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ECONOMIC ANALYSIS AND TECHNICAL EFFICIENCY OF WATERMELON PRODUCTION IN NIGER STATE OF NIGERIA

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ABSTRACT
The study examines the economic analysis and technical efficiency of watermelon production in Niger State of Nigeria. Multi-stage sampling procedure was used to draw up the sample and watermelon farmers in the area were the unit of the survey. Accordingly, 150 respondents were selected for the survey. Primary data were collected with the use of structured questionnaire. Information elicited for include socio-economic variables, farm information and management data, information on inputs and outputs and their relative prices, and information on constraints in watermelon production. Data were analyzed using descriptive statistics, farm budgeting techniques as well as stochastic frontier production function. The result of the analyses shows that the mean age of respondents was 41 years, 98% were males and most of them (88%) were married, and having average household size of 9 persons. A typical watermelon farmer in the study area realizes a gross farm income of ₦534,747.50/ha, and a net farm income of ₦459,769.56/ha and a return to investment of 6.13. The constraints to watermelon production in the study area include; inadequate capital for investment, high cost of inputs and their inadequacies, small farm size, poor market integration/pricing of produce, inadequate rainfall, problem of pests/diseases infestation, etc. It was concluded that watermelon is a profitable venture whose production can be increased if more land can be put under cultivation, ensuring that farmers have access to production inputs, provision of infrastructural facilities, land like good roads.

Keywords: Economic analysis, Production, Niger State, Technical efficiency, Watermelon.

INTRODUCTION
Agriculture in Nigeria is dominated by small-scale farming households who produce about 80 percent of the total food requirements (Adeniyi and Adeyemo, 2014). These farmers are characterized by strong dependence on agricultural labour market, little or no forms of savings or storage facility and agricultural practices adopted are highly labour intensive (Bakare, 2013, Tsado *et al*., 2013). The socio-economic and production characteristics of the farmers, inconsistent government policies, the poor infrastructural base, all interact and affect the sector, resulting in low production, high of urban food items, inflation, under-development and under-employment of resources and poverty (Mohammed, 2011). According to Okuneye (2015), there is considerably low production of valuable food crops in meeting the demand of teaming population in the country, particularly watermelon production.

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Watermelon (*Citrullus lonatus*) belongs to the family of *Cucurbitacea* in the plant kingdom. According to Food and Agriculture Organization (FAO, 2011) statistics, China is the world's leading producer of watermelon; the top twenty leading producers of watermelon produced a collective volume of approximately 92.7 million metric tons in 2011, of which China produced 75%. Turkey, Iran and Brazil commanded a production share (of the 20 leading producers) of 4.7%, 3.5% and 2.4% respectively in 2011. Nigeria produced more water melons in 2011 (139, 223 tons) than the leading fresh produce.

Watermelon is a warm season crop that is cultivated worldwide because of its numerous nutritional benefits. Watermelon can be made into wine, or other traditional brews. In Sudan and Egypt, for example, watermelon seeds can be roasted, salted and eaten as snacks. Watermelon fruits are used as a source of drinking water during drought seasons in parts of the world watermelon is highly relished as a fresh fruit because of its thirst-quenching attribute in addition to many other identified nutritional values and advantages. Quantitative assessment indicates that watermelon has 46% calories, 20% Vitamin C, and 17% Vitamin A and has higher hycopene than tomato (Biswan *et al.*, 2017). According to Maoto *et al*. (2019), it contains hycopene, vitamins A, $B_{6,}$ C, carotenoids, and antioxidants. Thus, its consumption has increased, owing to its nutritional profile and allied health benefits. The fruit is effective in reducing cancer, cardiovascular disorders, diabetes, blood pressure and obesity (Lum *et al.*, 2019). Therefore, the consumption of the commodity in the recent times has witnessed remarkable development as it cuts across all facets and socio-economic classes. Presently, the largest production of the crop in Nigeria still comes from the northern parts.

Watermelon business acts as a means of livelihood for the producers and marketers. It generates high revenue to the government from the market (allafrica.com, 2009). The top watermelon exporting countries in 2009 are Spain, Mexico, and United States, Italy, Morocco, Netherland, Greece, Honduras, Brazil and Vietnam with estimated global sales of US$ 1.55 billion (workman, 2020). Therefore, the potentials of watermelon as a cash generating crop is significant for farmers especially those residing near the urban areas. Nigeria and Niger State in particular has a suitable climate for growing many agricultural products including watermelon, because of its suitable soil structure and edaphic factors, and climate conditions. As stated earlier, watermelon has a long history in Nigeria most especially in the method of production. Most farmers have undertaken the use of traditional technologies to produce high value crops like maize, rice, sugarcane, cocoyams, watermelon, leafy vegetables and other crops in diverse cropping system (Ismaila, 2004). Watermelon production is a profitable economic activity because of the availability of the ready-made market within the vicinity of production areas and across all the states of Nigeria. It has been observed that Nigeria has the potential particularly in terms of land and human resources needed to produce enough food for the country (Ndanitsa, 2005; Adeoye, 2012; Mairabo, 2021). To be self-sufficient in food production and self-reliant in the economy, the problem of promoting staple food crops to ensure food security must be tackled (Ndanitsa, 2005; Ndanitsa and Umar, 2007; Balogun *et al.,* 2012). Vegetable production has been playing a vital role in human nutrition, poverty reduction and improving the socio-economic status of farmers. Vegetables like watermelon are important items in the daily diet of the Nigerian family. They are cheap and readily available source of vitamins, minerals and dietary fibre, and are low in fat and calories (Abba, 2004). Similarly, there is also reported shortfall in watermelon supply with respect to local demand thereby putting pressure on the price of the watermelon during off-peak period. This makes watermelon unaffordable to many households in Nigeria and further decreases the per capita consumption rate. There is little chance of malnutrition occurring where enough vegetables are consumed. Watermelon consumption is on the increase due to the increasing awareness of its

nutritional value, its production has not been popular among farmers in Niger State (Dauda *et al.,* 2008). The productivity of farmers can be raised by adoption of improved technologies or improvement in efficiency or both. Meanwhile, most of the efficiency studies carried out in the Northern parts of Nigeria (Hamidu, 2000; Baiyegunhi *et al.,* 2010; Jirgi, 2013) have shown that resources are not efficiently utilized. To achieve economic optimum output and thus profitability, resources have to be optimally and effectively utilized.

The current challenges of rising costs of production requires a focus on technically efficient production systems. Profit maximization requires a farm enterprise to produce the maximum output given the level of inputs employed, use of the right mix of inputs in the light of the relative price of each input (input allocative efficiency). In spite of various initiatives aimed at improving the agricultural sector, especially the horticultural sub-sector, the sector still remains relatively underdeveloped. The horticultural and vegetable sub-sector of agriculture also reflects the problems in the agricultural sector. These constraints include inadequate knowledge and technology of production, insufficient planting materials, land tenure problems, poor extension services and insufficient post-harvest facilities (Babatola, 2004). This has call for urgent research on fruits and vegetable production (especially watermelon) in Niger State and Nigeria at large.

Watermelon product is sold in fresh form for human consumption. The absence of adequate storage and processing facilities contribute to its glut in the market, forcing the price to fluctuate thereby affecting the producer's income and jeopardize farmers' confidence in its continuous production (Ndanitsa, 2005 and Ndanitsa, 2007). It is therefore, important to generate evidence-based information on productivity of resource use and profitability of watermelon production in Niger State, Nigeria.

The broad objective of this study was to examine the economics of watermelon production in Niger State. However, the specific objectives were to: (i) describe the socio-economic characteristics of watermelon farmers in the study area; (ii) describe the marketing channels of watermelon; (iii) estimate the costs and returns as well as profitability in watermelon production; (iv) determine the technical efficiency of watermelon; (v) identify the distribution of technical efficiency of watermelon; and (vi) identify the constraints of watermelon production.

However, its overall resource use inefficiency can seriously affect production and realization of its potential. The profitability of this agricultural enterprise could only be improved upon if the current levels of productive resource-use and activities are known. The productivity of farmers can be raised by adoption of improved production technologies and providing sustainable ways of improving output of the crop through a more efficient use of the resources at the farmers disposal (Ndanitsa, 2005; Ndanitsa, 2007 and Mairabo, 2021).

MATERIALS AND METHODS

The Study Area

The study was conducted in Niger State which is in Guinea Savannah ecological zone of Nigeria. The States coordinates is 10.2155^{o}N, 5.3904^{o}E. With annual growth rate of 3.4%, the state has estimated population of 5,337,149 in 2015, of which 85% of the people are farmers, while the remaining 15% engaged in other businesses. Annual rainfall ranges from 1,100 mm in the Northern part to 1,600 mm in the Southern part of the state. The mean average temperature is around 32^{o}C. Major crops grown in the state include yam, cotton, maize, sorghum, millet, soybean, cowpea, rice and groundnut. Some of the major tree crops cultivated in the state include mango, citrus, cashew, banana, pawpaw. Vegetables and fruits cultivated include spinach, okra, tomatoes, pepper, melon *egusi* and watermelon. Livestock animals

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reared are goat, sheep, cattle, chicken, camel, donkey, horse and pets, like dogs and cats. The state is bordered to the North by Zamfara State, West by Kebbi State, South by Kogi State, South-West by Kwara State, North-East by Kaduna State and South – East by Federal Capital Territory (FCT). The State also shares an International Boundary with the Republic of Benin along Agwara and Borgu LGAs to the North West, and this gives opportunity for trans – bordered trading, especially of agricultural commodities (Ndanitsa *et al.*, 2021). The State covered a land area of 93,700square kilometers (about 10% of the total land area of Nigeria) out of which about 85% is arable. The three principal ethnic groups of the State are the Nupe, the Gwari and the Hausa. Other ethnic groups include the Koro, the Kadara, the Kambari, the Kamuku, the Pangu, the Bassa, the Fulani, the Dukawa, the Gade, the Godara, the Ganagana, the Mauchi, the Ayadi, the Ingwai, the Dibo, the Kakanda, the Gulengi, the Abishiwa and the Shigini. Most of the groups can be said to have evolved and instituted a system of political leadership with either a king or chief surrounded by other title holders.

Sampling Procedure and Sample Size

The unit of the population of the study is watermelon farmers in the study area (Niger State). Preliminary investigations on the study suggests that Lapai LGA (in Agro-ecological zone I) and Mashegu LGA (in Agroecological zone II) are the areas where the crop is commonly cultivated (Table 1).

Table 1: Sampling Procedure for Watermelon Farmers in Niger State, Nigeria

LGAs	List of villages	30% of villages	Number of farmers	60% of farmers
Lapai	Ebo	Muye	15	9
	Muye			
	Birnin Maza	Ebo	58	35
	Tashibo			
Mashegu	Kawo Mashegu	Mallamawa	33	20
	Gadan Kasanga	Tudun Kuba	31	19
	Mallamawa	Gadan Kasanga	49	29
	Tudun Kuba	Kawo	64	38
	Koboji			
	Kawo			
	Jemako			
	Tungan Maje			
	Magama			
	Tungan Boka			
	Sabon Rami			
	Jigawa			
Total	**18**	**6**	**250**	**150**

Field Survey data, 2020

Multi-stage sampling technique was used to select respondents (farmers of watermelon) for the study. In the first stage, Lapai and Mashegu LGAs were purposively selected for the study due to high concentration of its growers as shown in the preliminary survey. The second stage involves the selection of localities (villages) producing watermelon from the list of sampling frame provided/obtained from the Block Extension Supervisors (BES) in the state, and 30% of the villages from the sampling frame were randomly selected from each of the two LGAs in the state. The third stage of the sampling technique involves the random selection of 60% of the farmers from each of the selected villages. The summary of the selection of sampling techniques is presented in Table 1.

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Method of Data Collection

As stated earlier, the unit of the study was the watermelon farmers in the study area. Primary data were collected from the respondents through observations and interviews; using a structured questionnaire, interview schedule by the researcher with the assistance of trained enumerators. The questionnaire was used to elicit information on the socio-economic characteristics of the respondents such as age, gender, marital status, household size, educational status, trading activities and years of farming experience. Other information and variables inventoried include: Farm production and management data; covering all information from land preparation to harvesting with respect to the quantity and cost of purchased inputs used in the production of watermelon. Some specific information collected also include:

Methods of Data Analysis

Descriptive statistics (means, frequency distribution tables, frequency counts, grouping, measures of dispersion and percentages) and inferential statistics (stochastic frontier analysis using simultaneous equation model; farm budgeting techniques) were used to achieve the stated objectives of the study. Accordingly, descriptive statistics was used to achieve the socio-economic characteristics (objective i) and constraints faced by the watermelon farmers in the study area (objective vi). Farm budgeting technique is widely used in farm management and production economic studies for the determination of costs and revenue for a given production period (Olayide and Heady, 1982). Farm budgeting tool enables the estimation of the total expenses (costs) as well as total receipts (revenue) within a production period (Olukosi and Erhabor, 1988). Net Farm Income is a budgeting tool used in evaluating tool the costs and returns of farm (Olukosi and Erhabor, 1988). The net farm income is defined as total revenue (TR) minus total cost (TC). This was used to estimate the costs and returns in watermelon production in the study area (objective iii). Furthermore, the total cost of production includes both total variable cost and total fixed cost. Total variable cost includes; cost of seed, cost of fertilizer, cost of labour, and cost of agrochemicals, while Total Fixed cost include cost of land. The model is specified as follows:

$NFI = TR - TC$ …(1)

$TR = GFI = TVP = TPP.P_X$ …(2)

$TC = TVC + TFC$ …(3)

$GFI = TVP = TPP.P_X$ …(4)

where;

NFI = Net farm income (Naira/ha)

TR = Total revenue (Naira/ha)

GET = Gross farm income (Naira/ha)

TVP = Total value of production (Naira/ha)

TPP = Total physical product (Kg/ha)

P_x = Unit market price of the product (Naira/kg)

TC =Total costs of production (Naira/ha)

TFC = Total fixed cost (Naira/ha); i.e., cost of renting land and depreciation allowance.

TVC = Total variable cost (Naira/ha); i.e Cost of Purchase inputs, such as fertilizer, labour and agrochemicals.

GM = Gross margin (Naira/ha)

Meanwhile, the fixed inputs are not normally used up completely in a single production cycle. They will be depreciated using the straight-line method, which is given by the expression below:

$D = (P - S)/N$ …(5)

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where;
P = Depreciation (Naira)
P =Purchase value (Naira)
S = Salvage value (Naira)
N = Life span of asset (Years)

Stochastic frontier production function was employed to determine the Technical efficiency factors affecting the output of watermelon production among farmers in the study area (objective iv). The approach in its implicit form is given by:

$Y_i = f(x_i\ \beta) + \ e_i$ …(6)

$e_i = \ v_i - \ u_i$ …(7)

where;
Y_i = quantity of output of the ith farm
x_i = Vector of the inputs used by the ith farm
β = a vector of the parameters to be estimated
e_i = composed error term
v_i = random error outside farmer's control
u_i = technical inefficiency effects
$f(x_i,\beta)$ = a suitable function of the vector

Following (Greene, 2005; Ndanitsa, 2005, Abdullahi, 2021; Mairabo, 2021 and Ndanitsa, 2021), Cobb Danglas functional form was chosen as the lead equation, and is specified as follows:

$In\ Y = \ \beta_0 + \ \beta_1 + \ In\ x_1\ i + \beta_2\ In\ x_2\ i + \beta_3\ In\ x_3 i + \beta_4\ In\ x_4\ i + \ \beta_5\ In\ x_5 i + (v_i - u_i)$ …(8)

where;
In = The Natural Logarithm
Y = Output of watermelon (kg)
β_0 = Constant term
β_1-β_5 = regression coefficients
x_1 = farm size (ha)
x_2 = quantity of seed (kg)
x_3 = quantity of fertilizer (kg)
x_4 = total labour used (man-days)
x_5 = quantity of agrochemical (pesticides) (litres)
v_i = random errors outside the farmers' control
u_i = technical inefficiency effects

The determinants of technical inefficiency are defined by:

$U_i = \ \delta_0 + \ \delta_1\ In\ Z_1 + \ \delta_2\ In\ Z_2 + \ \delta_3\ In\ Z_3 + \ \delta_4\ In\ Z_4 + \ \delta_5\ In\ Z_5 + \ \delta_6\ In\ Z_6 + \delta_7\ In\ Z_7$ …(9)

where;
U_i = Technical inefficiency effects.
δ_0 = Constant
$\delta_1\ - \delta_7$ = Parameters to be estimated
Z_1= Age of farmers (years).
Z_2 = Formal education (years of formal schooling).
Z_3= Household size (number of years in farming watermelon.
Z_5 = Watermelon related cooperative membership (years of participation).
Z_6= Amount of credit obtained (Naira)
Z_7 = Extension visit (number of visits).

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RESULTS AND DISCUSSION

Socio-economic and Demographic Characteristics of Sampled Watermelon Farmers

The socio-economic characteristics considered for analysis include age, household size, level of education, farming experience, marital status, membership of cooperative organization, and extension contact. The analysis of these variables is presented in Table 2. The result in Table 2 shows that majority of the respondents (68%) were within the age brackets of 30 – 49 years old, with mean age of 41 years and with the CV of 24.3%. This implies that majority of the respondents are still within the productive working age, active, agile and can withstand the demands (labour) for watermelon farming. Adesoji and Farinde (2006), Ndanitsa (2021) and Mairabo (2021) found out that age of farmers is very critical in agricultural production, and that farmers below the age of 40 years are engaged in rigorous farm work to accomplish cultural practices such as planting, weeding, and harvesting. Crop production in the rural areas is still dominated by the use of locally fabricated manual farm implements, generally referred to as crude tools, like hoes, cutlasses and sickles. Abdulgafar *et al.* (2017), also reported an average age of 43.6 years for farmers in Niger State of Nigeria.

Results in Table 2 further show that majority of the respondents sampled (98.0%) were males while the remaining (2.0%) were females. They constitute the farmers cultivating watermelon in the study area. This shows that male farmers actually dominated the farming population (of watermelon), probably because farming is labour intensive. Also, majority, that is 88.0% of the respondents were married. This implies that majority of watermelon farmers in the study area were married. This is in line with the study by Abdullahi (2010), who reported that large proportion of small-scale farmers in Nigeria are males and are married. This finding is also in conformity with the finding of Idi (2016) who suggested that the dominance of married farmers in a community is care for the family. Similarly, Mairabo (2021) also revealed the importance of marital status on agricultural production to be associated with the supply of agricultural family labour. Based on these findings, it is expected that family labour would be readily available for the production of watermelon in the study area, since the majority of the farmers were married couples.

Table 2 also reveals the educational status of respondents in the study area. The highest level of education attained by farmers is important, as it has a direct relationship with ability to acquire skills, especially for modern farming practices. Table 2 also reveals the educational status of respondents in the study area. It shows that majority of the respondents (92.7%) had one form of formal education or the other. About 8.7% of farmers had up to primary level of education, 38.7% had up to secondary and 12.0% had tertiary education. This implies that 59.4% of the farmers are literate and modernized, and would be willing to adopt innovations to enhance productivity via credit obtained with consequent increase in income. This will also ease the problem of training farmers on how to access and effectively utilize agricultural credit obtained (Ndanitsa, 2011). This is in agreement with the findings of Ogah (2011), Akaya (2015), who both in a separate study, stated that the level of education determines the level of available opportunities geared towards improved livelihood, food security enhancement, and poverty reduction. Similarly, Simoniyan and Balogun (2010) submitted that education increase farmer's ability to make correct and meaningful choices or decisions of farm operations, while Ogah (2011) had earlier established that the level of education raises human capital investment and increases their managerial ability.

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Table 2: Socio-economic and Demographic Characteristics of Respondents

Characteristics	Frequency
Age (Years)	
20 – 29	14 (9.3)
30 – 39	63 (42.0)
40 – 49	39 (26.0)
50 – 59	28 (18.7)
>59	6 (4.0)
Total	150 (100.0)
Minimum	20
Maximum	75
Mean	41.0
Standard deviation (SD)	9.9
Coefficient of Variation (CV)	24.3
Household size	
1 – 5	29 (19.3)
6 – 10	68 (45.3)
11 – 15	30 (20.0)
16 – 20	15 (10.0)
>20	8 (5.3)
Total	150 (100.0)
Minimum	1
Maximum	28
Mean	9.0
SD	5.6
CV	55.9
Educational level	
No formal education	11 (7.3)
Primary education	13 (8.7)
Secondary education	58 (38)
Tertiary education	18 (12.0)
Adult education	5 (3.3)
Quranic education	45 (30.0)
Total	150 (100.0)

Note: Figures in parentheses are percentages
Source: Field Survey Data Analysis, 2020

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Table 2: Socio-economic and Demographic Characteristics of Respondents **Cont'd**

Characteristics	**Frequency**
Farming experience	
1-5	18(12.0)
6-10	26 (17.3)
11-15	16 (10.7)
16-20	47 (31.3)
21-25	14 (9.3)
26-30	6 (4.0)
31-35	8 (5.3)
36-40	8 (5.3)
>40	7 (4.7)
Minimum	150 (100.0)
Maximum	2
Mean	65
SD	11.9
CV	62.7
Marital status	
Single	15 (10.0)
Married	132 (88.0)
Widowed	3 (2.0)
Divorced	0 (0.0)
Total	**150 (100.0)**
Gender	
Male	147 (98.0)
Female	3 (2.0)
Total	**150 (100.0)**
Cooperative membership	
Member	144 (96.0)
Non-Member	6 (4.0)
Total	**150 (100.0)**
Extension contacts	
Contact	20 (13.3)
Non-contact	130 (86.7)

Note: Figures in parentheses are percentages
Source: Field Survey Data Analysis, 2020

Results in Table 2 show that a larger proportion (63.5%) of respondents had household size of between 6–15 persons. The large household size may serve as source of cheap and readily available farm labour supply depending on the compaction and very likely increased output (Adesoji and Farinde, 2006). More so, the significance of household size in agriculture hinges on the fact that the availability of labour for farm production activities, the total area cultivated to different crop enterprises, the amount of farm produce retained for domestic consumption, and the mark table surplus are all determined by the size of farm household (Abdulazeez, 2015; Ndanitsa, 2017; Ndanitsa 2021 and Mairabo, 2021).

The faming experience of the respondents in the study area measured the number of years they were involved in farming activities. The mean farming experience was 19 years. The minimum and maximum farming experience for the farmers was 2 and 65 years respectively, while the CV was 62.7, which suggests that there is high level of variation in the farming experience among the watermelon farmers in the study area. Gomina (2015), posited

that farming experience is used as a measure of efficiency in management, i.e., the more experience a farmer is the more his ability to manage farm resources effectively and efficiently, which is expected to translate in to higher returns for entrepreneurs in an area. The finding of this study further buttresses the work of Afolabi (2010), on the analysis of low repayment amongst small scale watermelon farmers, which established that farming experience, has significance on the ability of the farmers to acquire and repay low advanced to them. The finding is also in live with Dauda *et al.* (2015) who reported that majority (86.5%) of the farmers in Niger State had more than 10 years' experience in farming. It is however in disagree went with the findings of Amao *et al.* (2014) and Sani (2015), who reported that watermelon farmers with more than 10 years of experience in Oyo State and Kaduna State respectively were 54% and 67%. The disparity could be as a result of the differences in location as well as in the extension agents serve as a link between the research institutes and farmers. The study revealed that 31.3% of the watermelon farmers had access to extension contact, majority (68.7%) of the respondents had no access to extension contact. This suggests that there are still significant challenges in providing extension and advisory services (access to adequate knowledge, improved technology, financial services and other relevant social services in the area. This can be attributed to poor funding of extension delivery systems, poor resourcing, low extension to farmers and ratio, hinted involvement of rural farmers and populations in extension processes and stencil type training activities for which every farmer is expected to fit into (Ndanitsa, 2013), to the lack of appropriate strategies for effective research and adequate extension methods (IFPRI-World Bank, 2010). The adoption and new technology/innovation by the farmers is a function of their access to technology, modern education and frequency of extension n visit to them. An extension worker are the key actors for disseminating information to the farmers about innovations by the research institutes as well as gives the researcher (or the research institutes) feedback about farmers' challenges for possible remedy.

Marketing Channels for Watermelon in Niger State

Watermelon is a commodity that the farmers must sell within the shortest possible time or smell the product (Ndanitsa *et al.*, 2020), this is because the product has a low shelf life. Watermelon is a highly valued fruit that is cultivated and marketed within the State for its watery and fleshy juice that is highly appreciated by its numerous consumers. Generally, there are four (4) key actors or players involved in watermelon enterprises, especially its marketing. They include producers, wholesalers, retailers and the consumers. The first stage in watermelon marketing system are the producers who often provide the fruits to other actors either directly or indirectly till reaches the hands of the ultimate consumer. These producers (farmers) sell their commodities in the field or in commercial markets at farm gate prices, directly to the wholesalers with just low retailers that will be opportune to buy directly from the producers. The wholesalers are the marketers who purchase and sell the commodity in high quantity. They purchase the product from the producers and/or from other wholesalers in the marketing chain. They transport the fruit from buying markets to the selling markets, where they sell to other wholesalers and to retailers and at times they sell to consumers. Similarly, the retailers are the next actors who purchase by retail and also sell by retail. Retailers can operate from the producers' environment. Sometimes, these retailers purchase product at farm gate price from the producers, but majority of the retailers purchase their products from the wholesalers. All the marketing agents carry out one form of marketing functions or the other from the point of production to the ultimate consumption level, e.g., transporting, sorting, grading, storing, packaging, etc. Figure 1 shows the marketing channel of watermelon in Niger State, Nigeria.

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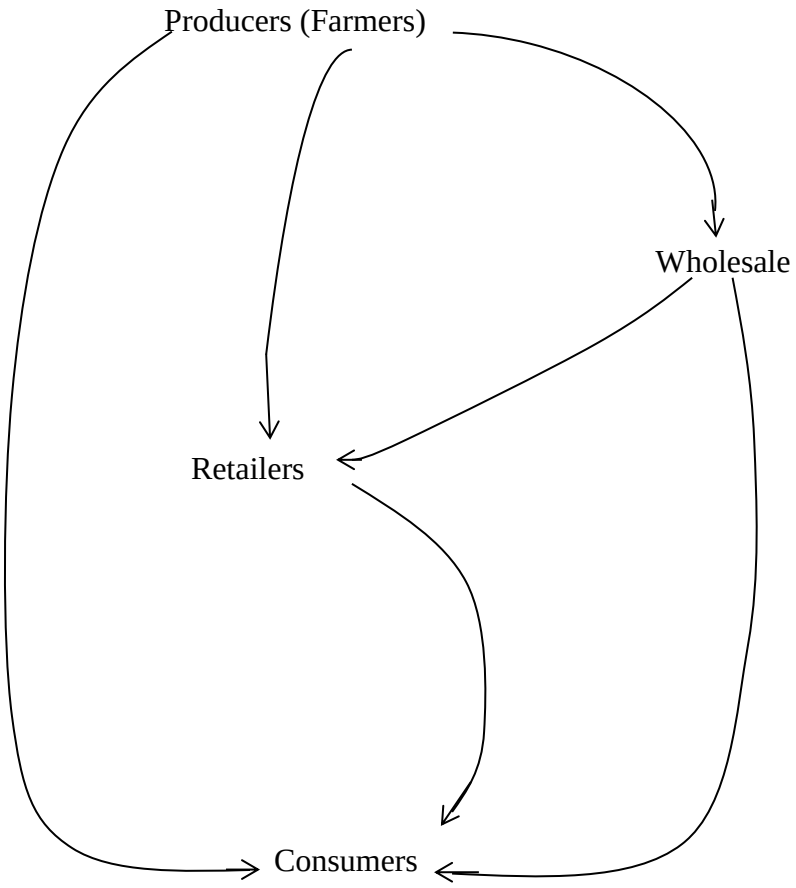

Figure 1: *Marketing whannels of Watermelon in Niger State, Nigeria.*

Profitability of Watermelon Production in Niger State

The result of cost and return analysis which helps to determine the profitability of watermelon in the study area is presented in Table 3. The Table indicates that estimated cost and returns analysis for watermelon production result show that the total cost incurred was ₦74, 977.94/ha which comprises of the total variable cost of ₦60, 026.49/ha and total fixed cost of ₦14, 951.45/ha. The cost of labour was found to be the highest cost component, accounting for about 46.01%, followed by transportation (24.16%) and land (rent) (11.60%). Similarly, a typical watermelon farmer in the study area realizes a total revenue of ₦534, 747.50/ha, and net farm income of ₦459, 769.56/ha and a return on investment of 6.13. This finding corroborates with that of Ndanitsa (2005), in his study of economics of *fadama* crop production in Niger State of Nigeria. The researcher revealed a total revenue of ₦535, 400/ha, and a net farm income of ₦450, 780.00/ha and a net return to investment of 6.42 in vegetable/fruit production. However, the researcher further revealed that the income benefit was secured with a high variable cost for the enterprise, as over 90% of the total cost of production was accounted for by the variable cost, and that the cost of lobour input alone constituted over 35%. Thus, it can be concluded that watermelon production in the study area is economically viable. This finding is in consonance with Sani and Haruna (2014) in a study on impact of *fadama* III project on resource utilization under rainy season and dry season water melon production; who reported average mean (27.1 tons/ha) total area contribution to output valued at ₦1,733.0 per ton. In dry season, it was 100.7 tons/ha valued at ₦1,812.0 per ton for beneficiaries compared with total area contribution to output of 70.8 tons/ha valued at ₦425.0

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per ton for non-beneficiaries. This signifies that the beneficiaries were better off than the non-beneficiaries in both rainy and dry season farming in terms of total plot area cultivation. This result is also in line with those of Baba *et al.* (2014), Sani (2015), Ndanitsa *et al*. (2017) and Ndanitsa *et al*. (2021) in their separate studies in Kebbi State, Kaduna State, Niger State and Niger State, respectively.

Table 3: Cost and Return Analysis of Watermelon Production

Item	Average quantity per hectare	Unit Price (₦)	Value (₦)	Percentage of total cost (%)
A. Revenue				
Yield (Number of Fruits)	2,138.99	250.00	534,747.50	
B. Variable Cost				
Seeds (kg)	2.4	160	3840.00	0.51
Fertilizer (kg)	61.92	64.50	3,993.84	5.33
Agrochemicals (Ltr)	2.76	1,100	3,036.00	4.05
Labour (Man days)	69	500	34,500.00	46.01
Transportation			18,112.65	24.16
Total Variable Cost (TVC)			60,026.49	
C. Fixed Cost				
Land/Rental (ha)			8,000.00	10.67
Depreciation Allowance on Farm Implements			6,951.45	
Total Fixed Cost (TFC)			14,951.45	
Total Cost (TC)			74,977.94	
Gross Farm Income (GFI) (TR-TVC)			474,721.01	
Net Farm Income TR-TC			459,769.56	
Return on Investment NFI/TC			6.13	

Source: Field Survey Data Analysis, 2020

Technical Efficiency Factors in Watermelon Production in Niger State

This estimates the technical efficiency of watermelon farmers in the study area. The Maximum Likelihood Estimates (MLE) of the stochastic production frontier used to determine the technical efficiencies of respondents is presented in Table 4. Table 4 shows the MLE of the stochastic frontier production function for the watermelon farmers in the study area. The estimated sigma square (σ^2) is 0.007, which is significant at 1%, Lamda (λ) estimated at 1.237 is greater than 1. This indicates a good fit and the correctness of the model specified (distributional assumption) of the composite error term (Tradesse and Krishmamoothy, 1997). Similarly, out of the five variables included in the model, only farm size was statistically significant at 1% significant. This suggests that a 1% increase in the area under watermelon cultivation will result in increased production of watermelon by the farmers (0.844 units) *cetris paribus.* This result is in line with the *apriori* expectation, which states that as an area under cultivation increase, farmers' output also increases, and this result is supported by the findings of Abdulahi (2021), where farm size significantly determines the output of maize and melon respectively at 1% significant levels. However, the coefficients of agrochemicals, labour, seeds were not statistically significant, and thus they do not have significant impact on the efficiency of watermelon in the study area.

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Table 4: Maximum Likelihood Estimates (MLE) of Stochastic Production Function of Watermelon Farmers in Niger State, Nigeria.

Variable	Parameter	Coefficients	Standard Error	t-value
Constant	β_0	4.163***	0.365	10.96
Farm size	β_1	0.844***	0.187	4.03
Fertilizer	β_2	0.167	0.116	1.49
Agrochemicals	β_3	-0.143	0.105	-1.28
Seed	β_4	-0.012	0.0174	-0.06
Labour	β_5	0.028	0.095	0.33
Sigma squared		0.007		
Lambda		1.237		

***implies significant level at 1% probability level
Source: Field Survey Data Analysis, 2020

Distribution of Technical Efficiency in the Study Area

Technical efficiency of 0.9 and above signifies optimal use of inputs. Therefore, Table 5 shows that 68.67% of the respondents optimally utilized their farm inputs (seeds, land, fertilizer, agrochemicals, and labour). As a result, it is expected to decrease inefficiency effects, and encourage higher production in the study area. This finding is in corroboration with Mairabo (2021) and Abdullahi (2021).

Table 5: Distribution of respondents based on Technical Efficiency Score

Technical Efficiency Score	Frequency	Percentage
0.83 – 9.01	2	1.33
0.91 – 0.95	45	30.00
0.96 – 1.07	103	68.67
Total	**150**	**100**

Source: Field Survey data Analysis, 2020

Constraints Associated with Watermelon Production

The constraints associated with watermelon production as identified by the respondents in the study area were ranked according to their severity, and is presented in Table 6. In other words, the constraints in decreasing magnitude of importance were problem of inadequate capital, problem of poor market integration and market linkages, problem of small size of farmland (subsistence production), inadequate rainfall/lack of irrigation facilities, poor road network and high cost of transportation, problem of pests and diseases infestation, inadequate processing and storage facilities, inadequate capital, problems of natural disasters like flooding and bush fires, poor market pricing high cost of inputs, inadequate extension services among others.

Table 6 revealed that the major constraints encountered by the respondents in the study are were high cost of inputs and their inadequacies (81.33%)(ranked 1st), followed by small size of farmland or subsistence production (77.33%), poor market integration and pricing of the commodity (78.67%), inadequate rainfall and lack of irrigation facilities (76.67%) and were ranked 2nd , 3rd and 4th, respectively. This suggests that high cost of inputs and their inadequacies by the farmers constitute a serious problem to watermelon farmer's productive capacity. This problem cannot be unconnected with the continuous devaluation of the Naira (₦) in the International Monetary Market. Most farmers also depend on natural rainfall in the production of watermelon, and this has been erratic in recent times, more so irrigation facilities

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are uncommon in most of these areas, thus making productively of watermelon very low and seasonal.

Table 6: Constraints associated with watermelon production (n = 150)

Constraints	*Frequency	Percentage	Rank
Problems of inadequate capital	92	61.33	8th
High cost and inadequate production inputs	122	81.	1st
Small farmland (subsistence production)	116	77.33	2nd
Poor market integration/pricing	118	78.67	3rd
Problem of pests and disease infestation	101	67.33	6th
Inadequate rainfall/lack of irrigation facilities	115	76.67	4th
Problem of natural disasters (e.g., flooding/bush fires)	40	26.67	10th
Poor road network and high costs of transportation	110	73.33	5th
Inadequate storage and processing facilities	94	62.67	7th
Inadequate extension services	48	32.00	9th

Source: Field Survey Data Analysis, 2020

Poor road network and high cost of transportation is a very serious problem not only in the rural communities, but even in the urban centers. This makes the movement of the product very difficult. Similarly, Ndanitsa (2005) submitted that the high cost of transportation is as a result of the continued deregulation of the downstream sector of the petroleum industry, and Abdullahi (2021) revealed that this development is capable of jeopardizing the confidence of the farmers to produce more. Mairabo (2021) also opined that high cost of improved seeds often forced watermelon farmers to continue recycling seeds from previous harvests which is not reliable and can jeopardize improved and sustainable productivity. This position was earlier affirmed by Ekong (2003) that farmers having little or no access to improved seeds continue to recycle exhausted seeds from generation to generation of cultivation. Sani (2015) also opined that watermelon farmers in Kaduna State, Nigeria, do not pull their resources together to acquire labour saving devices, such as mechanized farm inputs so as to reduce the cost of labour, other input supplies for watermelon production and consequently increase the profitability.

CONCLUSION AND RECOMMENDATIONS

Based on the empirical evidence from the findings of this study, it can be concluded that watermelon production in the study area (Niger State of Nigeria), is a highly profitable enterprise, especially for its growers. The study recommended as: enhance technical efficiency, it has become imperative to sustain production of watermelon through provision of credit facilities and implementation of agricultural development programmes in the State. Also, appropriate measures must be put in place by the government through its agencies in terms of input supply as well as logistics, which could help ensure efficiency in watermelon production. Watermelon farmers should pull their resources together under cooperative societies, to enable them proffer solutions to the problems of input supplies that is bedeviling its production. Since labour cost was identified as the most predominant cost item in watermelon production in the study area, there is need for research institutes to develop low cost technologies that will reduce the level of labour input dependent for various farm operations thereby reducing the cost of watermelon. Youths should be encouraged to go into watermelon production in the study area, so as to replace the current aging population. This can be facilitated through training and retraining of youths and access to low credit facilities. Similarly, Government and Non-

governmental organization (NGOs) should partner in promotion of agricultural programmes that will boost the production of watermelon in the area through advising support services, capacity building, skills acquisition, and extension services. Finally, farm inputs and supplies such as machineries and equipment, improved seeds, agrochemicals, fertilizers should be provided in time and at affordable prices to the farmers by relevant authorities. This will go a long way in encouraging than to increase productively, increase income and consequently improve their standard of living.

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