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Jibrin et al., ., Nigerian Journal of Agricultural Economics (NJAE). Volume 13 (1), 2023: Pages 31- 38

ANALYSIS OF TECHNICAL EFFICIENCY OF WATERMELON PRODUCTION IN KONDUGA LOCAL GOVERNMENT AREA, BORNO STATE, NIGERIA

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ABSTRACT
The study investigated the technical efficiency of watermelon production in Konduga Local Government Area of Borno State, Nigeria. Primary and secondary information for the study were obtained by the use of structured questionnaire. A two-stage random sampling procedure was employed. The first stage was the purposive selection of four villages while the second stage involved simple random sampling of 10 watermelon farmers from each of the selected villages resulting to a total of 40 respondents. Descriptive statistics, gross margin and inferential statistics were used for the analysis. Gross Margin Analysis was used to estimate profitability. A stochastic frontier model estimated technical efficiency of watermelon farmers in the area. The gross margin revealed that watermelon production is profitable. The result also showed that the key determinants influencing watermelon production were farm size, NPK fertilizers and labour. The sigma value indicated that watermelon farmers in the area are technically efficient. Quantity of watermelon seeds, farm size, agro-chemicals, NPK fertilizers, labour used and hired labour are the determinants of watermelon production and the farmers are technically efficient. Although pests and diseases, water scarcity, lack of improved seed, and poor market price are some of the constraints to watermelon production, the major constraints are finance, high transportation costs and high cost of labour. The study recommends government policy that will make credit accessible to watermelon farmers subsidize transport services and attract more labour to the sub- sector.

Key words: Analysis, Technical efficiency, Watermelon, Production, Konduga LGA.

INTRODUCTION
Watermelon (*Citullus lanatus*) is the fruit of a plant originally from a vine of Southern Africa. It is a member of the *Cucurbitaceae* family and is one of the most widely cultivated crops in the world at large and global production in 2012 reached 89.9 million mega grains. The crop is grown commercially in areas with long frost-free warm periods (Okeke, 2020). China, Turkey, Iran, Brazil, United States, Egypt and the Russian federation are the major watermelon producers in the world (Okeke, 2020).
Watermelon is usually an annual crop grown here in Nigeria. It can be planted as early season crop at the beginning of the rain and it has the advantage of being sold in the market throughout the year. Nigeria produced approximately 3.2 million metric tons of watermelon in 2020 (Ife, 2021).

Its fruit contains about 6% sugar and 91% water, is a good supplier of vitamin C and low in fat and sodium. It aids weight loss and has been recommended for obsessed people and aid for others to maintain steady body growth. It is highly nutritious and thirst-gunching and also contains vitamin C and A in the form of disease fighting agents. Watermelon contain large amount of beta carotene. Potassium is also available in it which is believed to help in control of blood pressure and possibly prevention of stroke (Okeke, 2020). Watermelon is utilized to produce juices, nectars and fruit cocktails.

Production of watermelon differs over time depending on location. Watermelon grows well both in the humid and drier savanna agro ecologies. Costs such as water and land least vary by the production location, but the amounts of inputs such as fertilizer, pesticide, depend on weather and soil. Generally, watermelon production is labour intensive, especially in harvesting and postharvest handling. Several reasons have been the basis for the need for improving production of watermelon; one of which is that it can survive even in a water-logged area (Ife, 2021).

The productivity of farmers can be raised by adoption of improved production technologies or improvement in efficiency or both. But with the low rate of adoption of improved technologies by farmers in Nigeria, improvement in efficiency becomes the best option in productivity enhancement in the short run (Johnson, 2019). Information on efficiency of production is important because the presence of shortfalls in efficiency means that output can be increased without additional inputs and new technology. Therefore, there is a need to provide empirical information on farm level production of technical efficiency on small-scale watermelon production.

Technical efficiency here refers to the ability to produce the highest food output with a given bundle of resource. Resources such as land, labour, water, seed, fertilizer and pesticides are utilized in a manner that maximizes output. Watermelon farmers operate under different conditions such as the quality and disease, weather changes, soil erosion and limited access to credit facilities. To determine the technical efficiency of watermelon production in Borno state, various components should be considered such as land preparation seed selection, irrigation techniques, fertilizer application, pest and disease management and harvesting methods. This will impact on the overall productivity and efficiency of watermelon farms in the state.

With the low rate of adoption of improved technologies by farmers in Nigeria, improvement in efficiency becomes the best option in productivity enhancement in the short run (Onyeke, 2021). Although some researches have been carried out on watermelon production little researches are carried out to investigate the technical efficiency of watermelon farmers. Okeke, (2020) worked on the production process for watermelon which includes research on the labour and equipment required for watermelon production.

Information on production efficiency is important because of the presence of shortfalls in efficiency means that output can be increased without additional inputs and new technology. The study analysed technical efficiency of watermelon production in Konduga Local Government, Borno State, Nigeria. Specifically, the study described the socio-economic characteristics of the watermelon farmers in the study area; evaluated the profitability of watermelon production; estimated the technical efficiency of watermelon producers; and identified the constraints associated with watermelon production in the study area.

METHODS AND MATERIALS

Study Area: *Konduga* Local Government Area is one of the 27 Local Government Areas of Borno State in Nigeria. It lies between longitude: $13^0 23^1$E - $13^0 28^1$E and latitudes: $11^0.37^1$N - 11.41^1N (Figure 1): *Konduga* LGA. It has an estimated population of 230,500 projected to 2022 and covers an area of 263 square kilometres. The borders of this area include Maiduguri Metropolitan Area to the North, Jere Local Government Area to the west, *Damboa* Local Government Area to the south, *Chibok* Local Government Area to South-East and *Ngala* Local Government Area to the North-West (Adams *et. al.,* 2020). *Konduga* LGA has a semi-arid climate with an average annual rainfall of about 500-600mm. The main vegetation in the area is thorny shrubs and grasses, along with some trees like *Terminalis serenoa*, Neem and Acacia. The ethnic groups in Konduga LGA are Kanuri, Hausa, Shuwa, Bura and Fulani. The main crops grown there are sorghum, millet, cowpea, groundnut and maize. The area is also home of livestock such as cattle, sheep and goat (Adam, 2020).

The production of watermelon in Borno State (*Konduga* Local Government Area) is mainly done during dry season, as watermelon requires warm temperatures for optimal growth. Farmers in

Konduga LGA typically start planting watermelon seeds in February or March depending on the availability of irrigation facilities to ensure successful watermelon production. The farmers prepare the land by ploughing and harrowing to create a well-drained soil, they also utilize organic fertilisers or compost to enrich the soil with necessary nutrients. Farmers often use drip irrigation or sprinkler system to provide water to the plant, ensuring they have sufficient moisture for healthy growth. Harvesting of watermelon usually takes place about 75 to 90 days after planting, depending on the variety. Farmers in Borno state look for signs of ripeness, such as change in colour of the fruits skin and drying of the curly tendril near the fruit stem (Onyeke, 2021).

Data for this study were obtained from both primary and secondary sources. The primary data involved the use of an interview schedule with a well-structured questionnaire administered to the farmers engaged in watermelon production. While secondary information involved the use of articles, journals and past student projects. Data were collected from the producers in the month of May/July 2023.

A two-stage sampling technique was used. The first stage involved a purposive selection of four villages popularly known for watermelon production. These are *Mundilmari, Dunomari, Malari* and *Takari*. The second stage involved a simple random selection of 10 farmers from the selected villages. A total of 40 respondents were selected.

The analytical tools that were utilised to achieve the objectives of the study included descriptive statistics, budgetary technique and inferential statistics. Descriptive statistics used included frequency distribution and percentages to describe the socio-economic characteristics of watermelon farmers in the study areas and identify the problems associated with watermelon production.

The farm budgetary techniques adopted to determine the profitability, costs and return in watermelon 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 Costs Incurred (TVC). If the outcome is positive, then watermelon production is profitable, if otherwise, it is a loss.

The Gross Margin Model is stated thus:

$$GM = TR - TVC$$

TR = Total Revenue obtained from Sales from watermelon (₦)

TVC = Total Variable Cost (₦),

Stochastic Frontier Production Function model is the inferential statistics used for the analysis of farmers technical efficiency. The model in its explicit form is specified as:

$$Y^* = \alpha o + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6$$

Where:

Y^* = Technical inefficiency effects

Z_1 = quantity of watermelon seeds (kg)

Z_2 = farm size cultivated (ha)

Z_3 = quantity of agrochemicals used (litres)

Z_4 = quantity of NPK fertilizers used (kg)

Z_5 = labour used (₦/man days)

Z_6 = hired land (₦/season)

α_1-α_6 are the scalar parameters to be estimated

αo = constant or intercept

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

$$Y = f(Xi, \beta) + ei$$

$$ei = vi - ui$$

Where:

Y = Output of watermelon (kg)

f = denote function form

X_1= quantity of watermelon seeds (kg)

X_2= farm size cultivated (ha)

X_3= quantity of agrochemicals used (litres)

X_4= quantity of NPK fertilizers used (kg)

X_5= labour used (₦/man days)

X_6= hired land (₦/season)

B_o-B_5= coefficient of parameter estimates

ei = is the error term made up of two components: vi is a random error having zero mean which is associated with random factors outside the farmers control such as topography, weather, measurement errors, disruptions of supplies and is assumed to be an independently and identically distributed N $(0,\delta^2 v)$ random variable and independent of ui. On the other hand, U_i is a non-negative truncated half normal random variable associated with farm specific factors, which leads to the i^{th} farm not

attaining maximum efficiency of production. U_i is associated with technical inefficiency of the farmers and ranges between zero and one. U_i follows an identical and independent half-normal distribution, N (0, δ^2 u). N represents the number of firms involved in the cross-sectional survey. The stochastic frontier production function model is estimated using the maximum likelihood estimation procedure (MLE) (Onyeke, 2021). The technical efficiency of an individual farm is defined in terms of the ratio of the observed output (Y) to the corresponding frontier output (Y*) given the available technology.
Tei = Y/Y* …………….………………… (5)
TEi= F (xi; β) exp (vi –ui)/F (xi; β) exp (vi) = exp (-ui) ………………. (6)
So that 0 < TEi< 1

Therefore, the technical inefficiency is equal to 0 < TEi< 1 The strength of the stochastic frontier approach is that it deals with the stochastic noise and permits statistical test of hypotheses pertaining to the structure and degree of inefficiencies.

A priori expectation: It is expected a priori that the coefficients X_1, X_2, X_5 and X_6 will be positive while the coefficients of X_3 and X_4 will be negative.

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Respondents: The result on Table 1 shows that majority (62.5%) of the respondents fell within the age range of 30-39 years. This implied that majority of the farmers (62.5%) were able bodied men and women who are in their productive, energetic and active ages and they could use improved technology and better ideas to improve their production. This is like Johnson *et al., .* (2019) study which reported that, younger watermelon producers in United States tended to have higher technical efficiency compared to older ones.

The result on Table 1 shows that majority (97.5%) of the farmers are men. Gender dynamics within the farming community indicated a significant male presence with only (2.5%) female. This gender disparity may have implications for decision-making processes, resource allocation, and the overall socio-economic development of female farmers in the study area. This is like the findings of Smith and Liu (2018) on gender dynamics in watermelon production in United States that women accounted for only 35% of watermelon producers with higher representation in small scale farming operation while 75% are men in the production of watermelon.

The result on marital status showed that (97.5%) of the respondents are married. This finding suggests that they have the responsibility of taking care of their family members so they must be involved in sustainable agriculture. This is quite possible considering the value system of a typical African society. The result further shows majority (50%) of the respondents had household size of 6-10 members, indicating the possible involvement of family members in farming activities. The distribution of household members engaged in farm work highlights the collective effort required for watermelon cultivation (Adeyemi *et al., .*, 2020).

On educational level of the respondents, the result indicated that 50% had Qur'anic education while 27.5% had primary qualification and 17.5% had secondary qualification. Thus, all the respondents are literate and are more likely to adopt modern farming techniques, utilize advanced technologies and implement efficient management.

The predominant occupation of the respondents being watermelon farming (60%) underscores the economic significance of this crop in the study area. However, the presence of 40% engaged in other occupations necessitates exploration into the diversification strategies adopted by farmers. Trading emerges a notable alternative occupation, reflecting the entrepreneurial nature of the farming community. This is like the findings of Nwachukwu *et al., .* (2019).

The duration of engagement in watermelon farming is diverse, with 37.5% of the respondents having 6-10 years of experience and 12.5% having 16-20 years. Experience in farming is a key factor affecting production. The longer the years of farming experience, the more exposed the farmer becomes and the more efficient the farmer is expected to be. It is also believed that the higher the years of farming experience of a farmer, the more the management ability of such a farmer in making farm decisions and the better the farmers were able to cope with shocks and stress.

Majority of the respondents (65%) were not members of cooperative societies while (35%) of the respondents were members of cooperative society. This is because most of the farmers were not well informed about the benefits of membership of cooperative societies which could help them in obtaining information on how to improve and boost production or probably because cooperatives may not have enough capacity to meet their needs. This is like the findings of Adams (2020) in Kaduna state, Nigeria that membership of cooperative is very important as it enhances access to information on improved technologies, markets and credits for the purchase of inputs and payment of hired labour.

Access to credit is limited, with only 15% of respondents having access to credit. The low percentage of respondents with access to credit may pose challenges for farmers in acquiring loans for expanding their farms to increase output. This is in line with Adeyemi (2020) that farmers with better access to credit facilities had higher incomes due to their ability to invest in improved irrigation system, use high quality seed and fertilizer that will provide favourable growing condition.

Profitability of Watermelon Production: The result on Table 2: shows that the Gross Revenue of ₦140,250.00, Total Variable Costs of ₦47,773.25 and Gross Margin of ₦92,476.95. This shows that watermelon production is profitable. This is like Smith and Liu (2018) which indicate that variable costs such as seeds, fertilizers and labour accounted a significant portion of total production cost of watermelon They also concluded that watermelon production was profitable and the profitability varied across regions due to differences in climate, market demand and input costs.

Technical Efficiency of Watermelon Production:
Table 3: provides a comprehensive overview of the technical efficiency of watermelon production based on various input factors. Using the efficiency model, labour, seed and fertilizer are positive but not significant. While agrochemical is negative and not significant, farm size is positive and significant. On inefficiency model, age and education are positive and significant, household size, experience cooperative and credit are negative but not significant which indicate that it has more influence on watermelon farming. The sigma coefficient indicated that watermelon farmers are technically efficient.

Constraints of Watermelon Production: Table 4: shows constraints to watermelon production. The most important constraints as ranked on the table are financial constraints, high transportation costs, high cost of labour, pests and diseases and water scarcity. Financial constraint constituted 97.5% of the respondents. This can limit farmers' ability to invest in modern technologies, purchase quality inputs, or adopt sustainable practices (Akinyemi *et. al.,* 2019). Similarly, 97.5% of the respondents indicated high transportation cost. Transportation challenges are prevalent among the surveyed farmers. The result also showed high cost of labour with 95% of respondents. Farmers could not pool their resources together to acquire labour saving devices such as mechanized farm inputs to reduce the cost of labour for watermelon production and subsequently increase the profitability. Pests and diseases constituted 87.5% of the respondents. This could be due to poor pest/disease control practices such as adequate and efficient use of agrochemicals (herbicides/insecticides). This affected production and the quality of product produced. The result also showed 80% of respondents with problem of water scarcity. This indicates a significant but intermittent challenge for watermelon farmers. Lack of improved seeds with 47.5% was one of the constraints faced by watermelon farmers in the study areas. This could be due to lack of accessibility to obtain improved seed varieties. Poor market price was another constraint with 30% of the respondents. This could be as a result of excess supply in the market. It could be an indication of a serious problem as farmers would not have appropriate market value for their products for profit efficiency.

CONCLUSION

The study concluded that watermelon farmers are married, young men that are energetic and well experienced but are non -members of cooperative society and do not have access to credit. Also, watermelon production is profitable. Quantity of watermelon seeds, farm size, agrochemicals, NPK fertilizers, labour used and hired labour are the determinants of watermelon production and the farmers are technically efficient. The major constraints are financial constraints, high transportation costs and high cost of labour.

The study recommends that government should enhance accessibility to improved seeds for watermelon production by linking farmers to the appropriate institutions through the extension agents such that farm inputs such as improved seeds and agrochemicals are made available in time and at affordable prices to the farmers. Also, farmers should be assisted to obtain credit facilities by reducing the bottlenecks associated with bank loans and more informal financial institutions should be encouraged in the rural areas.

REFERENCES

Adams, A. (2020). Marketing of Tomato and Onion in Jigawa State of Nigeria: A Spatial and Seasonal Price Analyses. An unpublished PhD dissertation submitted to the Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria, Nigeria.

Nigerian Journal of Agricultural Economics. 3(9):219–45.

Adeyemi C.O., Emerole C.O., Osondu C.K., Udah S.C & Ugorji S. E. (2020). Labour-use Efficiency by Smallholder Yam Farmers in Abia State Nigeria: A Labour-use Requirement Frontier Approach. *International Journal of Food and Agricultural Economics 1 (1) pp. 151-163.*

Akinyemi O.J. &. Shittu O.S. (2019). Cost-benefit Analysis of Watermelon Seed and Seed- oil Yield Responses to Phosphorus Fertilizer Application. *Int. Res. J. Agric. Sci. Soil Sci. (3):152–155.*

Adedeji, I.A., Tuku, N.E.; Waziri-Ugwu, P. R. G.(2019) Technical Efficiency and its Determinant in Watermelon Farming in Yobe State. Conference Proceedings of the 18th Annual National Conference of the Nigeria Association of Agricultural Economists, held at University of Agriculture, Abeokuta, Nigeria 16-19th October, Pp. 848-854.

Johnson, K. and Grabowski, R. (2019). Technical Efficiency in Nepalese Agriculture. *Journal of Development Areas, 1*9 (4): 515-525.

Nwachukwa K. (2019). Economic Efficiency of Rice Farming: A Stochastic Frontier Analysis Approach. *Journal of Agribusiness and Rural Development.* 4(58): 423–435.

Okeke, S. O. and Heady, E. O. (2020). Introduction to Agricultural Production Economics. University of Ibadan, Press Ibadan Nigeria, Pp428.

Onyeke, O. C. and Folayan, J. A. (2021). Stochastic Frontier Analysis of Technical Efficiency in Dry Season Leaf Vegetable Production among Small Scale Holders in Ekiti State, Nigeria. *Journal of Agricultural Environment*, 2(1): 359-364.

Smith, F. and Liu, J. (2018). Diversity and origin of cultivated and citrus type of watermelon .3(8):5-7.

Table 1: The result of socio-economic characteristics of the respondents (n = 40)

Variables	Frequency	Percentage (%)
Age		
20-29	6	15
30-39	25	62.5
40 – 49	7	17.5
40 and 59	2	5
Gender		
Male	39	97.5
Female	1	2.5
Marital Status		
Single	1	2.5
Married	39	97.5
Household Size		
1 – 5	8	20
6 – 10	15	37.5
11 – 15	11	27.5
> 15	5	12.5
Family Labour		
1-5	21	52.5
6-10	10	25
15 and above	3	7.5

Qur'anic education	20	50
Primary school	11	27.5
Secondary school	7	17.5
Tertiary school	2	5
Primary Occupation		
Watermelon Farming	24	60
Trading	16	40
Years of Experience		
1-5	7	17.5
6-10	15	37.5
11-15	5	12.5
16-20	7	17.5
<20	5	12.5
Membership of cooperative society		
Member	14	35
Non-Member	26	65
Years of membership		
1-5	12	30
6-10	22	55
<10	6	15
Access to credit		
Accessible	6	15
Non-Accessible	34	85
Sources of Income		
Friends and relatives	10	25
Cooperative	5	12.5
Traditional savings (Adashe)	5	12.5
Personal Saving	20	50
Monthly income		
> 50,000	6	15
51,000-100,000	18	45
101,000-150,000	3	7.5
151,000-200,000	8	20
<200,000	5	12.5

Source: Field Survey, 2023

Table 2: Result on profitability of watermelon production (n=40)

S/N	Item/ Variable	Average amount (₦)/ha
1	**Gross Revenue**	140,250.00
	Variable Cost	
2	Seeds (kg)	1,074.13
3	Water pump	1003.00
4	Fertilizers (bags)	1,100.00
5	Agrochemicals (L)	3,504.00
6	Farm Implements	10,312.00
7	Manure (kg)	26,303.63
8	Labour	4,330.00
9	Transportation	1 47.12
	Total Variable Cost	**47,773.25**
	Gross margin	**92,476.95**

Source: Field Survey, 2023

Table 3. Result on technical efficiency of watermelon production

Variables	Coefficient	T-Value	P-Value
General model			
Intercept	3.3461	29.6454	28.4362
Labor	0.2361	4.1565	1.4593
Seed	0.3084	1.5971	1.0211
Fertilizer	0.1632	1.0011	1.7452
Agrochemical	-0.02307	1.8545	-0.42037
Farm size	0.6047***	0.3203	4.34567
Inefficiency model			
Intercept	-9.6785	-4.72215	-5.8731
Age	0.12237***	3.9403	3.45603
Household size	-0.20102**	-5.5236	-4.83401
Education	0.0186*	0.9457	0.8456
Experience	-0.5472***	1.6782	2.3458
Cooperative	-0.4568***	-7.7873	-9.4547
Credit	-0.190E-03	-4.13260	-4.5430
Variable parameters			
Gamma		3.0107	
Sigma	0.74563 **	87.0754	5.2317
Log likelihood function	0.8734***		87.02745
LR test	-16.794		
	174.036		

Source: Field Survey, 2023. *** Significant at P<0.10 ** Significant at P<0.05 percent * Significant at P<0.01 percent

Table 4: Constraints to watermelon production

Variables	Frequency	Percentage (%)	Rank
Financial constraints	39	97.5	1
High transportation cost	39	97.5	1
High cost of labour	38	95	2
Pests and diseases	35	87.5	3
Water Scarcity	32	80	4
Lack of improved seed	19	47.5	5
Poor market price	12	30	6

Source: Field Survey: 2023