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Analysis of Profitability, Technical Efficiency and Allocative Efficiency of Watermelon Production in Federal Capital Territory, Nigeria

Luka ANTHONY[1]*, Elizabeth Samuel EBUKIBA[1], Funso Omolayo ALABUJA[1], Olugbenga Omotayo ALABI[1], [2]Kehinde John AFUYE

[1]Department of Agricultural Economics, University of Abuja, P.M.B 117. Gwagwalada, Federal Capital Territory, Nigeria

[2]Department of Agricultural Economics, University of Belgrade, Serbia

**Corresponding author: gqluka11@gmail.com*

ORCID: 0000-0001-8337-2341

Abstract

This study evaluated analysis of profitability, technical efficiency and allocative efficiency of watermelon production in Federal Capital Territory Abuja, Nigeria. Multistage sampling technique was used. Data were collected through the use of well-structured questionnaire administered to 120 sampled Watermelon farmers in the study area, one questionnaire was not retrieved therefore the analysis was don based on the 119 retrieved questionnaire from the sampled respondents. The following tools of analysis were used to achieve the stated specific objectives of the study. Descriptive statistics, gross margin analysis stochastic production frontier function and stochastic cost frontier function. The results of the socioeconomic characteristics revealed that majority (95%) of sampled respondents were male while only 5% of the sampled respondents were female. The gross margin obtained was ₦97,652.12 with an operating ratio and rate of return on investment of 0.67 and 2.29 respectively. The significant factors influencing total output of watermelon were Seed (P<0.05), fertilizer NPK (P<0.1), fertilizer urea P<0.1) and Chemical (P<0.01). The technical inefficiency component shows that the factors influencing technical inefficiency are Sex (P<0.01), Marital Status (P<0.01), Educational Level (P<0.01), Occupation and Household Size (P<0.01). The mean estimated value of the allocative efficiency for the farmers was (0.46870 or 47%). The allocative inefficiency model revealed that the factors influencing allocative inefficiency includes age of the farmers (P<0.01), sex (P<0.01), educational level (P<0.05) and the household size (P<0.1). The watermelon farmers encountered the following constraints in the cause of production inadequate capital, lack of land availability, unavailability of improved seed, Government policy on land use, high costs of farm inputs and affordability, poor information network and bad roads. Therefore, the study recommends that female farmers should be encouraged to participate in watermelon production, however, government and non-governmental organizations should create more avenue for women and youth to have access to credit to enable them have a means of livelihood and financial freedom. Extension officers should be made available to train farmers and to expose farmers to the importance of watermelon farming which will help them have more access to production inputs like improved seeds, fertilizers, chemical and credit facilities. Farmers should be encouraged to increase the size of their production in order to increase total output to minimize cost and improve efficiency, improved seed, capital, chemical and fertilizer should be provided to farmers at subsidized rate. Farmers should be encouraged to form and join cooperatives organizations to enable them have access to good market price.

Keywords: Profitability, Efficiency, Stochastic frontier, Watermelon, Nigeria

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INTRODUCTION

Agriculture remains the bedrock for economic growth, attaining development and poverty eradication in developing countries including Nigeria. Agriculture has also been regarded as the major engine and panacea for economic prosperity in the Country (Dawang &Yusuf, 2011). "The existing battle for the long-term economic growth will only be won or lost in the agricultural sector". However, how this pathway will lead to economic prosperity and economic growth is still subject to debate and argument among developmental specialists and top economists across the globe. Nigerian economy in the past decades strives on the agricultural sector. In most of the developing countries (low and middle-income countries alike), the agricultural sector still remains the major and the largest contributor to the economy providing inputs, food security, employment opportunities for youths, raw materials for other industries, foreign earnings from the exportation of the surpluses, and more importantly the enormous advantage of the value added in the various production processes (Dawang &Yusuf, 2011). After the discovery of the black gold in Nigeria, oil (post-oil boom), there was a tremendous decline in the agricultural sector's share recorded, in terms of its major contribution to Real Gross Domestic Product (RGDP). Water melon *(Citrullus lanatus*) is classified as a tender, warm seasonal vegetable that belongs to the family Cucurbitaceae. Watermelon (*Citrullus lanatus*) is among the native of the tropical Africa, where it has been in used for longer period of time by the wild tribes (Lakdan & Stanzen, 2017). Watermelon *Citrullus lanatus* is one of the most important crops that is widely cultivated in the world (Adeoye et al, 2020). Watermelon can be cultivated in the areas where soils are mostly sandy loam and well-drained (Shrefler et al., 2017; Hogue et al, 2022). It has a high nutritious content and thirst-quenching ability and also contains vitamins C and A in the form of disease-fighting beta-carotene. Potassium is also available in it which is believed to help in the controlling of blood pressure and its possibility of preventing body stroke (De Lannoy, 2001). It has anti-cancer effects ant it can improve heart health, it relieves the soreness of the muscle, watermelon reduces inflammation and oxidative anxiety, it improves skin health and digestion metabolism (Agriculture, 2022). The fruit is effective in reducing cancer, cardiovascular disorders, diabetes, blood pressure, and obesity (Lum et al., 2019). The potentials of watermelon production as a cash-producing crop are very enormous for farmers, it increases the income level of farmers, especially those residing near the urban areas (Bahari et al., 2012). Dessert watermelon is grown worldwide, has a characteristic of sweet taste, it's a low-calorie fruit that is mostly used in salads and juices (Bahari et al., 2012; Gbotto et al., 2016). The cooking type of watermelon, also called cow watermelon, is normally used in animal feed preparation, for cooking thick porridge, or mixed in dry maize (Zea mays L.) grain (Mujaju et al.,2011). The seed type watermelon is mostly grown in Central to West Africa and is used to extract oil, make egusi soup, snacks, and flour (Jensen, 2012). Watermelon fleshy fruits and rinds contains many edible nutrients that serve as a sources of carotenoids, it contains Vitamins A, B6, C, lycopene, and some elements of antioxidants (Jensen et al., 2011). Watermelon juice can be processed into wine, or other traditional brews. In some African Countries like Sudan and Egypt, they roast watermelon seeds, salt it and eaten as a snacks. Watermelon fruit provides juice that is used as alternative source of water for drinking during drought and dry season in some parts of Sudan and Nigeria (Ayodele & Shittu, 2013; Goda, 2007). Presently, Asia accounts for more than 80% of worldwide watermelon production. China is the number one producer accounting for 67.6% worldwide producing 134,175,133 tonnes per year (FAO,2019).

Africa, Europe, and North America have similar production output, around 3–4 million tonnes annually. Algeria is the leading watermelon producer in the African continent producing (4,300,921 million tonnes yearly), fifth in the world, contributing 1.6% to worldwide production, followed by Egypt (3,491,301 million tonnes yearly), nineth in the world while Nigeria produces 1,002,300 million tonnes as at 2017 (NBS,2017). Currently, Africa as a whole, is classified as the third producer of watermelon in the world (FAO, 2019 &Anonymous, 2019). Watermelon business acts as a means and sources of livelihood for the producers and marketers alike. It generates high revenue to the government through taxes and commissions from the marketers and producers as well. In Africa, watermelon production systems differ depending on the agro-climate, from greenhouses to open field with varying levels of technological application. In most rural communities, watermelon is grown as an intercrop with minimal inputs requirements (Maoto et al., 2019). The study of efficiency in agriculture is based on certain economic theories which describe various ways the production resources could be utilized to achieve maximum output level; one of which is technical efficiency, an engineering concept for measuring the performance of the system given the available resources. Technical efficiency is associated with behavioural objectives of maximization of output (Ndubueze-Ogaraku et al., 2021). Efficiency is generally associated with the possibility of attainment in optimal level of output from a given bundle of input at least cost (Ume et al., 2020). Efficiency is distinguished into three types of efficiency, technical, allocative and economic efficiencies. Technical efficiency is the capability of firms to utilize the best practice or technology in the production process so that the minimum possible resources are used to achieve the best or optimum output level (Ume et al., 2020). Measuring efficiency provides a way of quantifying and comparing the performance of each farmer, and identification of factors explaining any inefficiencies and differences in performances. The current major challenges of rising costs of water melon production requires a main focus on the issue of technically efficient method of production systems. Profit maximization in any farm business requires a farm business enterprise to produce the maximum output of watermelon given the level of production inputs employed during the process, use of the right mixture of inputs in the light of the relative prices of each input is also another challenge (input allocative efficiency) Ndanitsa, et al., 2021). Shortages of horticultural produce especially fruits and vegetables like watermelon are often very acute because of the low levels of technology used in its production process, harvesting system is labour intensive and the storage of water melon is very difficult, increasingly there is high demand for fruits and vegetables due to the desire for improving standards of living of the populace in Nigeria (Adeoye et al., 2020). Costs of production of watermelon would vary depending on the location where it is being produced, Costs of inputs such as water and land vary by the production location, but the amounts of inputs such as fertilizer, pesticide, and herbicides, depend on weather and soil (Adeoye et al., 2020). Generally, watermelon production is labour intensive, especially in harvesting and postharvest handling (Baameur, 2009). Several reasons have been the major reasons and the basis for the need of improving the production of watermelon; one of which is that it can survive even in a water logged area (Robinson, 2000). In addition, watermelon can serve the purpose of both a fruit and a vegetable; therefore, having a higher market demand creating a gap between demand and supply (Otunaiya & Adedeji, 2014). Deliberate efforts on production efficiency and profitability of watermelon needs to be enhanced for sustainability of its production. More awareness which is lacking is needed to market the fruit for its rich health and nutrition benefits and ensure profitability in its production for farmers who are in the production line. Several studies were conducted on watermelon farming at home and abroad. Rabbany et al., (2013) conducted research on the cost of production analysis of watermelon.

Yusuf et al., (2013) also reported profitability and adoption of watermelon technologies by farmers. Ibrahim et al. (2014) explored technical efficiency and its determinants in watermelon production. However, very little studies have been conducted jointly on profitability technical and allocative efficiency of watermelon production in the study area. Hence, this study was conducted to contribute to the existing literature by evaluating the watermelon farmer's profitability, technical efficiency and allocative efficiency in watermelon production. Therefore, this research study was designed to proffer solution to the following research questions.

Research Questions of the study

(i) What are the socio-economic and demographic characteristics of water melon farmers in the study area?
(ii) What is the costs, returns and the profitability level of the water melon production by the farmers in the study area?
(iii) What are the technical efficiency and the factors influencing technical inefficiencies of water melon production in the study area?
(iv) What are the allocative efficiency and the factors contributing to the allocative inefficiencies of water melon production among farmers in the study area?
(v) What are the constraints faced by water melon production by the farmers in the study area?

Objectives of the Study

The main objective of this study is to analyse Analysis of Profitability, Technical and Allocative Efficiency of Watermelon Production in Federal Capital Territory, Nigeria The specific objectives of this study are to;

(i) identify the socio-economic and demographic characteristics of watermelon farmers,
(ii) estimate costs, returns and the profitability level of water melon production,
(iii) evaluate the technical efficiency and factors influencing technical inefficiencies in water melon production,
(iv) evaluate the allocative efficiency and the factors contributing to allocative inefficiencies in water melon production,
(v) identify constraints faced by farmers involved in water melon production in the study area.

MATERIAL and METHOD

The Study Area

This study was conducted in Federal Capital Territory, Nigeria. The Federal Capital Territory, Nigeria came into being with the promulgation of Decree No 6 of 1976. The creation of the FCT came with four Area councils namely: Gwagwalada, Abaji, Kuje, Municipal Area Councils respectively (Ejaro, 2013). On October, 1st 1996, two more new area Councils Kwali and Bwari, were created to bring the total number of area councils in the Federal Capital Territory to six (Ejaro and Abubakar, 2013). The major crops grown in the area are Sorghum, Cowpea, Watermelon, Maize, rice among others.

Sampling Techniques and Sample Size

A multistage sampling technique was adopted for this study. In the first stage purposive sampling procedure was used to select Federal Capital Territory based of the numerous number and concentration of water melon producers in the area.

The second stage involved random selection of two area Councils Kuje and Bwari area Councils using ballot box method. In the third stage three villages were selected randomly from each area council based on the intensity of watermelon producers. In the fourth stage simple random sampling technique was used in each village to select the desired sample size of 120 farmers, one questionnaire was not retrieved therefore, the analysis was done based on 119 questionnaires returned back by the watermelon farmers.

Sources of Data

Primary data were used for this study and the data were collected with the aid of well-structured questionnaire. The output data collected includes the total yield of the watermelon produced cash receipts from selling, quantity consumed at home and those given out as gifts. The input data include farm size, quantity of agrochemicals, labour, quantity of seeds, quantity of fertilizers, cost of simple farm tools such as sprayers, cutlass, hoes and other simple farm implements used. The data generated also include the socio-economic characteristics of the farmers such as age, sex, marital status, household size, educational level, years of farming experience, extension contact, amount of credit received and years of membership of cooperative society.

Methods of Data Analysis

Descriptive Statistics: This involves the use of minimum, maximum, standard deviation, mean, range, percentages and frequency distributions in order to summarize the socio-economics characteristics of water melon farmers this was used to achieve the specific objective one (i) and pat of specific objective (ii).

Farm Budgetary Technique: The farm budgetary techniques adopted to determine the profitability, costs and returns of water melon production in the study area was Gross Margin Analysis (GM) and it is defined as the difference between the gross farm income (GFI) and the total variable cost incur (TVC). This was used to achieve the specific objective two (ii). The Gross Margin Model is stated thus:

$$GM = TR - TVC \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.. (1)$$

$$GM = \sum_{i=1}^{n} P_i Q_i - \sum_{j=1}^{m} P_j X_j \dots\dots\dots\dots\dots\dots\dots\dots (2)$$

Where,

P_i = Price of water melon ($\frac{₦}{Kg}$),

Q_i = Quantity of water melon (Kg),

P_j = Price of Variable Inputs ($\frac{₦}{Unit}$),

X_j = Quantity of Variable Inputs (Units),

$TR =$ Total Revenue obtained from Sales from water melon (₦),

$TVC =$ Total Variable Cost (₦),

Financial Analysis: This analytical tool was used to determine the ratios to show the profitability of water melon production. The financial analysis was used to achieve part of specific objective two (ii). Gross Margin Ratio according to Ben-Chendo et al. (2015) is defined as:

$$Gross\ Margin\ Ratio = \frac{Gross\ Margin}{Total\ Tevenue} \ldots\ldots\ldots\ldots. (5)$$

The operating ratio (OR) according to Olukosi and Erhabor (2015) is defined as:

$$Operating\ Ratio = \frac{TVC}{GI} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (6)$$

Where,

TVC = Total Variable Cost (Naira),

GI = Gross Income (Naira),

According to Olukosi & Erhabor (2015) an operating ratio of less than one (1) implies that the gross income from water melon production enterprise was able to pay for the cost of the variable inputs used in the production enterprise.

The rate of return per naira invested (RORI) in water melon production by farmers is defined as:

$$RORI = \frac{NI}{TC} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where,

$RORI =$ Rate of Return per Naira Invested (Unit),

$NI =$ Net Income (Naira),

$TC = Total\ Cost\ (Naira)$.

Stochastic Production Frontier Function Approach

The stochastic frontier production function was independently proposed by Aigner, *et al*., (1977); Coelli and Battese, (2005) and Farrel (1957). The stochastic production function is defined by

$$Y_i = f(X_i; \beta) = \varepsilon_i$$

$$\varepsilon_i = V_i - U_i$$

Where:

Y_i = observed total output of the ith sample farm f (*xi; β*) is a suitable functional form such as Cobb-Douglas production function, X_i vector of the inputs used by the i-th farm, β vector of unknown parameters to be estimated, ei is error term and random noise. The stochastic frontier production function model was estimated using the maximum likelihood estimation procedure (MLE) (Kumbhakar & Lovell, 2000; Battese & Corra, 1977). The technical efficiency of an individual firm is defined in terms of the observed output (Y_i) to the corresponding frontier output (Y_i*) given the available technology.

$TE_i = \frac{Yi}{Yi*}$

$$TE_i = F(\frac{(X_i; \beta)\exp(v_i - u_i)}{(X_i; \beta)\exp(v_i) = \exp(-u_i)}$$

So that 0 < TEi < 1

Therefore, the technical inefficiency is equal to 1 – TE

The stochastic frontier model for estimating the technical efficiency of the watermelon farms is empirically specified by the Cobb-Douglas frontier production function as:

$$LnY_i = \beta_0 + \sum_{i=1}^{6} \beta_i\, LnX_i + \cdots \beta_n LnX_n + V - U_i \ldots\ldots\ldots..(9)$$

The explicit function is stated thus:

$LnY_i = \beta_0 + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 lnX_4 + \beta_5 LnX_5 + \beta_6 LnX_6 + V_i - U_i$. (10)

Where,

$LnY_i =$ Output of Maize (Kg)

X_1= Seed Input (Kg)

X_2 = Farm Size (Hectares)

X_3 = Quantity of Fertilizer NPK (Kg)

X_4 = Quantity of Fertilizer Urea (Kg)

X_5 = Chemical Input (Litres)

X_6 = Labour Input (Man-days)

The Technical Inefficiency Component of the Stochastic Frontier Model is stated thus:

$$U_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 \ldots\ldots\ldots (11)$$

Where,

$U_i = Technical\ Inefficiency\ Component$

Z_1= Sex (1, Male; 0, Otherwise)

Z_2= Age of Farmers (Years)

Z_3= Education Level of Farmers (Years Spent Schooling)

Z_4= Marital Status

Z_5= Extension Contact (Number of Contact per Month)

Z_6= Household Size (Number)

$\alpha_0 =$ Constant Term

$\alpha_1 - \alpha_6 =$ Regression Coefficients

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

Stochastic Cost Frontier Function is stated thus:

$$\mathrm{C_i} = \mathrm{f}\left(\mathrm{P_i}, \mathrm{Y_i};\ \beta_j\right) + (\mathrm{V_i} + \mathrm{U_i});\ \mathrm{i} = 1, 2, \ldots, \mathrm{n}\ \ldots..(12)$$

$$lnC_i = \beta_0 + \beta_q lnY_i + \sum_{j}^{k} \beta_j\, ln\left(P_{ij}\right) + V_i + U_i \ldots\ldots.(13)$$

where, C_i is total cost of production Y_i is total output, X_{ij} are input quantities, and the P_{ij} are input prices. V_i assumed to be independently distributed random errors. It is assumed to be independent, identical and normally distributed with a mean of zero and constant variance $\{V_j \sim N(O, \sigma_V^2\ )\}$ Intuitively, the inefficiency effect is required to lower output or raise expenditure, depending on the specification. The Cost efficiency of individual farmers is defined in terms of the ratio of the predicted minimum cost C_i^* to observed cost C_i that is

$$\mathrm{CE} = \frac{C_i^*}{C_i}$$

Thus allocative efficiency is derived from cost efficiency and it's an inverse of cost efficiency and it ranges between zero (0) and one (1) (Adejor et al, 2018). The explicit form of the stochastic cost frontier function is specified as shown below as used by (Dawang & Yusuf, 2011; Aboaba, 2020; Abdul et al, 2018; Adejor et al, 2018 and Bitrus et al, 2020).

$$\mathrm{L_nC_i} = \beta_0 + \beta_1 \mathrm{L_nY_1} + \beta_2 \mathrm{L_nX_2} + \beta_3 \mathrm{L_nX_3} + \beta_4 \mathrm{L_nX_4} + \beta_5 \mathrm{L_nX_5} + \mathrm{V_i} + \mathrm{U_i} \;\ldots..(14)$$

$LnC_i =$ Total Cost of Watermelon Production
$\mathrm{L}_n\mathrm{Y}_1 =$ Output of Watermelon (Kg)
X_2=Cost of Seed Input (Kg)
X_3 =Cost of Fertilizer (Kg)
X_4 =Cost of Chemical Input (Litres)
X_5 = Cost of Labour Input (Man-days)
The Allocative Inefficiency Component of the Stochastic Cost Frontier Model is stated thus:

$$U_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 \ldots\ldots\ldots (15)$$

Where,
$U_i = Allocative\ Inefficiency\ Component$
Z_1= Sex (1, Male; 0, Otherwise)
Z_2= Age of Farmers (Years)
Z_3= Marital Status
Z_4= Education Level of Farmers (Years Spent Schooling)
Z_5= Extension Contact (Number of Contact per Month)
Z_6= Household Size (Number)
α_0 = Constant Term
$\alpha_1 - \alpha_6$ = Regression Coefficients
$\mathrm{V_i}$ = Random Noise
$\mathrm{U_i}$ $= Inefficiency\ Component$

RESULTS and DISCUSSION

Socioeconomic Characteristics of the Watermelon Farmers in the study Area

Table 1 shows the results of the socio-economic characteristics of the sampled watermelon farmers in the study area, the result showed that majority (95%) of sampled respondents were male while only 5% of the sampled respondents were female this shows that watermelon production is dominated by male farmers in the study area. This result is in line with Anyiro et al., (2012) who suggests that water Mellon production is gender sensitive and requires innate physical exertion of carefully selected force. Also 89.1% of the sampled water Mellon farmers were married while 5% were single. This is also in agreement with Anyiro et al., (2012). The results further show that 56.3% of the sampled water Mellon farmers had 1-5 members per household while 38.7% had 11-15 number of persons per household. This is consistent with the findings of Effiong (2005; Idiong, 2006; Udensi et al., 2011 and Okoye et al., 2008) who reported that a relatively large household size is more likely to provide more labour required for farm operations such as weed control and fertilizer application. Though large household size may not guarantee for increased labour efficiency since family which comprises mostly children of school age are always in school. More so 33.6% obtained secondary school level of education while 46.2% had no formal education at all. The level of education of a farmer not only increases his farm productivity but also enhances his ability to understand and evaluate new production techniques. The implication of education level attained by farmers is that the respondents are better positioned to take advantage of new technique and innovation that could improve agricultural efficiency and boost food security.

Imburr et al., (2008) reported that improved education level brings about positive changes in the knowledge, attitude and skills through research and extension. About 33.6% were between the age ranges of 41-50 years of age while 29.4 were within the age range of 31-40. This result revealed that most of the sampled farmers are in their active age of productivity, this will make them allocate more time to farm activities in the study area. This result is also consistent with Obike et al., (2016) who observed that the age bracket of productivity is increased production and likelihood of poverty reduction in the area. The results further revealed that 42% had 1-10 years farming experience while 26.2% had 11-20 years farming experience and 25% of the sampled respondents had 21-30 years farming experience in the study area. This result is in consonance with the findings of Okoye et al., (2008) and Nwaru, (2003) who reported that farmers count more on their experience than educational attainment in order to increase their productivity. This result is also in line with Ebukiba et al., (2020); Ebukiba et al., 2022) who reported that farming experience increases the level of efficiency as the farmers accumulated experience results in increase in farm productivity. However, the more educated an individual farmer is, the less likely would he be available for agricultural labour. Table1 also depict that 60.5% of the sampled respondents had farm size ranges between 1-2 ha while 37.8% had a farm size of 3-4 ha this indicated that the watermelon farmers were dominated by smallholder farmers in the study area.

Table 1. Socioeconomic Characteristics of the Sampled Respondents in the Study area

Variables	Frequency	Percentage
Gender		
Male	107	89.92
Female	12	10.08
Marital Status		
Single	6	5.0
Married	106	89.1
Widow	2	1.7
Widower	5	4.2
Household size		
1-5	67	56.3
6-10	46	38.7
11-15	4	3.4
16 and above	2	1.7
Educational Status		1.7
Primary school	2	1.7
Secondary school	40	33.6
Tertiary institution	22	18.5
No formal education	55	46.2
Age		
20	7	5.9
21-30	18	5.1
31-40	35	29.4
41-50	40	33.6
51 and above	19	16.0
Farming experience		
1-10	50	42.0
11-20	31	26.1
21-30	30	25.2
31 and above	8	6.7
Farm Size		
1-2	72	60.5
2.1—4	45	37.8
4.1 and above	2	1.7
Total	**119**	**100**

Source: Field Survey (2022).

Institutional Variables Used by Watermelon Farmers in the Study Area

Table 2 shows that majority (64.7%) of the sampled respondents were members of cooperative organization and majority (86.6%) of the water mellon farmers had access to credit while only 13.4% could not access credit facilities. The results further revealed that 37% could not have any source of credit while 49.7% of the respondents source their credit through other means only 7.6 % of the respondents accessed credit through commercial banks in the study area. Majority (89.9) could not have access to extension services in the study area. This is in line with Adeoye et al., (2020) who reported that most of the watermelon farmers supplied their own capital by themselves. Also majority (68.9%) had access to fertilizer while 31.1 did not had access to fertilizer in the study area. This is consistent with the findings of Simonyan & Obiakor (2012) which indicated that membership of cooperative society and occupational status are both significant and positively related to household labour use. This result implies that farmers will rely more on their household members for labour if they do not belong to cooperative societies. Cooperative societies/farmers associations are sources of good quality inputs, labour, credit, information and organized marketing of products. This result also agrees with the findings of (Adeoye et al., 2020; Simonyan et al., 2011).

Table 2. Institutional Variables of Water Mellon Farmers in the Study Area

Variables	Frequency	Percentage
Cooperative membership		
Yes	77	64.7
No	42	35.3
Access to Credit		
No	103	86.6
Yes	16	13.4
Sources of Credit		
Non**e**	44	37.0
Commercial Banks	9	7.6
Cooperative Bank	7	5.8
Others	59	49.6
Total	119	100
Access to Extension		
Yes	12	10.1
No	107	89.9
Access to Fertilizer		
No	37	31.1
Yes	82	68.9
Total	119	100

Source; Field Survey Data (2022)

Costs and Return and Profitability of Watermelon Production in the Study Area

Table 3 presents the results of the estimated cost and returns involved in the watermelon production in the study area the analysis show that the cost of labour has an estimated value of ₦30,818.75 which represent 84.1% of the total variables cost incur in the water Mellon production in the study area followed by cost of chemical with an estimated average value of ₦4,605.00. This is in line with Okeke et al., (2020), who opined that labour requirement attracts higher cost in agricultural production. The total variable cost on average was ₦42,597.88 with an estimated total revenue of ₦140,250.00 on average basis, the gross margin obtained was ₦97,652.12 with an operating ratio and rate of return on investment of 0.67 and 2.29 respectively this result implies that watermelon production is profitable in the study area.

The rate of return of 2.29 indicates that every 1 naira invested in watermelon production will yield ₦2.29 returns on investment which covers profit, taxes, commissions, and other expenses incur in the process of water mellon production in the study area. This is in line with (Alabi et al., 2020 and Alabi et al., 2021) who reported in their research that those positive values of gross margin and farm income indicate that the water mellon enterprise is profitable in the area, this result is consistent with the findings of (Adeoye et al., 2020 and Ndanitsa et al., 2021) who asserted that Watermelon production was 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 Returns obtained in Water Mellon Production in the Study Area

Items	Average Value (₦)/ha	Percentage
A. Variable Cost		
Seed	1,074.13	0.025
Fertilizer	1,100.00	0.026
Chemical	4,605.00	0.108
Labour	30,818.75	0.841
Transportation	5,830.63	0.019
B. Total Variable Cost	42,597.88	
C. Total Revenue	140,250.00	
D. Gross Margin	97,652.12	
Operating Ratio	0.69	
Rate of Return on Investment	2.29	

Source: Field Survey (2022)

Estimates of the Technical Efficiency of Watermelon Farmers in the Study Area

The results of the maximum Likelihood (MLE) of the parameters of the Stochastic frontier production function and inefficiency component were estimated for water mellon farmers using Stata software version 14. The MLEs of the Cobb-Douglas stochastic frontier model with half-normal distributional assumptions on the efficiency error term were estimated. The estimate of gamma is a measure of the level of the inefficiency in the various parameters and ranges from 0 to 1. Gamma estimate was 0.0083 water mellon farmer. Indicating the amount of technical inefficiency of the farmers in the study area. This result can be interpreted that 0.83% of the random variation in the output of watermelon farmers was due to difference in technical efficiency. The parameter of sigma square was 0.092. The mean value of technical efficiencies for watermelon farmers was 0.4978 implying that, on average the sampled respondents were able to obtain 50% of the potential output from a given mixture of production inputs, therefore, in a short run, there is a shortfall scope of (50%) and of increasing the efficiency of water mellon production among farmers by adopting the technology and techniques used by best watermelon farmers. This result shows that farmers are efficient but not at optimum level in the watermelon production in the study area. The estimated coefficient of seed was 0.282 and was significant at ($P<0.01$). The coefficient of seed 0.282 implies that a unit increase in the quantity of seed results in 28.2% increase in the total output of watermelon in the study area. The estimated coefficients for NPK Fertilizer was (0.19 was significant at ($P<0.05$). The positive signs of the coefficients of NPK fertilizer indicates that a unit increase in the quantity of NPK fertilizer as a result of more usage by farmers will result in increase and decrease in output of water mellon by 19.3%. This result is in line with the report of Sani et al, 2016). The estimated coefficient of labour was 0.126 and it was not significant.

This agreed with the findings of (Sani et al., 2016; Bitrus et al., 2020; Girei et al., 2013) who observed that the magnitude of the coefficient of labour would induce an increase in the output of crop, and vice versa. The estimated coefficient of chemical was (0.487). The coefficient of chemical 0.487 was positive and statistically significant at P<0.01), this shows that a unit increase in the quantity of chemical as a result of more usage will result in 49% increase in the output of watermelon in the study area. The technical inefficiency model estimates are shown in table 4. The negative sign of the estimated parameter means that the variable reduces technical inefficiency (increases technical efficiency). The positive signs increases inefficiency (decreases technical efficiency). The results revealed that the sex of the farmer's, marital status, educational level, occupation and household size were significant, and therefore reduces technical inefficiency (or increase technical efficiency). The variables sex and marital status has positive estimates and were statistically significant at (P<0.01), therefore decreases technical efficiency and increases technical inefficiency of watermelon production by 47% and 25% respectively. The estimated coefficient for household size was negative and statistically significant, the estimated coefficient of household size was (-0.369) this indicates a unit change in household size by one family member will result in the increases in technical efficiency of watermelon production by 37%, this could be due to the fact that small scale farming is characterized by family labour which is mostly supplied by the household members. These findings are in agreement with the findings of (Otunaiya & Adedeji, 2014). The estimated coefficient of education has a negative sign and was statistically significant at (P<0.01). This indicates that the literacy level of farmers increases technical efficiency, this could be as a result by the fact that education exposes and encourages the farmers to adopt new technologies, the farmers could also use their education in the use of available resources and they were more exposed to new methods of farming and were able to adopt new innovations with regards to watermelon production in the study area. This finding is contrary with the findings of Yusuf et al, (2022) who reported that educational level of farmers is not significant in watermelon production.

Table 4. Maximum Likelihood Estimates of the Stochastic Frontier Production Function for Watermelon Farmers in the Study Area

Variables	Parameter	Coefficient	Standard Error	Z-value
Stochastic frontier				
Constant	β_0	2.1322	1.0868	1.96**
Seed	β_1	0.2822	0.1338	2.11**
Fertilizer NPK	β_2	0.1931	0.1151	1.72***
Fertilizer Urea	β_3	-0.7258	0.4050	-1.79***
Labour	β_4	0.1263	0.2300	0.5
Chemical	β_5	0.4871	0.1948	2.50**
Farm Size	β_6	-0.1545	0.2705	-0.57
Inefficiency Model				
Age	Z_1	-0.0633	0.0495	-1.28
Sex	Z_2	0.4672	0.0769	6.07*
Marital Status	Z_3	0.2539	0.0667	3.80*
Educational Level	Z_4	-0.3866	0.0542	-7.14*
Occupation	Z_5	-0.4597	0.0840	-5.47*
Household Size	Z_6	-0.3693	0.0477	-7.74*
Sigma^2	$\boldsymbol{\sigma^2}$	0.0915	0.0154	
Gamma	$\boldsymbol{\gamma}$	0.0083	0.3689	
Log likelihood =		-15.8705		
Number of Observation	**N**	119		
Mean Tech efficiency	$\overline{\boldsymbol{TE}}$	0.4978		

Source: Field Survey Data, (2022). *** Significant at 10 percent level: ** Significant at 5 percent * Significant at 1 percent

Distribution of Technical Efficiency Score Among Watermelon Farmers in the Study Area

The estimates of the technical efficiency score distribution of the sampled watermelon farmers revealed that 3.4% of the sampled respondents fall within the technical efficiency range of 0-0.2 and 32.8% were within the range of 0.21-0.4 level of technical efficiency respectively while 47% of the watermelon farmers attained 0.41-0.6 level of technical efficiency. About 2.5% and 14.3% attained 0.61-0.8 and 0.81-1.0 level of technical efficiency respectively. The minimum technical efficiency value attained by individual watermelon farmer was 0.011 while the maximum technical efficiency attained was 0.999. The mean technical efficiency obtained by the watermelon farmers in the study area was 50%. This result show that, the watermelon farmers were not highly technically efficient in watermelon production but had a shortfall of 50% below perfection technically which need to be scalp up through the adoption of the available existing technology. This result is in line with Otunaiya & Adedeji, (2014) who reported similar results, this implies that there is need for improvement in the production performance of the watermelon farmers in the Study area.

Table 5. Distribution of Technically Efficiency Score Among Watermelon Farmers

Technical Efficiency Score		Frequency	Percentage
0-0.2		4	3.4
0.21-0.4		39	32.8
0.41-0.6		56	47.1
0.61-0.8		3	2.5
0.81-1.0		17	14.3
Minimum	0.0111		
Maximum	0.9990		
Mean TE	0.4978		

Source: Field Survey Data, (2022).

The Estimates of Stochastic

Cost Frontier Function of Watermelon Farmers in the Study Area

The estimated parameters of the stochastic cost function for watermelon farmers are presented in Table 6 the results showed that the variance of the parameter estimates, sigma squared (σ^2) was 0.1379. Gamma coefficient was 0.13. the estimated gamma parameter of 0.13 implies that about 13% of the variation in the total cost of production of water mellon among farmers were due to the differences in the cost efficiencies. This means that the cost inefficiency effect makes significant contributions to the cost of producing watermelon in the study area. The mean estimated value of the allocative efficiency for the farmers was (0.46870 or 47%). None of the samples respondents had 100% cost efficiency index. This implies that if an average farmer were to reach Allocative Efficiency level of its highest efficient counterpart, then the average farmer could realize 53% cost saving among the farmers. This in line with (Makuya et al., 2018; Maurice et al., 2015) who reported that the allocative efficiency of the sampled farmers ranged from 0.18 to 0.98. The mean allocative efficiency was estimated to be 47%, meaning that an average watermelon farmer in the study area has the scope for increasing allocative efficiency in the short-run under the existing technology. The cost of seed was negative and statistically significant at ($P<0.1$), cost of fertilizer, cost of labour were not significant while cost of chemical and total output were all positive and statistically significant at ($p<0.01$) probability levels for watermelon farmers. The coefficient of chemical 0.24 implies that a unit increase in the cost of chemical results in 24.48% increase in the total cost of watermelon production in the study area this shows that there is an association between the total cost of production and the cost of chemical among farmers. This result is in line with the findings of (Oladele, 2015).

The coefficients of total output 0.08 for farmers were positive and statistically significant at (P<0.01) probability level, this implies that a unit increase in the total output is associated with 8% increase in the total cost of production among farmers in the study area. This is in consonance with (Adeoye et al., 2020). The allocative inefficiency model component revealed that the factors influencing allocative efficiency includes age of the farmers, sex, educational level and the household size. The coefficient of age was (0.1719) and was positive and statistically significant at (P<0.01) probability level this implies that a unit change in the age of farmer will results in 17% increase in allocative efficiency this could arise as a result of old age as the age increases the farmer's ability to be efficient in cost allocation decreases due lack of adopting new technology in watermelon production, this finding is in line with Toluwase & Owoeye, (2017) who reported similar results. Other factors influencing allocative inefficiency in watermelon production were Sex P<0.01, Education P<0.05) and Housed Size (P< 0.01) respectively. This is consistent with Makuya et al., (2018) who reported that education level of watermelon farmers reduces cost inefficiency, an educated watermelon farmer has more ability to understand fast and produce according to good farming practices which will facilitate allocative efficiency in watermelon production than the one who is not educated or with less level of education.

Table 6. Maximum Likelihood Estimates of the Stochastic Cost Frontier Production Function for Watermelon Farmers in the Study Area

Variables	Parameter	Coefficient	Standard Error	Z-value
Stochastic frontier				
Constant	P_0	1.4468	0.5773	2.51*
Cost Seed	P_1	-1.6961	0.9701	-1.75***
Cost Fertilizer	P_2	-2.12e-07	6.62e-07	-0.32
Cost Labour	P_3	0.0627	0.0737	0.85
Cost Chemical	P_4	0.2430	0.0771	3.15*
Output	P_5	0.0888	0.0000	6.37 *
Inefficiency Model				
Age	Z_1	0.1719	0.0594	2.89*
Sex	Z_2	0.3015	0.0731	4.12*
Marital Status	Z_3	-0.0102	0.0729	-0.14
Educational Level	Z_4	-0.0770	0.0339	-2.27**
Occupation	Z_5	-0.1331	0.1003	-1.33
Household Size	Z_6	0.1227	0.0683	1.79***
Sigma^2	$\boldsymbol{\sigma^2}$	0.1378	0.0390	
Gamma	$\boldsymbol{\gamma}$	0.5756	0.1149	
Log likelihood =		1.2973		
Number of Observation	**N**	119		
Mean Allocative efficiency	$\overline{\boldsymbol{AE}}$	0.468		

Source: Field Survey Data, 2022 *** Significant at P<0.1: ** Significant at P<0.05 percent * Significant at P<0.01 percent

Distribution of Allocative Efficiency Score Among Watermelon Farmers in the Study Area

The estimated values of the allocative efficiency revealed that about 2.53% of the sampled respondents fall within the range of 0-0.2 while 33.6% fall within the distribution score of 0.2-0.4 level of allocative efficiency score respectively also majority 50.4% attained 0.41-0.6 level of allocative efficiency score. About 10.1% and 3.4% attained 0.61-0.8 and 0.81-1.0 level of allocative efficiency score. The minimum level of allocative efficiency value attained by individual watermelon farmer was 0.011 while the maximum level of allocative efficiency score attained by the watermelon farmers was 0.899 with mean allocative efficiency level score of 0.468.

This shows that the watermelon farmers were relatively efficient in allocating productive resources but not at optimum level. This result revealed that the watermelon farmers had a shortfall of 53% below perfection in allocative efficiency which need to be attained by the farmers to be perfectly efficient in allocating resources. This result is in line with (Adejor et al., 2018 and Abdul et al., 2018) who obtained similar results in their respective research study.

Table 7. Distribution of Allocative Efficiency Score Among Watermelon Farmers in the Study area

Allocative Efficiency Score	Frequency	Percentage
0-0.2	3	2.5
0.21-0.4	40	33.6
0.41-0.6	60	50.4
0.61-0.8	12	10.1
0.81-1.0	4	3.4
Minimum	0.011	
Maximum	0.899	
Mean AE	0.468	

Source: Field Survey Data, (2022)

Constraints Encountered by Watermelon Farmers in the Study Area

Table 8 shows the analysis of the constraints faced by the yam farmers in the study, the results shows that 44.5 % of sampled farmers were faced with inadequate capital, this result is in line with Idisi et al., (2019) who founded inadequate capital as the major constraints militating against yam production. They further buttress that non availability of credit to the farmers could limit adoption of yam production technologies, because the adoption of improved technology has cost implications while 47.9% of the respondents experienced lack of land availability.

Table 6 further shows that 40.3% were faced with challenges of government policy on land use as a major constraint militating against water Mellon production in the study area, more so 16.8% were faced with unavailability of hired labour in water mellon production while 63% encountered bad road to transport yam from the farm and to the market as some major constraints in the study area. This is similar to the findings of (Parmar et al., 2017). Furthermore 23.5% of the sampled respondents experienced unavailability of Mellon mini sett as some major constraints while 8.4% were faced with lack of fertilizer/chemicals. Also 27.7%, 10.9% and 75.6% were faced with unattractive price, lack of extension agents and high cost of farm inputs and affordability while 59.7% opined that poor information network was the major constraints faced by the sampled respondents in water mellon production in the study area.

This result is consistent with the findings of Idisi et al., (2019) who observed that most farmers generally were faced with lack of land availability, disease outbreak, bad roads, lack of extension services, unattractive prices and unavailability of hired labour as the major constraints in agricultural production.

Table 8. Results of Constraints Encountered by the Sampled Watermelon Farmers in the Study Area

Variable	Frequency	Percentage
Inadequate Capital	53	44.5
Lack of Land Availability	57	47.9
Government Policy on land use	48	40.3
Outbreak of Pest and Disease	12	10.1
Unavailability of Hired Labour	20	16.8
Inadequate transportation	37	31.1
Bad Roads	76	63.9
Inadequate marketing System	41	34.5
Unavailability of improved seed	28	23.5
Lack of Fertilizer/Chemical	10	8.4
Unattractive price	33	27.7
Lack of extension agents	13	10.9
Limited scale and uneven distribution	21	17.6
High Costs of farm inputs and affordability	90	75.6
Poor Information Network	71	59.7
Total	**119**	**100**

Source, Field Survey Data, (2022) Multiple Response Allowed

CONCLUSION

Based on the findings emanating from the study, the following conclusion were made. Most of the water mellon farmers were male**,** and majority of the farmers had no formal education, the sampled farmers are in their active age of productivity. Water mellon production is a profitable enterprise in the study area with an operating ratio and rate of return on investment of 0.67 and 2.29 respectively. The significant factors influencing total output of water mellon are Seed fertilizer NPK fertilizer urea and Chemical, the technical inefficiency component shows that the factors influencing inefficiency were: Sex, Marital Status, Educational Level, Occupation and Household Size. The farmers were not technically efficient in allocating resources they had a shortfall of 53% below the optimal frontier which need to be scalp up to make them operate at the optimal production level. The allocative inefficiency model revealed that the factors influencing allocative inefficiency includes age of the farmers ($P<0.01$), sex ($P<0.01$), educational level ($P<0.05$) and the household size ($P<0.1$). The water Mellon farmers encountered the following constraints in the cause of production inadequate capital, lack of land availability, unavailability of improved seed, Government policy on land use, high costs of farm inputs and affordability, poor information network and bad roads network.

Policy Recommendations

1. Production inputs such as fertilizer, seed and chemical should be subsidize to famers to encourage them operate at large scale level for earning more profit
2. Since the level of education was significant extension officers should be made available to train farmers and to expose farmers to the importance of watermelon farming which will help them have more knowledge on the usage of the production inputs like improved seeds, fertilizers, and agrochemicals
3. Farmers should be encouraged to increase the size of their production in order to increase total output to minimize cost and improve efficiency level.

4. More awareness should be created about watermelon farming among farmers using extension communication machineries such as media, internet, radio and farm visits. Farmers should be encouraged to form and join cooperatives organizations to enable them have access to good market price.
5. Adequate infrastructure such as good roads, market, storage facilities and good transport system should be provided to ease the farming activities in the study area

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