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Research Article

Market Concentration and Efficiency's Determinants of Tomato Production in Oyo State, Nigeria

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Abstract

The study assessed the efficiency of tomato production and market concentration among farmers in Orire Local Government, Ogbomoso, Oyo State, Nigeria, employing a multi-stage sampling technique, resulting in a sample size of 120 respondents. A structured questionnaire developed by the researcher was utilized as the research instrument. Analysis was conducted using descriptive statistics, budgetary techniques, the Herfindahl-Hirschman Index (HHI), and the Cobb-Douglas production model. Findings revealed that 76.7% of respondents were male, with an average age of 52.6 years. Additionally, 89.2% were married, and 69.2% had formal education. The average household size was 5.4, with an average farm size of 4.3 hectares. Respondents had an average of 16.4 years of experience in tomato production. The cost and return analysis indicated that tomato production is profitable in the study area, with a return on investment of N1.71, meaning every 1 naira invested yields a return of N1.71 kobo. The market concentration index was 1325, suggesting competitive market conditions. The Cobb-Douglas model identified key factors influencing production efficiency: education, household size, farm size, farming experience, credit access, seeds, fertilizer, pesticides, and herbicides. The study recommends that financial institutions offer affordable credit facilities and that agricultural extension services and post-harvest practice workshops be provided to enhance farmer incomes and reduce tomato waste.

Keywords: Tomato, production, efficiency, price competitiveness, farmers, Nigeria

Introduction

In many emerging economies, agriculture is pivotal for development, economic growth, and poverty reduction. It serves as the foundation for economic prosperity, providing food, employment, inputs, and raw materials for the industrial sector in countries like Nigeria. Additionally, agriculture generates significant foreign earnings through exports and adds substantial value to various production processes [1]. The agricultural sector's vitality extends to overall industrial activity, as it supports the prosperity of numerous other sectors. Vegetables and horticultural crops are crucial in agriculture, possessing significant potential and comparative advantages in liberalized markets, thereby enhancing the agricultural sector's contribution to the national economy [2].

Vegetables not only offer nutritional benefits and health protection but also provide small-scale farmers with livelihoods and generate foreign exchange for the economy. The tomato (*Lycopersicum esculentum* Mill.), a highly nutritious vegetable often mistaken for a fruit, is extensively used in culinary dishes worldwide [3]. Belonging to the Solanaceae family, tomatoes are climacteric fruits with a short shelf life of 2-3 weeks [4]. In Nigeria, tomatoes are widely used across various tribes and can be cultivated throughout the southern region, with the Savannah zone being particularly ideal due to fewer tomato diseases [6]. Nigeria, producing 2.3 million metric tonnes annually, is the second-largest producer of tomatoes in Africa and the 14th globally, with a 27.8% increase in production since 2018 [6]. Despite being a top producer, Nigeria is also a major importer of tomato paste [7].

A study by the Global Alliance for Improved Nutrition revealed that over 45% of Nigeria's fresh tomatoes are lost due to poor handling and logistical issues [7]. Soil degradation, land fragmentation, high poverty, and limited production factors further challenge farmers' ability to increase production [8,9].

These inefficiencies highlight the need to examine production efficiency and price competitiveness among tomato farmers. Inefficient resource use has constrained food production, resulting in low farmer incomes nationwide [10]. Understanding production efficiency is crucial for addressing low productivity in tomato farming. Increasing input use and improving technical efficiency can enhance agricultural output and productivity [11]. Measuring production efficiency allows for evaluating farmer performance and identifying inefficiencies [12]. According to Sofoluwe and Tijani [10] and Shettima., *et al*. [13], production efficiency is the ability to maximize output with given resources and technology. Therefore, assessing production efficiency and price competitiveness is vital for profit maximization.

Given that agriculture is the largest employer and essential for feeding the world's growing population, production efficiency is a critical issue. Tomatoes, one of the most important vegetable crops in the Solanaceae family, are in high demand due to their income elasticity and their rich content of minerals, vitamins, and health-promoting acids. Tomato cultivation requires extensive management, significant labour and capital investment, and meticulous attention to detail. However, the unique characteristics of agricultural production, including tomato farming, pose several challenges that can lead to low productivity. One major issue is farmers' inadequate utilization of available technologies, contributing to agricultural inefficiencies. Studying production efficiency is essential, as it is a key factor in the sustainable crop production of small-scale agricultural activities. Effective use of agricultural inputs is necessary to avoid resource wastage and ensure sufficient food production to meet demand. Inefficient input use can jeopardize food availability and security. In light of these challenges, this study aims to investigate tomato production efficiency and market concentration among farmers in Orire Local Government, Ogbomoso, Oyo State, Nigeria.

The specific objectives of the study are to

- Ascertain the socio-economic characteristics of farmers in the study area;
- Estimate the cost and returns of tomato production in the study area;
- Analyze the market concentration measures of the farmers in the study area; and
- Analyze the factors influencing the efficiency of tomato production.

Materials and Methods

Description of study area

The study area is Ori Ire Local Government Area (LGA) in Oyo State, Nigeria, with its headquarters located in Ikoyi town. Ori Ire LGA was established on May 10, 1989. It stretches from the Ipeba River along the Ogbomoso/Oyo Road to Dogo Junction near Igbeti, the headquarters of Olorunsogo LGA, covering a distance of approximately 96 kilometers. The total area of Ori Ire LGA is 2,040 square kilometers. Ori Ire LGA is bordered to the north by Olorunsogo LGA, and to the east by the Oba River, sharing boundaries with Ogbomoso North and Ogo Oluwa LGAs. To the northeast, it shares a boundary with Surulere LGA and Kwara State to the northwest, and to the south, it is bordered by Atiba LGA. The LGA encompasses several villages, including Ikoyi-Ile, Iluju, Moleyo, Baba Loosa, Banmeke, Idi Ayin, Lemole, Alamula, Oolo, Odogbo, Abaja, Abeabaja, Acute, Afekulu, Afun, Afun-Ile, Afun-Iju, Agbeni, Agidi, Ago Fulani, Aiyetoro, Ajegunle, Gbola, and Ajibowu, among others. The population of Ori Ire LGA is predominantly Yoruba, with origins from Ogbomoso, Ikoyi, Oyo, and Ilorin. The primary occupation of the residents is farming, particularly the cultivation of food and cash crops, due to the area's fertile soil. The contributions of Ori Ire LGA to food production in Oyo State are significant and noteworthy.

Method of data collection

To achieve the study's objectives, primary data sources were utilized. Data were gathered through questionnaires and interviews. The researcher developed a well-structured questionnaire, which was administered to tomato farmers in the study area. For those unable to read and write, interviews were conducted.

Sampling technique

A multi-stage sampling technique was employed for this study. In the first stage, ten intensive agrarian villages were randomly selected from all the villages in Ori Ire Local Government Area, Oyo State, Nigeria. The selected villages were Ikoyi-Ile, Iluji, Moleyo, Baba Loosa, Banmeke, Idi Ayin, Lemole, Alamula, Oolo, Odogbo, and Abaja, chosen for their high number of tomato farmers. In the second stage, twelve tomato farmers were randomly selected from each village, resulting in a total sample size of 120 farmers for the study.

Analytical technique

The data collected for the study were analyzed using descriptive statistics, farm budgeting techniques, and multiple regression analysis. Descriptive statistics were used to address the first objective. The farm budgeting technique was applied to achieve the second objective. The Herfindahl-Hirschman Index (HHI) was employed to meet the third objective, and the Cobb-Douglas production function model was utilized to achieve the fourth objective.

Descriptive statistics

Descriptive statistics, which involve the use of frequency table, mean, and percentages were used to describe the respondents' socioeconomic characteristics.

Farm budgeting technique

Farm budgeting technique was used in objective two to determine the cost and returns of tomato production in the study area. Budgetary techniques employed include return on investment (ROI) and Benefit cost ratio (BCR). This indicator was used to determine the worthiness of tomato production in the study area.

Herfindahl-hirschman index (HHI)

The Herfindahl-Hirschman Index (HHI) was used to analyze market concentration measures. In order to assess the level of competition in tomato markets in the study area, a higher level of concentration would suggest lower price competitiveness. Hence, a market with an HHI of less than 1,500 is considered a competitive marketplace, an HHI of 1,500 to 2,500 is moderately concentrated, and an HHI of 2,500 or greater is highly concentrated.

$$HHI = s1^2 + s2^2 + s3^2 + s4^2 + s5^2 + s6^2 + s7^2 + s8^2 + s9^2 + s10^2 + s11^2 \ldots\ldots\ldots\ldots sn^2 \ldots\ldots\ldots\ldots \text{(v)}$$

where

sn = the market share percentage of firm *n* expressed as a whole number, not a decimal

Cobb douglass production function model

Factors influencing the efficiency of tomato production in the study area was determined by Cobb Douglass production function Model. The model is specified as

$$\ln Yi = \beta o + \beta 1 \ln X1 + \beta 2 \ln X2 + \beta 3 \ln X3 + \beta 4 \ln X4 + \beta 5 \ln X5 + Vi - Ui \quad \ldots\ldots\ldots\ldots\ldots \text{(iii)}$$

Where; ln= Natural Logarithm; Yi = Efficiency index; X_1 = Age; X_2 = Level of Education; X_3 = Years spent in School; X_4 = Household size; X_5 = Farm size (ha); X_6 = Farming Experience; X_7 = Access to Credit; X_8 = Seed; X_9= Fertilizer; X_{10} = Pesticide; X_{11} = Herbicide; Vi = Error term which are random variables; Ui = Error term which are non-random variables or technical inefficiency effect; βo= Intercept; β1-β5= Regression coefficient

Results and Discussion

Socio-economic characteristics of tomato farmers

Table 1 reveals that 76.7% of the respondents were male, while 23.3% were female. This high male involvement in farming may be due to their greater physical strength and ability to work longer hours compared to females, potentially resulting in higher productivity. This finding aligns with Akerele., *et al.* [14] and Ijigbade., *et al.* [15], who also found more male involvement in farming activities. The age distribution shows that 26.7% of respondents were under 41, 30.8% were between 41-50, 8.3% were between 51-60, and 39.2% were between 61-70 years old. The average age of 52.6 years suggests that respondents are physically and economically active, providing ample labour for tomato production. According to Olapade-Ogunwole., *et al.* [16], age significantly affects productivity and coping ability in business. The majority (89.2%) of respondents were married, 7.5% were widowed, and 3.3% were single. The high percentage of married farmers suggests that family labour likely contributes to their farming activities. About 69.2% of respondents had some formal education, while 30.8% had none. This indicates that most farmers are equipped with the knowledge necessary to adopt tomato production technologies and maximize input use efficiency, consistent with [17], who found similar trends among tomato farmers in Kogi State. The household size data show that 62.5% of respondents had 1-5 members, while 37.5% had 6-10 members, with an average household size of 5.4. Larger households suggest that family labour is readily available, reducing production costs, as noted by Abiodun., *et al.* [18] and Dolapo., *et al.* [11], who highlighted the importance of family labour in traditional agriculture. Approximately 48.3% of respondents had farms of 1-3 hectares, 28.4% had 4-6 hectares, 20% had 7-9 hectares, and 3.3% had over 10 hectares. The average farm size was 4.3 hectares, classifying all respondents as small-scale farmers [19]. This implies that significant contributions

to food security and agricultural output in the area are unlikely. About 26.7% of respondents relied on family labour, 14.2% on hired labour, and 59.2% on both. Most tomato farmers thus use a combination of family and hired labour. A majority (60.8%) of the farmers did not belong to any cooperative society, potentially missing out on benefits provided by such groups [20,21]. The primary occupation for 63.3% of respondents was farming, 21.7% were artisans, and 15% were civil servants, indicating the prevalence of farming in the study area. Respondents had an average of 16.4 years of tomato farming experience, suggesting they play vital roles in agricultural practices and decision-making, corroborating [11], who found that most tomato farmers had over 15 years of experience. The majority (68.3%) had access to credit, while 31.7% did not, indicating that financial assistance could enhance their production potential. None of the respondents had access to agricultural extension agents, which could negatively impact the quality of production information available to them, consistent with [11]. Most respondents (72.5%) had access to market information, and 69.2% received market information prior to sale, which is essential for making informed decisions. However, 54.2% did not have access to regular customers, and 96.7% lacked contract agreements with agribusinesses, potentially limiting their market opportunities.

Variables	Frequency	Percent	Mean
Age of the respondents			
Less than 41years	26	26.7	
41-50	37	30.8	
51-60	10	8.3	52.6
61-70	47	39.2	
Sex of the respondents			
Male	92	76.7	
Female	28	23.3	
Marital status of the respondents			
Single	4	3.3	
Married	107	89.2	
Widow	9	7.5	
Educational level			
No formal education	17	14.2	
Primary education	30	25.0	
Secondary education	42	35.0	
Tertiary education	31	25.8	
Household size			
1-5	75	62.5	
6-10	45	37.5	5.4
Farm size (acres)			
1-3	58	48.3	
4-6	34	28.4	4.3
7-9	24	20.0	
10 and Above	4	3.3	
Source of labour			
Family	32	26.7	

Hired	17	14.2	
Both Family & Hired	71	59.2	
Membership of cooperatives			
Yes	47	39.2	
No	73	60.8	
Major occupation			
Farming	76	63.3	
Artisan	26	21.7	
Civil Servant	18	15.0	
Years of Experience			
1-6	43	35.8	
7-12	20	16.7	
13-18	9	7.5	16.4
19-24	19	15.8	
25-30	8	6.7	
>30	21	17.5	
Access to credit			
Yes	82	68.3	
No	38	31.7	
Access to market information			
Yes	87	72.5	
No	33	27.5	
Contract agreement with business			
Yes	87	72.5	
No	33	27.5	
Market information prior to sales			
Yes	83	69.2	
No	37	30.8	
Total	120	100.0	

Table 1: The socioeconomic characteristics of the respondents.

Source: Field Survey, 2023.

Cost and returns of tomato production in the study area

Table 2 details the costs and returns associated with tomato production in the study area. The total fixed cost was estimated at N39,869.17, with rent on land comprising 33.9%, cutlass costs at 7.2%, hoe costs at 8.6%, knapsack sprayer costs at 17.2%, and basket/bag costs at 33.1%. The total variable cost was calculated to be N40,643.34. This includes expenses for labour (covering nursery preparation, transplanting, weeding, fertilizer application, and harvesting), seeds, fertilizer, pesticides, herbicides, and transportation. These items represented 49.5%, 4.5%, 4.6%, 7.1%, 6.7%, and 27.6% of the total variable costs, respectively. The total revenue generated from tomato production amounted to N137,675.00, with a return on investment (ROI) of N1.71k. This indicates that for every 1 naira invested, there is a return of N1.71kobo, suggesting that tomato farming is a profitable venture

in the study area. This finding is consistent with the research of [16,22,23], who also reported that tomato production and other farm produce are profitable enterprises with a Benefit-Cost Ratio (BCR) greater than one in their various studies.

Item	Value in (₦)	Percentage
	FIXED COST	
Rent on Land	₦13,520.83	33.9
Cost of Cutlass	₦2,850.83	7.2
Cost of Hoe	₦3,426.67	8.6
Cost of Knapsack Sprayer	₦6,866.67	17.2
Cost of Basket/Bag	₦13,204.17	33.1
TFC	₦39,869.17	100.0
	VARIABLE COST	
Labour Input	₦20,113.34	49.5
Seed	₦1,827.50	4.5
Fertilizer	₦1,874.17	4.6
Pesticide	₦2,875.83	7.1
Herbicide	₦2734.17	6.7
Transportation	₦11,218.33	27.6
TVC	₦40,643.34	100.0
TOTAL REVENUE	₦137,675.00	
TOTAL COST (TVC+TFC)	₦80,512.51	
PROFIT = TR-TC	₦57,162.49	
ROI =TR/TC	1.71	
BCR = ROI*100	171	

Table 2: Analysis of Cost and Return Structure.

Source: Field Survey, 2023.

Market concentration measures

Table 3 presents the market concentration metrics for farmers in the study area. Farmers' output ranged from 30kg to 100kg. The most common output was 60kg, with 27 out of 120 farmers producing this amount, whereas only one farmer produced 55kg. The highest output, 100kg, had a percentage share per unit of 1.46 and a total market share of 10.22. Conversely, 30kg was the lowest output, with a percentage share per unit of 0.44 and a total market share of 9.24.

To assess the market concentration among farmers, the Herfindahl-Hirschman Index (HHI) was calculated, yielding a value of 1325. This indicates that tomato production in the study area is competitive. Oseni., *et al*. [23] state that market or business competitiveness allows a business to offer goods and services effectively and efficiently compared to its rivals. The competitiveness of tomato production in this region can be attributed to a significant number of farmers receiving market information before sales and having access to market data.

Out Put (kg)	Frequency	Percentage Share per units	Market Share (%share/ unit × frequency)	Square of Market Share	HHI
30	21	0.44	9.24	9.24^2	85.3776
35	4	0.51	2.04	2.04^2	4.1616
40	9	0.58	5.22	5.22^2	27.2484
46	4	0.67	2.68	2.68^2	7.1824
50	17	0.73	12.41	12.41^2	154.0081
53	4	0.77	3.08	3.08^2	9.4864
55	1	0.80	0.80	0.80^2	0.64
60	29	0.88	25.52	25.52^2	651.2704
70	11	1.02	11.22	11.22^2	125.8884
88	7	1.29	9.03	9.03^2	81.5409
98	6	1.43	8.58	8.58^2	73.6164
100	7	1.46	10.22	10.22^2	104.4484
TOTAL	120		100.0		1324.869

Table 3: Herfindahl-Hirschman Index (HHI) market concentration measures of the farmers in the study area.

Source: Field Survey, 2023.

Analysis of Factors Influencing Tomato Production Efficiency

Table 4 reveals that the R-square and Adjusted R-square values are 0.934 and 0.923, respectively. This indicates that 93% of the variation in the total quantity of tomatoes harvested is explained by the variables included in the model. Additionally, the F-value of 84.747, which represents the joint contribution of all explanatory variables, is statistically significant at $p < 0.05$. The Cobb-Douglas production function identified several key factors influencing the efficiency of tomato production. The coefficient for years spent in school is 0.864, indicating that a unit increase in education leads to an 86.4% increase in production efficiency. This aligns with [16,24], who found that education positively impacts farmers' efficiency. The coefficient for household size is -2.337, suggesting that a 1% increase in household size results in a 23.4% decrease in production efficiency. This finding contradicts [11], who suggested that larger households provide more labour, potentially increasing output and profitability. With a coefficient of 2.400, farm size positively and significantly affects production efficiency. A 1% increase in farm size leads to a 24% increase in efficiency, consistent with findings by Dolapo., *et al*. [11] and Ibitoye., *et al*. [17]. The coefficient for farming experience is 0.309, indicating that each additional year of farming experience boosts production efficiency by 30.9%. The coefficient for access to credit is 29.840, implying that a 1% increase in credit access results in a 298% increase in efficiency, highlighting the critical role of financial resources. The coefficient of 0.004 for seed input shows that a unit increase in seeds used enhances efficiency by 0.4%. This supports the findings of [25,26], who reported similar results. These inputs also positively influence efficiency, with coefficients of 0.017, 0.032, and 0.020, respectively. This means that a percentage increase in these inputs results in corresponding increases in efficiency by 1.7%, 3.2%, and 2.0%. Mwangi., *et al*. [5] also found that tomato production is highly responsive to these inputs. These findings underscore the importance of various factors, including education, farm size, and access to credit, in enhancing the efficiency of tomato production in the study area.

Conclusion and Recommendations

The study reveals significant insights into the efficiency of tomato production and market concentration among farmers in Orire Local Government, Ogbomoso, Oyo State, Nigeria. The findings indicate that tomato production in the study area is predominantly managed by males, with the average farmer being 52.6 years old, married, and possessing some level of formal

Variable	Coefficient	Std. Err	T value	P value
Constant	184.837	18.678	9.896	.000
Age	.167	.096	1.744	.084
Level of education	.295	1.666	.177	.860
Years spent in school	.864	.326	2.650	.009
Household size	-2.337	.827	-2.827	.006
Farm size	2.400	.436	5.506	.000
Farming Experience	.309	.147	2.069	.041
Access to credit	29.840	3.889	7.673	.000
Seed	.004	.001	2.912	.004
Fertilizer	.017	.003	5.824	.000
Pesticide	.032	.004	8.432	.000
Herbicide	.020	.004	5.531	.000
R Square	.934			
Adjusted R Square	.923			
F-value	84.747 (.000)			
Durbin-Watson	2.680			

Table 4: Results of the Cobb Douglass production functional Model (OLS) for factor influencing the efficiency of tomato production in the study area.

Source: Field Survey, 2023.

education. The study shows that tomato farming is a profitable venture with a return on investment of N1.71k per naira invested. Market concentration, as measured by the Herfindahl-Hirschman Index (HHI), suggests a competitive environment with an HHI value of 1325. Key factors influencing production efficiency, identified through the Cobb-Douglas production function, include education, farm size, household size, farming experience, access to credit, and inputs like seeds, fertilizers, pesticides, and herbicides. Education and access to credit were particularly impactful, significantly enhancing efficiency. Conversely, larger household sizes were associated with decreased efficiency, contrary to some expectations. Based on the findings of this study, it can be recommended that financial institutions should provide accessible and affordable credit facilities to farmers. Enhanced access to credit can significantly improve production efficiency and overall productivity. Implementing educational programs and workshops focused on modern agricultural practices and management can help farmers improve their productivity. This aligns with the finding that education positively impacts farming efficiency. Organizing seminars and workshops on post-harvest practices can help reduce tomato wastage, thereby increasing farmers' incomes and enhancing the profitability of tomato farming. Encouraging the formation and participation in cooperative societies can provide farmers with better access to resources, information, and collective bargaining power, thus enhancing their market competitiveness. These recommendations aim to address the key factors affecting tomato production efficiency, thereby contributing to sustainable agricultural development and improved livelihoods for farmers in the study area.

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