickup loads of Balls/ha)	14.695
Price/Pickup load	75,000
Total Revenue/ha	1,102,125
Variable Cost of Material and Labour Inputs	
Cost of watermelon seeds(bundle/ha)	5,000
Cost of fertilizer and Chemical inputs/ha	96,560.525
Total Cost incurred on all labour works /ha	30,233.025
Total transportation cost/ha	27,063.40
Land rent/ha	19,303.575
Total Variable Cost/ha	178,160.525
Fixed Cost	
Tool Cost	13,750
Total Cost	191,910.525
Gross Margin (TR – TVC)/ha	923,964.475
Net profit (TR– TC)/ha	910,214.475
Benefit-Cost Ratio	5.743

The Table 3 above shows the cost and return analysis of watermelon production in the study areas. The watermelon producers in the study areas has a net profit of #910,214.475. This clearly shows that there is a high return rate on the watermelon production in the study areas. It also shows that watermelon production is labour intensive as typical of agricultural production and this conforms to the findings of Adeoye *et al.,* (2011). The cost structure also suggests that watermelon production is profitable.

3.3 Cropping System Utilized by Watermelon Farmers

Table 4 below shows the cropping system adopted by watermelon farmers. Item 1 shows that 71.43% of the respondents' plant solely watermelon as against 28.57% of the respondents intercropped. Item 2 reveals that 62.5% of the 40 respondents intercropped watermelon with cassava, 15% and 12.5% intercropped with maize and tomato respectively, while the remaining 10% intercropped with pepper. 96.43% of the watermelon farmers in the study areas sow their seeds directly and only 3.57% transplant seedling of watermelons in item 3. In item 4, (14.29%) of the farmers inherited the land they cultivate as this show that the primitive land acquisition system has great effect on the scale of farming is common in the study areas. 17.85% of the farmers paid more than #20,000 for rent per annum, 3.57% of them paid less than #5,000 and 14.29% of them paid between #5,100-10,000 for the land and 50% of them paid between #11,000 20,000 for the land rent.

Table 4: Cropping System Utilized by Watermelon Farmers

S/N	Items	Options	Frequency	%
1	What cropping system do you use?	Sole cropping (watermelon lone)	100	71.43
		Watermelon intercrop	40	28.57
2	What do you intercrop with watermelon?	Watermelon + cassava	25	62.5
		Watermelon + maize	6	15
		Watermelon + tomato	5	12.5
		Watermelon + pepper	4	10
3	Watermelon planting method do you employ in planting?	Direct seedling	135	96.43
		Transplanting	5	3.57
4	How much do you pay as rent on land?	Inherited land	20	14.29
		Less than 5,000	5	3.57
		Between 5,100-10,000	20	14.29
		Between 11,000-20,000	70	50
		Above 20,000	25	17.85

4. Conclusion and Recommendations

This study has shown that watermelon production in the study areas were profitable and it revealed that cost of planting, cost of fertilizer and cost of agrochemicals all have positive productivity coefficients indicating that any increase in the use of these variable inputs will increase the gross revenue of the farmers. Finally, effective extension services and enabling environment is recommended to be created to promote transfer and adoption of improved technologies among watermelon farmers to prevent wastage and government contributions should increase by providing incentives to the farmers in the study areas.

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