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ASSESSMENT OF TECHNICAL EFFICIENCY OF WATERMELON PRODUCTION IN FEDERAL CAPITAL TERRITORY, NIGERIA

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Abstract
This study assessed the technical efficiency of watermelon by examining the structure of costs and returns on watermelon production, estimating technical efficiency of water melon farms, analysing the determinants of technical efficiency, and identifying constraints limiting water melon production in the Federal Capital Territory of Nigeria. A four-stage sampling procedure was used to collect primary data from the study area. Data were analysed using descriptive statistics, farm budget analysis; Maximum Likelihood (MLE) of Cobb-Douglas based stochastic frontier production function, Ordinary Least Square (OLS) regression and Likert-type Scale analysis. Farm budget analysis of costs and returns analysis results indicated that on-season water melon production net farm income (NFI) of ₦50, 274.93 per hectare while the value for NFI for off-season water melon production is ₦166,678.57 per hectare. From the Cobb-Douglas based stochastic frontier production function estimates, seed and fertilizer were positively significant (P< 0.01), agrochemical was positively significant (P< 0.05), labour was negatively significant (P< 0.01) while farm size was negatively insignificant. The mean level of technical efficiency for water melon farm estimated was 89.1% and inefficiency level was 10.9%. The study therefore concludes that water melon production is profitable in both seasons of production. It was recommended that the existing associations and cooperatives should be used to enhance delivery of agricultural extension services, train farmers, as well help in mobilizing rural and peri-urban resources for agriculture.

Keywords: Water melon, Nigeria, Efficiency, Cobb-Douglas, Maximum Likelihood.

Introduction

The potentials of water melon as a cash producing crop is enormous for farmers especially those residing near the urban areas. The reason for the high demand is partly due to the prevalent diet-related health problems that have become common in developed countries due to over-consumption of meat and fat which are being seen in urban populations in developing countries as well as among the rural poor. Generally, most fruits and vegetables in Nigeria are produced not only to ensure nutritive food demands but also to meet the industrial and commercial needs. To attain self-reliant in food production and supply, the need to promote the production of common and exotic vegetables and fruits such as water melon deserves an attention.

Water melon is consumed in many parts of the country mostly in the urban areas. In spite of its nutritional, industrial and commercial values, the production is low even with its high market price especially during the off-season (Agbo *et al*., 2013). Water melon is a crop that is tolerant to wide range of environmental conditions and it can be planted more than once in a year. Its production requires less input such as pesticide, when compared to most other fruit crops. Water melon is supposed to be one of the fruit crops to be produced on a commercial scale for industrial use. The juice from this tasty fruit can be used for a nutrition drink as well as wine production, while the seed can be useful in pharmaceutical industries as raw material (Bob, 2010). The leftover can be utilized by feed industry. This will not only boosts agribusiness investment but also opens the industrial sector to reduce the prevalent unemployment issue. Water melon consumption is also good for preventing cardio -vascular diseases, cancer, slowing of ageing process and lessening the chance of developing cataracts in the eyes (Wehner & Maynard, 2003).

However, the production of fruits and vegetables has been observed to be low in most developing countries in spite of availability of the factors necessary for their production. Nigeria is known to be blessed with abundant resources for the production of various fruits as such water melon is produced twice annually. The dry season production is possible due to irrigation technology and available wetlands distribution within the country. In spite of these,

few water melon farmers produce in the two seasons and the scale of efficiency in the use of resources is low as Rahman, (2013) reported the non-existence of efficient farm in Nigeria. However, water melon can be grown virtually everywhere in the tropics, subtropics and temperate region where rain and irrigation is adequate (Messiaen, 1992). The identified hidden potential in this fruit crop has been outlined to include favourable production variables, high demand with low supply, high prices mostly in off-season, as well as the comparative and competitive advantages its possess necessitating the need to understudy its production. It is on this premise that information on water melons farms in terms of productivity, efficiency, profitability and constraints to production becomes necessary (Tindal, 1983).

Hence, given the enormous of water melon, it is therefore imperative to examine the extent resources are used in the production and determine whether opportunities exist for improvement. This is because increase output is directly related to production efficiency/ inefficiency given the state of technology; and when farms are efficient in the use of resources, it will simultaneously increase the net returns and be profitable. More so, there are many farm-level studies on efficiency in Nigeria, and no specific investigation into farm level technical efficiency involving sole water melon production has been carried out in the study area. Thus there exists an information gap in the literature. To bridge this gap, this study examines the current level of technical efficiency of water melon farms and the determinants in Federal Capital Territory. Hence, the problem in focus centers on the technical efficiency which assess how resources are used in water melon farms. It also borders on how the various factors that explain efficiency can be examined so as to improve water melon production in the study area. The specific objectives include to: determine the structure of costs and returns to water melon production; estimate the technical efficiency of water melon farms; identify the determinants of technical efficiency of water melon farms and identify constraints limiting water melon production in the study area.

Methodology

The Study Area

The study was conducted in the Federal Capital Territory (FCT), Nigeria. It is located in the North Central region of the country. The territory is demarcated into six Area Councils, namely Abuja Municipal, Bwari, Kuje, Abaji, Kwali and Gwagwalada Area councils. It covers an area of about 235,300 km^2 and has a population of about 1.405 million (NPC, 2006). The territory lies between latitudes 8^0E and 9^0E and longitudes 10^0N and 11^0N of the prime meridian, and bordered by Niger, Nassarawa, Kogi, and Kaduna states FCT-ADP (2006). The minimum average temperature ranges between7.7^0C to 35.9^0C. The amount of rainfall ranges between 6.9mm to 9.1mm during dry season, which lasts from November to April; 19.3mm to 485.8mm in the rainy season which last from May to October. The climate is an intermediate between the extreme of dryness, coolness and hotness in the far Northern states and middle belt wetness, warmness and humid weather FCT-ADP (2006).The vegetation varies mainly from guinea savanna to derived savanna merging into thin bush in the adjourned river bounds. Fadama belt is barely scattered all over the territory around rivers and streams estimated as 758 ha (FCT-ADP, 2006). The agricultural land is put at 21,654ha while savanna and grazing land has 2538ha (FCT-ADP, 2006). With this area of land, the indigenes and few tenants mostly in the rural and peri-urban areas consider agriculture as source of livelihood and practice it as a profitable venture. The main crops produce include: yam, cassava, cowpea, groundnut, guinea corn, maize, sorghum, melon, beniseed, okro, pepper, garden egg, water melon, some leafy vegetables. Livestock reared are poultry, goat, sheep, and cattle with fish farming in a wide scale (FCT ADP, 2006).

Sampling Procedure and Sample Size

A four-stage sampling procedure was employed with regard to the three Agricultural zones adopted by FCT-ADP. In the first stage, all the ADP zones were considered on the basis that they are the zones where the water melon is cultivated. The second stage involved all the six Area Councils in the territory comprising of Abuja Municipal, Kuje, Gwagwalada, Abaji, Kwali and Bwari which are known for horticultural crop production and farming activities. The third stage was the random selection of three communities from each of the Area Councils. In the final stage, nine water melon farmers were randomly selected from

each selected communities using water melon farmers' association lists, as a sample frame, to form a sample size of 162 farmers. However, 150 farmers were used for the study.

Source and Method of Data Collection

This study used primary and secondary data respectively. The primary data were gathered using both instruments of questionnaire and interview. The study questionnaire was first pre-tested for reliability and validity. Data collected in the study area were from sole water melon farms. Interview using the questionnaire was conducted by the researcher, trained enumerators and staff of FCT Agricultural Development Project (FCT-ADP) and Agricultural Departments of the six Area councils. The use of these staff already working minimized the likely language problem and resistance by farmers which frequently characterized this kind of exercise. Secondary data was obtained from Agricultural Departments of Area Councils, FCT-ADP, Nigeria Bureau of Statistics (NBS), CBN, FAO, Department of Agriculture in FCT Administration, internet and other publications that supplement the primary data.

Analytical Techniques

The analytical tools used include descriptive statistics such as measures of central tendencies and dispersion (mean, medium, mode, range, and standard deviation), percentages, frequency and tabulation to describe socio-economic and demographic characteristics of the respondents. Farm budget analysis (Gross Margin and Net Revenue Analyses) was used to determine the costs and returns to water melon production. Multiple regression analysis involving the estimation of Stochastic Frontier Production Function was used in estimating technical efficiency of water melon production. Ordinary Least Square (OLS) regression analysis was used in identifying the determinants or factors that contribute to the observed technical efficiency while Likert type-scale was used in describing the constraints involved in water melon production.

Farm Budget Analysis

To determine the costs and returns to water melon production for each respondent, a partial budget analysis (Gross Margin) was used. The equations used in estimating the various parameters include:

$NFI = GM - TVC$ ---------- (1)

Alternatively, $NFI = TR - TC$ ---------- (2)

$GM = TR - TVC$ ---------- (3)

$TC = TFC + TVC$ ---------- (4)

$TR = P \times Q$ ---------- (5)

Where: NFI = Net Farm Income (₦/ha), GM = Gross Margin (₦/ha), TR = Total Revenue (₦/ha) = P*Q, TVC = Total Variable Cost (₦/ha), TFC = Total Fixed Cost- (₦/ha), P = Price of water melon (₦/Kg), Q = Physical output of water melon (tonne/ha)

Estimation of Cobb-Douglas based Stochastic Frontier Function

This tool of analysis was used in estimating the technical efficiency of water melon production. Following Battese and Coelli (1993), the model is specified in an implicit form as follows:

$Y_i = f(X_i, \beta) + (V_i - U_i)$ ----------(6)

Cobb-Douglas was used as the form of production function to determine the extent to which the inputs used explained the variability of output. The reason for the choice of this production function is because of it is attributes, (Jeffrey and Xu, 1998). The explicit form of the Cobb-Douglas function is expressed as:

$LnY_i = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + V_i - U_i$ ---------- (7)

Where:Ln = Natural logarithm notation, Y_i = Water melon output of the i^{th} farm (tonne/ha), X_1 = Land measured as total farm area (ha) used in production, X_2 = Labour (hired and household) in man days, X_3 = Quantity of water melon seed planted in kg, X_4 = Quantity of agro- chemicals (herbicides & pesticides) used in litres, X_5 = Quantity of fertilizer in kg, V_i = Random variable outside the control of the farm and reflecting noise and shocks, U_i = Deviations from maximum potential output attributed to technical inefficiency, β_0 = intercept and β_1 to β_5 = Production function parameters to be estimated

OLS Estimation of the Determinants of Technical Efficiency of Water melon Farms

This was used in identifying the determinants of or factors that contribute to the observed technical efficiency. The OLS procedures were employed in the second step of estimation. In this stage, the Transformed TE index (TTEI) was regressed against the explanatory variables hypothesizes as

contributing factor to the farms' technical efficiency, following Rahji, (2005), Tsoho, (2008) and Fakayode, (2009).Transform Technical Efficiency Index is a value obtained when the natural logarithm of the ratio of technical efficiency to technical inefficiency is computed for each of the respondents and summed. Thus, the value of the TTEI was computed for individual farm as specified as:

$$TTEI = \ln\{\frac{TE}{1-TE}\} \quad (8)$$

Reason for adopting this procedure is due to its advantage of making it possible for the technical efficiency ratio to assume any value instead of zero and one (Admassie, 1999). More so, the adaptation makes uses of all available information on both technical efficiency and inefficiency, which is deemed to be an improvement over using only one of them as is commonly done, Tsoho (2008), Fakayode, (2009).

With the transformation, the dependent variable (TTEI) regressed against hypothesized determinants is explicitly expressed as:

$$TTEI = b_0 + b_1Z_1 + b_2Z_2 + b_3Z_3 + b_4Z_4 + b_5Z_5 + b_6Z_{6+} E_i \quad (9)$$

Where:TTEI = Transformed value of technical efficiency index, Z_1 = Farm Size (ha), Z_2 = Level of education (years of schooling), Z_3 = Household size (number of persons), Z_4 = Membership of Association / Cooperative (Member = 1, Non-member = 0), Z_5 = Gender (male = 1, female = 0), Z_6= Water melon Farming Experience (years), $b_0$to b_6 = coefficient to be estimated

The data gathered on these factors were fitted to different regression models (Cobb–Douglas, semi-log, quadratic and the exponential models) and analysed. The model that gave the best fit was selected as the best estimated equation based on statistical and econometric criteria. These criteria include the magnitude of calculated R^2, number of independent variables that were statistically significant, and the number of independent variable's coefficient signs that conform to a priori expectations.

Likert-Type Scale Analysis

A Likert-type scale was employed to assess the level of severity of the different constraints facing water melon production. Clason and Dormody (1994) identified the Likert-type scale as comprising single unrelated and independent questions whose responses cannot be combined into a composite scale as in the case of the Likert scale.Water melon farmers were guided to rate the provided opinions on a 3-point numerical rating of: High constraint (HC) = 3, Moderate constraint (MC) = 2, and Low constraint (LC) =1. Their responses were calculated for percentage score, mean score and then ranked. The values of the mean score were used to rank the constraints facing water melon production in descending order and this defined the severity of the constraint.

Results and Discussion

This section presents and discusses the results obtained from the estimated models specified in the methodology. The presentation is in four parts. The first parts deals with the socio-economic and demographic characteristics of the respondents as well as the production resources of water melon farms. The second covers the MLE of the stochastic production function. The third is on the analysis of the determinants of technical efficiency indices, while the fourth deals with the constraints to water melon production in the study area.

Analysis on the Socio-economic/ Demographic characteristics and Production Resources

Table 1 shows the socio-economic and demographic characteristics of water melon. Age according to Adewumi and Omotesho (2002) affects labour productivity and output. It could affects adoption of innovation in traditional settings even interest in a particular agribusiness. The mean age of the respondents was 41. 61 years, this is in the modal age of 41-50 years and constitutes 37.33% of the respondents. This showed that most of the young adults were not involved actively in water melon farming. This could be as a result of quest for a "clean" job which is the bane for youth involvement in agriculture in Nigeria. The mean household size was 7. 23 and this falls in the range of 6 – 10 which is 29.66% of the respondents. The findings on sole water melon farmers' household's sizes implies that farmers could draw some level of family labour from their households considering the mean households sizes. This implies a likely reduction in the cost of hired labour. Education is known to facilitate farmer's understanding and use of improved crop production practices. Only 4% of the respondents have no formal education while 96% have one form of education or the other. This implies that most of the farmers had one form of education or the other and are educated in which adoption of innovation and technology are ready to improve

in production practices. This may accounts for the fair level of innovation and technology adoption by the farmers who have wholly shifted to the use of herbicide to control weeds on their farms. On the respondents' membership on co-operative, the percentage of those that are into Co- operative so as to make money is 78.67%. This implies that their membership will facilitate the water melon farming business.

Table 1: Socio-economic and Demographic Characteristics of Water melon Farmers

Characteristics	Frequency	Percentage %
Sex		
Female	12	8
Male	138	92
Total	**150**	**100.00**
Age		
21 – 30	26	17.33
31 – 40	40	26.66
41 – 50	56	37.33
51 – 60	18	12.00
61 – 70	10	6.66
>71	0	0.0
Total	**150**	**100.00**
Mean Age	*41.61*	
Standard deviation of Age	*11.76*	
Household size		
≤ 5.00	66	44.00
6.00 - 10.00	44	29.33
11.00 - 15.00	24	16.00
16.00 - 20.00	11	7.33
≥ 21.00	5	3.33
Total	**150**	**100.00**
Mean Household size	*7.23*	
Standard deviation of Household size	*5.31*	
Educational Status		
No formal education	6	4.00
Primary education	76	50.67
Secondary education	40	26.67
Quaranic education	14	9.33
Tertiary education	7	4.67
Adult education	7	4.67
Total	**150**	**100.00**
Primary source of income		
Trading	20	13.33
Farming	130	86.67
Total	**150**	**100.00**
Cooperative society		
To subsist	32	21.33
To make money	118	78.67
Total	**150**	**100.00**

Source: Field Data, (2015)

Analysis on Production Resources Used on Water melon farms

The analysis on the use of production resources is shown in Table 2. The results shows the different ways by which the water melon farmers acquired their lands. It shows that the majority of the farmers which represents 39.33% obtained their farmlands as

an inherited family possession. The mean farm sizes for the water melon farmers was 4.5 hectare. This implies that the farm units were generally small sized. Water melon farming in the study area is therefore on small scale basis. This finding agrees with Okunlola and Adekunle, (2000) studies that majority of the Nigerian farmers are small scaled.

Some farmers use family labour on their farms. The family labour used was sourced from adults and children in the farmers' households. None of the water melon farmers employ communal labour form of non-family labour to operate their farm. The reason is that it may not help them as the crop requires caution and care to avoid mistakes but prefers the labour they know and their experiences counts, more so they prefer to pay and sometime even give them lunch to maintain and encourage them. Capital is one of the important resources needed in any production activity. It is required to finance the production purchases of inputs, payment of labour and to acquire other capital assets. The results indicates that 64.7% of the respondents sourced their capital from personal saving and none of the respondents obtained any form of credit from any formal source such as banks and other financial institutions. This implies that farming through such personal savings may lead to low investment, yield and returns.

Table 2: Production Resources Used in Water melon farms

Resources	**Frequency**	**Percentage**
Mode of Land Acquisition		
Inheritance	59	39.33
Purchase	16	10.67
Rented	38	25.33
Community land	4	2.67
Borrowed	11	7.33
Both rent and inheritance	22	14.67
Total	150	100
Water melon Farming Experience (Yr)		
≤ 10	98	63.33
11 – 20	42	28
≥ 21	10	6.67
Total	150	100
Farm Size (Ha)		
≤ 5	101	67.3
5.01 - 10.00	46	30.67
≥ 10.01	3	2
Total	150	100
Type of Non-family Labour Employed		
Hired labour	150	100
Communal labour	0	0
Total	150	100
Source of Capital		
Personal savings	97	64.7
Friends/relations	24	16
Cooperative	0	0
Personal savings & Friends/relations	29	19.3
Total	150	100

Source: *Field Data (2015)*

Analysis on Family and Hired Labour

From Table 3, the total family labour used per hectare was 26.68 man-days representing 23.80% while hired labour was 83.0762 representing 76.19 %. A total of 109.03 man-days was used to cultivate one hectare of water melon farm. This implies that higher labour is mostly used than family labour. A look at the operations it clear that family labour is not used in operations like herbicides, fertilizers and pesticides applications. This is not unconnected with the sensitiveness of the operation which requires skills and caution. However, agro-chemical application is now a service delivery business where most youths specialize and operate as a means of livelihood. This goes hand in hand with fumigation services.

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Table 3: Distribution of family and hired labour input by operation/ha

Operation	Family	Hired	Total Man-days	Percentage
Land preparation	4.36	2.43	6.79	6.23
Herbicides Application	0.00	1.34	1.34	1.22
Planting	2.56	3.44	6.00	5.50
Weeding	12.36	56.37	68.73	63.04
Fertilizer Application	0.00	4.45	4.45	4.09
Pesticides Application	0.00	1.34	1.34	1.22
Harvesting/Loading	3.45	7.35	10.08	9.25
Others	3.95	6.35	10.30	9.41
Total	26.68	83.07	109.03	
% of Total	**23.80**	**76.19**	**100**	**100**

Source: Field Data (2015)

Costs and Returns

In any production process, cost is incurred and income is earned from the sales of output. In the African context, either of these could be cash or non-cash. From the result on Table 4, the on-season Gross return from water melon production was ₦203,793.63 while the total variable cost (TVC) amounted to ₦117,285.17. This indicates that water melon production is profitable in the study area during the on-season with a Gross margin of ₦86,508.46 per hectare. However, higher Gross margin was recorded during the Off-season as there was an increase in price of water melon by 57.37%. This mean that the price of input remains stable while there was an upward change in the price of output. Off-season Gross revenue amounts to ₦320,197.27 and Gross margin of ₦202,912.10. The Net Farm Income was ₦50,274.93 and ₦ 166, 6728.57 for On- and Off-seasons respectively. The Off-season NFI value obtained is lower than ₦229,585:06 recorded in Oyo State by Adeoye *et al* (2011) but higher than ₦105,002:95 recorded by Ibrahim (2000) in Borno State.

Table 4: Summary of Costs and Returns Structure of Water melon Production (₦ /Ha)

Items	On-Season	Off-Season
	₦	₦
Gross Revenue	**203,793.63**	**320,197.27**
Less Total Variable Cost (TVC):		
Seeds	1,125.00	1,125.00
Fertilizer	4,477.08	4,477.08
Herbicides	3,136.14	3,136.14
Pesticides	3,267.71	3,267.71
Hired labour	99,695.91	99,695.91
Transportation	5,583.33	5,583.33
Gross Margin (GM)	**86,508.46**	**202,912.10**
Less Total Fixed Cost (TFC):		
Interest on Capital	31,413.59	31,413.59
Rental value of land	3,099.48	3,099.48
Depreciation (Knapsack sprayer, wheel barrow, etc.)	1,720.46	1,720.46
Net Farm Income	**50,274.93**	**166,678.57**

Source: Analysis of Field Survey Data, (2015)

Maximum Likelihood Estimates (MLE) for Water melon Farms

Table 5 depicts the Maximum Likelihood Estimates (MLE) of the Cobb-Douglas based stochastic production frontier functions for water melon farms. The results of the estimates model revealed that, all the coefficients of the physical variables conforms to a priori expectation of positive signs except farm size and labour. The labour coefficient (-2.42) with a negative sign significant at 1% indicates an inverse relationship of labour use and output. This implies that an increase in labour by one unit will decrease output by the corresponding coefficient value. This reduces the technical efficiency level of the water melon farms in the study area. This negative sign puts forward a situation of improper usage of human resources aspects of production by farmers. The study carried out by Agbo *et al* (2013)

buttressed the importance of labour in farming, particularly in developing countries where mechanization is only common in big commercial farms. In this study, farming is mainly on a small scale which involves the use of traditional farming implement such as hoe and matchet.

The positive sign of seed, agrochemicals and fertilizer implies that as such variables are increased, water melon output increases. These coefficients denote the possible positive change in output of water melon as a result of a unit change in these inputs. For coefficient estimate of seed (1.01), it implies that increasing seed by 1 per cent will increase water melon output by about 1.01 percent. The quantity of seed determines to a large extent, the output obtained. If correct seed rates, and quality seeds are not used, output will be low even if other inputs are in abundance. This is consistent with the findings of Shehu, Iyortyer, Shelia and Jorgur, (2010) among Benue Farmers where yam seed rate had a significant positive relationship with yam output.

The coefficient estimate of 0.08 for agrochemicals was positive and statistically significant at five percent level of probability. This implies that 1% increase in the use of agrochemical will increase output of water melon by 7.62%. The coefficient estimate of fertilizer was 2.97 and positively significant at 1%. This implies that a 1% increase in fertilizer will increase output by 2.97%. Fertilizer is a major land augmenting input because it improves the quality of land and the productivity. This study is in agreement with the works of Addiscot, Witmore and Poulson (1991) as they reported that increasing fertilizer, increases output among cereal crop farmers. The variance parameters of the production function represented by Sigma-square (σ^2)and Gammer (γ) are all significant at one percent. The sigma square (σ^2) value of 0.03 which is positive and significantly different from zero indicated a good fit and the correctness of the distributional assumption specified. The variance ratio - gamma (γ) which measures the effect of technical efficiency and , or inefficiency on the observed various output of the farms gave a value of 0.87, which is close to 1, this is in line with the findings of Omotesho, Muhammad-Lawal and Falola (2010).This implies that about 87.16% variation in the output of water melon in the farms was due to differences in their technical efficiencies or technical inefficiencies while the remaining 12.84% can be attributed to random errors. The generalized likelihood ratio is significant at 0.01 level implying the presence of one sided error component, ($-U_i$). This therefore means that technical inefficiency is significant and a classical regression model of conventional production function, based on the OLS estimation technique would not adequately represent the production data.

Table 5: MLE of Cobb-Douglas Based Stochastic Frontier Function for Water melon farms

Production Factors	Parameters	Coefficients	Standard Error	t-ratio
Constant	X_0	-1.91	1. 01	-1.90
Farm Size in hectares	X_1	-0.75	0. 69	-1. 09
Labour in man-days	X_2	-2.42***	0.43	-5.68
Seed in Kg	X_3	1.01***	0.29	3. 53
Agro-chemical in litres	X_4	0.08**	0. 04	2. 17
Fertilizer in Kg	X_5	2.97***	0.53	5.59
Diagnostic Statistics	**Symbols**			
Total Variance – Sigma^2	σ^2	0.03***	0. 01	5. 60
Variance Ratio – Gamma	γ	0.87***	0.062	14.06
Log Likelihood function	LLF	123.02		
Sample Size	n	150		

*** and ** estimates are sig. @ 1% and 5% respectively.
Source: MLE of Field Data (2015)

Frequency Distribution of Technical Efficiency Index of Water melon Farms

Table 6 presents the technical efficiency index distribution of the water melon farms in the study area. The mean technical efficiency of the sampled farms in the study area was 89.10 per cent, with a coefficient variation across the farms of 0.23. Water melon farms technical inefficiency is therefore 10.90 per cent. This means that on the average, output

reduced by 10.90% due to inefficiency. Thus, this represents the largest proportion of the inputs that can be reduced to attained feasible technical efficiency without the output being affected or reduced. The technical efficiency range for the farms is between 69.00-98.00 per cent.

Table 6: Distribution of Farm-Specific Technical Efficiency Indices of water melon farms

Technical Efficiency level	Frequency	Percent (%)
0.60 - 0. 70	4	2.67
0.71 - 0.80	11	7.33
0.81 - 0. 90	64	42.67
≥ 0.91	71	47.33
Total	**150**	**100.00**
Coefficient of variation	0.23	
Minimum Technical Efficiency	0.69	
Maximum Technical Efficiency	0.98	
Mean Technical Efficiency	0.89	

Source: *FieldData (2015)*

Elasticity of Production and Return to Scale

The elasticity of production measures the responsiveness of output to a unit change of input. The aim is to estimate the degree to which the inputs considered in the model affected the output. Table 7 shows the production elasticity and return to scale of the water melon farms in the study area. The 1.01 elasticity value for seed implies that water melon output is positively elastic to seeds (quality/ improved seed), while the elasticity value for fertilizer being 2.97 implies that water melon output is positively elastic to fertilizer use. The elasticity value for labour being - 2.42 implies that water melon output is negatively inelastic to labour likewise the farm size.

The summation of the inputs elasticity (RTS) was 0.87 which indicates that water melon production in the study area was in the second stage of the production surface. Stage II is the stage of decreasing positive returns to scale where the use of productive resources can be said to be inefficient and production believed to be below the frontier. At stage 2, production could be increased by using more of the resources with positive elasticity. Hence, it is advisable that the production units should maintain the current level of fixed inputs (farm size) utilized, reduce the number of labour employed and to increase the use of the variable inputs with positive elasticities for effective use of land resources in order to attain not only maximum output but for return to scale economies to be operational. This result was in line with the findings of Tsoho (2008) who reported that the dry season vegetable farmers in sokoto state operates in the second stage of production. Likewise, Fakayode (2009) in his studies on upland and lowland rice production observed that rice farmers are at the second stage operating at decreasing return to scale.

Table 7: Elasticity of Production and Returns to Scale for Water melon Farms

Variable	Parameters	Elasticity	Degree of elasticity
Farm size	β_1	-0.75	Inelastic
Labour	β_2	-2.42	Inelastic

Seed	β_3	1.01	Elastic
Agro-Chemicals	β_4	0.08	Inelastic
Fertilizer	β_5	2.97	Elastic
Return to scale	RTS	0.87	

Source: *Maximum Likelihood Estimates (MLE) of Field Data (2015)*

OLS Determinants of Technical Efficiency of Water melon Farms

The results of the analysis of the relationship between the efficiency indices and its determinants (OLS) are given on Table 8.Based on the criteria for selecting the OLS lead equation as discussed earlier, the lead equation for the water melon farms Technical Efficiency determinants model is the semi-log equation model. The results indicate that, the overall ability of the variables included in the model is limited (R^2 values are generally low) and not all regressors are significant. These results agree with the findings of several researchers who have generally obtained an R^2 value of less than 0.5 in their secondary analysis similar to this study. For example, Amara and Robert (1990), Jeffrey and Xu (1997) and Bem-Bahessem and Womack (2000) obtained 0.19, 0.31 and 0.468 respectively. Probably it was due to the omission of certain important variables that may influence them but correct data were not available to capture them. The table shows that farming experience, education, and cooperative society and gender, all have the expected positive signs. Only the co-efficient for farm size of water melon farms do not conform to *apriori* expectations. Those variables that are positive contribute to water melon farms Technical Efficiency, while the farm size variable with negative co-efficient limits the TE. The sign of the farm size though significant at 1 per cent with a negative sign correlates with the sign obtained in the primary analysis. This implies that farm size significantly decrease technical efficiency.

The positive farming experience sign, coefficient and being significant at 1% emphasize the fact that, for a water melon farm to be technically efficient there is need for requisite experience considering the critical period of water melon field crop at planting, vegetative growth, flowering and fruiting stage, Banaeian and Namdari , (2011). Thus experience contributes to TE. The positive sign and coefficient for the type of education of the farmers suggests direct relationship with TE. This is so because educational level enhances farmers' ability to seek, decipher and make a good use of information about production inputs. In this study all the farmers have one form of education or the other. Thus the two quantitatve variables - education and farming experience - combined to capture farrmers knowledge on technical efficiency, agrees with the studies of Bem-Bahessem et al (2000).

The remaining variables coefficients for the household size, cooperative society membership and gender are insignificant even at 10% level. Thus they limit and show no significant influence on technical efficiency rather contributes to Technical inefficiency of the farms. The R^2 value is 0.584 implying that the water melon Technical efficiency determinants included in our regression model accounts for about 58.4 per cent variations in the technical efficiency level of water melon farms. The F-ratio is 4.516 and significant at 1% level implying that the joint effects of the included variables in our model were significant for the technical efficiency of water melon farms.

Table 8: OLS Regression Estimates for Determinants of Technical Efficiency of Water melon Farms

		Co-efficient							
Functional forms	**Constant**	**Farm size Z_1**	**Education Z_2**	**Household size**	**Cooperative society**	**Gender Z_5**	**Experience Z_6**	**R^2**	**F**

				Z_3	Z_4				
Linear	2.342	-0.137***	-0.037	0.001	0.023	0.115	0.0722***	0.457	3.516
	(3.102)	(4.531)	(-0.878)	(0.136)	(0.235)	(0.435)	(13.018)		
Semi-log	**0.896**	**-0.219*** **	**0.079***	**-0.204**	**0.214**	**0.107**	**0.0713*** **	**0.584**	**4.815**
	(18.228)	**(8.112)**	**(1.967)**	**(-0.115)**	**(0.336)**	**(0.209)**	**(19.274)**		
Cobb-Douglas	0.735	-0.139***	0.0481	-0.00084	-0.0112	-0.0101	0.021	0.351	2.54
	(5.738)	(12.815)	(1.003)	(-0.00018)	(-0.117)	(-0.118)	(0.280)		
Exponential	0.5438	-0.342	0.142	0.0042	-0.0147	-0.216	0.0524	0.018	1.34
	(4.112)	(-6.328)	(0.743)	(0.068)	(-0.0328)	(0.0421)	(0.234)		

***, * Significant at 1%, and 10% level. Note figures in brackets are t-values
Source: Field Data (2015)

Analysis on Constraints to Water melon Production

Constraints to water melon production in the study area is shown in Table 9. Result shows that non-availability of irrigation facility is a major constraint faced by the farmers. This is seen as few farmers participate in off-season production in spite of the fact that the profit in this period is high. It indicates that most farmers will like to produce during the off-season for a sustainable supply throughout the year. Also, high cost of transportation, destruction of farms by cattle mostly during the off-season are also major constraints faced by the water melon farmers. Most respondents complained of losing their entire farm to cattle mostly during the off-season production. This is so because, pasture availability for cattle by this period is very low and herdsmen move their cattle to wetland areas where the animal can graze and this the area where dry season farming is mostly practiced. This problem leads to farmers-herdsmen clashes which are common and it is reported in some parts of the country. The constraints of high cost of fertilizer, pest and diseases prevalence and limited credit facility in terms of inaccessibility and non-affordability with the issue of the complexity of credit procurement procedure constitute challenges in the production of this fruit-vegetable

Table 9: Distribution of constraints to water melon production (n = 150)

Constraints	Percentage				
	High	**Medium**	**Low**	**Mean**	**Rank**
Limited credit facilities	86.70	13.30	0.00	2.80	7th
Pest and diseases prevalence	98.00	0.00	2.00	2.90	6th
No agricultural extension services	56.00	34.00	10.00	2.46	9th
High cost of fertilizer	92.70	7.30	0.00	2.92	5th
High cost of pesticides and herbicides	32.00	18.70	50.70	1.81	10th
Market problem	68.70	16.70	14.70	2.54	8th
Climate change	22.70	30.70	46.70	1.76	11th
Transportation	97.30	2.70	0.00	2.97	2nd
Farms destroyed by cattle	94.00	6.00	0.00	2.94	4th
Low price during on-season	96.70	3.30	0.00	2.96	3rd
Non-availability of irrigation facility	98.00	2.00	0.00	2.98	1st

Source: Field Data (2015)

Conclusion and Recommendation

Based on the findings of the study, it is evident that water melon farms in the study area have good margin hence water melon enterprise is profitable and the technical efficiency is encouraging. However, it is clear that water melon production in the study area is observed to be below the expected frontier output. In addition, since the technical efficiency was 89 per cent, this result suggests that substantial gains can be attained without additional conventional inputs. This means that there is scope for increasing TE by 11 per cent if all the farm would adopt the production technology currently used by the technically efficient farm. By this the productive resources employed in

the water melon farms will be better managed to raise the farm's level output per hectare as this will then raise the current frontier to expected level. Indications as to the significant contributions of various factors on technical efficiency of water melon production may imply that aside the influences of production inputs in water melon, there exist a part of water melon farm technical efficiency which is inherent in the water melon farmers' socio-economic characteristics. In the light of the study findings therefore, efforts at improving water melon production in the study area is a steps in the right direction considering the decreasing rate of returns to scale estimated for fruit.

The study also identified that after on-season; most of the water melon consumed in the area is brought into the Federal Capital Territory from states in the north-east and north-west parts of the country. But there exits available production potentials, increasing demand, attractive prices mostly during the harsh weather and Muslim's fasting periods when the fruit-vegetable is noted to be mostly appetizing and of high demand. This calls for a scale-up of the production mostly by encouraging off-season production. Water melon is neither a food crop, nor crop for export as well as a raw material source for industrial use presently in country. But countries like china, Iran, USA, Egypt are ranked high in its production, indicating there are hidden potentials yet to be uncovered in the country. However, the fruit-vegetable brings in reasonable cash to investors as producers and marketers. Thus, other than the medicinal and industrial benefits, the water melon can be said to be a nutrition security crop, and it can alleviates poverty as well as reduce unemployment which are socio-economic issues in Nigeria.

Hence, it is recommended that more wetlands should be put into water melon cultivation to increase production mostly during the off-season and improve the efficiency at which water melon farms operate. This is because of the higher estimates of technical efficiency, viability and profitability of the water melon farms. Therefore, it is suggested that intensive efforts at expanding the present scope of water melon farming be encouraged. Also, there should be further research on other resources necessary for water melon production. Such research could help improve the efficiency with which these resources are being utilized. Moreover, it was indicated in the study that some of the water melon farmers are members of cooperative societies. The potentials of these cooperatives should therefore be exploited in the study area, as this will stimulate the delivery of agricultural extension services, promotes the provision of irrigation facility for off-season production, facilitates credit procurement and management, check water melon farms destruction by cattle, reduce farmers-herdsmen clashes, promotes marketing of water melon and also helpstimulate resource mobilization for peri-urban horticulture. Also, the industrial use of the fruit crop should be researched into. The use of the fruit, seed, root, leaves, left-over from research outcome be set on a pilot scale and later promoted in light of agricultural and industrial transformation agenda of our developing econom

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