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FACTORS INFLUENCING THE ALLOCATIVE EFFICIENCY OF THE SMALL-SCALE TOMATO (*LYCOPERSICUM SPECIES*) PRODUCTION IN KADUNA STATE, NIGERIA: IMPLICATIONS FOR FOOD SECURITY AND RESOURCE MANAGEMENT

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Abstract

This study evaluated factors influencing the allocative efficiency of the small-scale tomato (*Lycopersicum species*) production in Kaduna State, Nigeria: implications for food security and resource management. A multi-stage sampling technique was used to select 120 small-scale tomato farmers. The data from primary sources was collected with the help of a well-structured and well-designed questionnaire. This data was analyzed using descriptive and inferential statistics. The result indicates that the mean age of the small-scale tomato resource farmers is 46 years old; the mean household size of the respondents is 7 persons, while the mean resource farm size is 1.17 ha. The minimum and the maximum allocative efficiency scores of the tomato farmers are 0.30 and 0.93 respectively. The results of the profitability analysis indicate that the tomato production is profitable with a gross margin and a net farm income of ₦550, 960 per ha and ₦497, 190 respectively. The gross margin and operating ratios are 0.69 and 0.28 respectively. The resource inputs and socio-economic factors influencing the allocative efficiency of tomato production are the following: age, farm size, household size, gender, marital status, level of education, access to extension services, and membership in a cooperative organization. The study recommends that farmers should be provided with the following resource inputs: improved seeds, chemicals, fertilizer inputs, credit facilities and extension services in order to reduce resource wastages, increase efficiency and productivity.

Keywords: allocative efficiency, small-scale tomato production, resource management, food security, Kaduna State, Nigeria

INTRODUCTION

In recent decades, there has been an improvement in the global food production. The percentage of underfed individuals has fallen from 33% to 13% even though the world's population has tripled since 1945 (FAO, 2006). Today, the average global citizen consumes roughly 25% more calories than he/she did in 1945, while also eating better and more food. However, 50,000 out of 400,000 newborns every day begin their life with a chronic food deficiency (Food and Agriculture Organization (FAO, 2006). According to estimates, the agricultural industry grew on average by roughly 7% annually between 1997 and 2008 (World Bank 2009a; United Nations Development Programme (UNDP) 2006; World Bank 2009b). The extension of staple crops into new regions is thought to be the reason for the rate of growth, as agricultural production has been stagnant or falling (Nkonya *et al.,* 2010; World Bank 2009a; UNDP 2006; World Bank 2009b). Traditional farming methods are used in the rural sector to produce agricultural products in a labor-intensive manner. The bulk of agricultural production in Nigeria takes place in rural areas and ironically, the level and incidence of poverty and food insecurity is very pronounced in these areas. The bulk of people in abject poverty live in a mostly agrarian economy. A sizable portion of Nigerian farmers are subsistence smallholders who cultivate 1–2 hectares of land using a low-tech, traditional system. Nigeria's social and economic growth depends heavily on agriculture (NPC, 2004). The provision of food for local consumption and agro-allied industries, as well as employment and foreign exchange revenues, are all impacted (Okunneye, 1995). With an estimated contribution of 51% in 1999/2000 (Njoku, 2001) and 33.4% in 2008/2009 (World facts book Nigeria, 2009), agriculture is the second-largest contributor to the Gross Domestic Product (GDP) after petroleum. However, due to its poor growth in comparison to other economic sectors, Nigerian agriculture has been in decline. For instance, the petroleum industry, the sector with the strongest growth, experienced an annual growth rate of 8.1% in 2000. In addition, the index measuring per-capita food output dropped from 150 points in 2000/2001, to only 120 points in 2002/2003 (Nkonya *et al*., 2008).

One of the major vegetables grown in Nigeria is tomato (*Lycopersicom esculentum*), which is consumed in a variety of ways (Aditi *et al.*, 2011; Aremu *et al.*, 2016). Nigeria produced 3.58 million tons of tomato in 2021 and 3.84 million tons of tomato in 2020, the total area and consumption of tomato in 2021 were 844.633 ha and 3,345,000 tons respectively (FAO, 2021). The report of FMAFS (2023) shows that a minimum total production of about 1.51 million metric tons of tomato per annum, valued at 87.0 billion, grown on a land area of 254,430 hectares in Nigeria, with 0.7 million metric tons lost during post-harvest. The tomato demand in Nigeria is put at 2.2 million metric tons per annum leaving a gap of 1.4 million metric tons. The country is now ranked as the world's 14th-largest tomato producer overall and second only to Egypt in Africa (FAO, 2010a, FAO, 2021). The recorded decline in tomato production from 6 million tons to 1.86 million tons and then to 1.51 million metric tons has led to scarcity, and may be a result of the low return on investment in the tomato production due to the high risk involved, the unplanned production process, and the distribution network problems. The nation still imports tomatoes to suit its needs despite its ranking in the global and regional tomato production (Edeh, 2017; Okojie, 2017). The value of Nigeria's yearly tomato imports is estimated at US$170 million by Sunday *et al.* (2018). This is due to the widespread consumption of tomatoes counting for roughly 18% of households' daily vegetable consumption (Babalola *et al.,* 2010). The plant contains elements like iron and phosphorus as well as abundant amounts of vitamins A and C. Additionally, it is the richest source of nutrients, dietary fibers, antioxidants like lycopene and beta-carotene, the molecules that protect the cells from cancer, as well as minerals like iron and phosphorus. Due to the impact of seasonality, Nigeria's Northern regions are where the most tomato cultivation occurs (Aminu *et al*., 2007). The majority (90%) of producers are small-scale farmers with less than 5 hectares of land (FAOSTAT, 2014; Sahel Research, 2015). In Nigeria, the large scale tomato production is done mainly under irrigation during the dry season when the temperatures are mild and humidity is moderate. However, pests and diseases that thrive in such warm, humid circumstances typically have an impact on tomato production during the rainy season. Ugonna *et al.* (2015) reported that tomato farmers, like all other farmers, are restricted by poor production practices because of low soil fertility, a lack of improved seeds and technology, an ineffective weed and pest control programme, high post-harvest losses, a lack of infrastructure for processing and marketing, among other factors. The yield of tomatoes per hectare in Nigeria is currently low, estimated at 20 to 40 tons per ha/year on average, and 40 to 50 percent of the production is lost due to Nigeria's poor handling, processing, and preservation practices (FAOSTAT, 2014).

Efficiency measures how effectively production firms use variable resources for the purpose of profit maximization given the best production technology available, the level of fixed factors, and product and factors prices. Technical efficiency is measured by the ratio of actual and potential output at a given mix of inputs. Technical efficiency measures the ability of a firm to avoid waste by producing as much output as the input usage allows or using as little input as the output production allows. Technical efficiency compares the actual to the maximum attainable productivity or the actual output to the maximum output for a given level of input. Allocative efficiency refers to the ability of a firm to produce at a given level of output using cost-minimizing input ratios (Ettah & Angba, 2016). Allocative efficiency is the ability of a firm to combine inputs and output in optimal proportions in light of the prevailing prices. Allocative efficiency is measured by the ratio of the optimal cost to the costs incurred at the technical efficient level. The costs are optimal when inputs would be used to the point where their marginal products equal their prices or opportunity costs. A critical analysis of existing literatures leads to the current research gap showing that no research work has been done on the factors influencing the allocative efficiency of tomato production in Kaduna State, Nigeria. This study employed the stochastic frontier production model to estimate the allocative efficiency scores; the Tobit regression model was used to evaluate the factors influencing the allocative efficiency of tomato production in the area.

Objectives of the Study

The broad objective is to evaluate the factors influencing the allocative efficiency of the small-scale tomato (*Lycospersicum species*) production in Kaduna State, Nigeria: implications for food security and resource management. The specific objectives were to:

(i) determine the socio-economic profiles of the small-scale tomato farmers;

(ii) analyze the cost, returns and profitability of the small-scale tomato production;

(iii) determine the technical, economic and allocative efficiency scores of the small-scale tomato farmers;

(iv) evaluate the resource inputs and the socio-economic factors influencing the allocative efficiency of the small-scale tomato production, and

(v) determine the resource constraints facing the small-scale tomato farmers in the study area.

Literature Review

The study of Ahmed & Oyewole (2012) analyzed the profitability and resource use efficiency in tomato production in Kano State, Nigeria. The study utilized descriptive statistics, farm budgeting, the Cobb-Douglas production function, marginal productivity and resource use efficiency. The results pointed to a net farm income of 46, 499.00 Naira per hectare. The significant factors influencing the output of tomato farmers were farm size, manure, labour, seeds, and chemical input. Also, Mwangi et al. (2020) evaluated the technical efficiency in tomato production among the smallholder farmers in Kirinyaga County, Kenya. The study utilized descriptive statistics and the stochastic frontier production function model using the Cobb-Douglas production function. The study reported an average technical efficiency of 0.3955, the maximum likelihood estimates result showed that land size, fertilizer, and seed quantity were among the significant factors influencing the output of tomato farmers. Furthermore, Adenuga et al. (2013) evaluated the economic and technical efficiency of dry season tomato production in selected areas in Kwara State, Nigeria. The analytical tools used were descriptive statistics, margin analysis, and the stochastic production function model. The results showed an estimated gross margin of 18, 956.75 Naira per hectare. The significant factors influencing the output of tomato farmers were farm size, labour, seeds, and herbicides. In the inefficiency model, the significant socio-economic factors include age, education, and access to credit. In addition, Khan et al. (2020) assessed the technical efficiency of tomato farms in District Lasbela, Balochistan. The study employed descriptive statistics and the stochastic production frontier model; the result revealed that the average technical efficiency of a tomato farm in the district was 0.85. The result of the MLE model shows that seed, labour, tractor hours, pesticides, area, and hybrid seeds were significant and positively related to the tomato yield. The significant socio-economic factors include age, experience, education, area under tomato, cost of tomato production, and diammonium phosphate. The research work of Ogunniyi and Ladejo (2011) examined the technical efficiency of tomato production in Oyo State, Nigeria. The study employed descriptive statistics and DEA analysis. The mean technical efficiencies were 0.423 and 0.548 under a constant return to scale (CRS) and a variable return to scale (VRS). The determinants of technical efficiency were education, experience, diversification, marital status, and gender. Also, Ogaji et al. (2013) analyzed the technical efficiency in tomatoes production in Zaria Local Government Area, Kaduna State, Nigeria. The study employed descriptive statistics and the stochastic frontier model. The mean technical efficiency was 0.60. Among the factors influencing the technical efficiency were age, farm experience, contact with extension agent, and access to credit.

METHODOLOGY

This research was conducted in Kaduna State, Nigeria. Kaduna State occupies between Longitudes 06^0 $15^{|}$ and 08^0 $50^{|}$ East and Latitudes 09^0 $02^{|}$ and 09^0 $02^{|}$North of the equator. The State has land totaling 4.5 million hectares. The state vegetation is divided into two (2), the Southern guinea savanna and Northern guinea savanna. There are two (2) seasons in Kaduna State: wet and dry. The dry season is between October to March, and the wet season starts from April and lasts until October; in between the wet and dry seasons is the brief harmattan period which spans from November to February. The mean or average rainfall is about 1,482mm, the temperature of Kaduna State ranges from 35^0C to 36^0C, which can be as low as 10^0C to 23^0C during the harmattan period. The population of Kaduna in 2021 was 8.9 million people. They were involved in agricultural activities. The crops grown include the following: okra, pepper, maize, ginger, sorghum, rice, yam, cassava, millet, and tomatoes. Animal reared include: cattle, goats, sheep, rabbit, and poultry. The multi-stage method of sampling was used. One hundred (120) smallholder tomato farmers were selected. The data obtained from the smallholder tomato farmers were of primary sources and were collected using a well-designed and well-structured questionnaire. The questionnaire was administered to the smallholder tomato producers using well trained enumerators.

Research Design

A descriptive cross-sectional research design was employed in this study with the aim of describing the socio-economic profiles or characteristics of the tomato producers, and to evaluate the technical, economic, allocative efficiency scores and the socio-economic factors influencing the allocative efficiency of tomato production.

Sampling Techniques and Sample Size

A multi-stage sampling technique was adopted for this study. In the first stage, the purposive sampling procedure was used to select the Kaduna State based of the numerous numbers and the concentration of tomato producers due to the predominance of tomato production in the area. The second stage involved a random selection of four (4) local government areas, tomato is majorly grown in the area, this informed the choice of the local government area, in this line a reconnaissance survey was conducted to identify all local government areas actively involved in tomato production, the four (4) local government areas were selected using the ballot box method. In the third stage, three (3) villages were selected randomly from each local government area based on the intensity of tomato producers, a reconnaissance survey was conducted in each local government area to identify all villages actively involved in tomato production, the three (3) villages in each local government area were selected using the ballot box method. In the fourth stage, from the sampling frame of 171 tomato farmers, proportionate – a simple random sampling technique was used to select the desired sample size of 120 tomato farmers. This study employed the formula advanced by Yamane (1967) in the determination or estimation of the sample size. The sample size was calculated based on the assumption of 5% expected margins or error, and 95% confidence interval. The formula is stated thus:

$$n = \frac{N}{1+N(e^2)} = 120 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

n = Desired Sample Size (Number)

N = Sample Frame (Number)

e = Maximum Acceptable Margin of Error as Determined by the Researcher (5%).

Methods of Data Collection

The data for this study was collected through the use of a well-designed and well-structured questionnaire. The data collected was cross sectional data from primary source, the data collected from the small-scale tomato producers informs about the socio-economic profiles of the farmers, prices of production inputs, quantity of inputs used and constraints faced by farmers in the course of tomato production in the study area. The data was analyzed using the following descriptive and inferential statistics:

Descriptive Statistics: The data collected from the field survey on the small-scale tomato farmers was summarized through the use of mean, frequency distributions, and percentages. Descriptive statistics was used to summarize the socio-economic profiles of the small-scale farmers as stated in specific objective one (i).

Farm Budgetary Technique: The gross margin and the net farm income analysis of tomato production was estimated using the following models:

$$GM = TR - TVC \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$GM = \sum_{i=1}^{n} P_i Q_i - \sum_{j=1}^{m} P_j X_j \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$NFI = TR - TC \ldots\ldots\ldots\ldots\ldots. (4)$$

$$NFI = \sum_{i=1}^{n} P_i Q_i - \left[\sum_{j=1}^{m} P_j X_j + \sum_{k=1}^{k} GK\right] \ldots. (5)$$

Where

P_i = Price of Tomato (₦/Kg)

Q_i = Quantity of Tomato (Kg),

P_j = Price of Variable Inputs (₦/Unit)

X_j = Quantity of Variable Inputs (Units),
TR = Total Revenue obtained from Sales from Tomato (₦),
TVC = Total Variable Cost (₦),
GK = Cost of all Fixed Inputs (Naira)
NFI = Net Farm Income (Naira)

The farm budgetary technique was used to analyze the profitability of the small-scale tomato production as stated in specific objective two (ii).

Financial Analysis: According to Alabi *et al*. (2020), the gross margin ratio is defined as:

$$Gross\ Margin\ Ratio = \frac{Gross\ Margin}{Total\ Revenue} \quad (6)$$

According to Olukosi & Erhabor (2015), the operating ratio (OR) is defined as:

$$Operating\ Ratio = \frac{TVC}{GI} \ldots\ldots\ldots\ldots\ldots (7)$$

Where,
TVC = Total Variable Cost (Naira),
GI = Gross Income (Naira),

The financial analysis was used to analyze the profitability of tomato production as stated in specific objective two (ii).

Stochastic Production Efficiency Frontier /Cost Efficiency Frontier Model

The stochastic frontier approach was used in this study. This approach was preferred to the non-parametric DEA analysis because it uses the maximum likelihood method which gives more robust results than the DEA method which relies on mathematical programming. In addition, other advantage of the stochastic frontier approach is that it differentiates the inefficiency related to farmers from that due to random effects not controlled by the producers (Coelli et al., 2005; Onumah et al., 2010, Kumbhakar and Lovell, 2000). Also, the basic assumption of non-parametric and deterministic approaches that all deviations from the border are due to farm inefficiency is very unrealistic in the agricultural sector because inefficiency in this sector is also attributable to harmful insects, climatic risk, government policies, international markets, and phytopathology (Njeru, 2010). The Cobb-Douglas production function is used in this study because it is flexible and self-dual (Amegnaglo, 2018). Other advantage of the Cobb-Douglas production function lies in the easier interpretation of the returns to scale. According to Alabi *et al*. (2022), the stochastic production frontier model is stated as follows:

$$Y_i = f(X_i, I?_i)e^{v_i - u_i} \quad (8)$$

The stochastic production frontier model was used to estimate the technical, cost, economic and allocative efficiencies scores as stated in specific objectives three (iii).

Allocative Efficiency Model

Allocative Efficiency (AE) is computed as follows:

$$\mathbf{AE} = \frac{\mathbf{1}}{\mathbf{CE}} \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

$$AE = \frac{EE}{TE} \ldots\ldots\ldots\ldots\ldots (10)$$

Where,
AE = Allocative Efficiency
TE = Technical Efficiency
EE = Economic Efficiency
CE = Cost Efficiency

Tobit Dichotomous Regression Model:

The study used the Tobit regression model to analyze the factors influencing the allocative efficiency. The model was used given the fact that the allocative efficiency has both the lower and upper bounds (Allocative Efficiency value ranges from 0 to 1), this provide a better approximation of the Tobit model. This according to the character of the dependent variable (efficiencies) of the Tobit regression model which are presented as relative frequencies and can also be censored. The ordinary least squares (OLS) methods would cause error in predictions (Cameron and Trivedi, 2005; Gujarati and Porter, 2010). These errors in OLS would result from gross violations of the assumptions necessary for the validity of the OLS model. The assumptions of the OLS model include the normality of distributions, homoscedasticity of errors (equal variances) and exogeneity of the independent variable. The OLS leads to inconsistent parameter estimates if any of the assumptions are violated (Cameron and Trivedi, 2005). The Tobit model, on the other hand, uses the maximum likelihood estimation (MLE) procedures to estimate errors in the presence of a non-normal distribution. The MLE is considered the most efficient estimator for an asymptotically distributed dependent variable (Wooldridge, 2002). The dichotomous response model is defined as follows:

$$Y_i^* = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_5 X_5 + \alpha_6 X_6 + \alpha_7 X_7 + \alpha_8 X_8 + U_i \ldots (11)$$

$$Y_i = \begin{cases} 1 \text{ if } Y_i^* \geq 1 \\ Y_i^* \text{ if } 0 < Y_i^* < 1 \\ 0 \text{ if } Y_i^* \leq 0 \end{cases}$$

Y_i^* = Latent or Unobserved Variable
Y_i = Efficiency Score Representing Allocative Efficiency (Number)
X_1 = Age (Years),
X_2 = Farm Size (Hectares),
X_3 = Household Size (Units)
X_4 = Gender (1, Male; 0, Otherwise)
X_5 = Marital Status (1, Married; 0, Otherwise)
X_6 = Level of Education(0, Non − Formal; 1, Primary; 2, Secondary; 3, Tertiary)
X_7 = Access to Extension Services (1, Access; 0, Otherwise)
X_8 = Membership of Cooperative Organizations (1, Member; 0, Otherwise)
U_i = Error Term,
$\alpha_1 - \alpha_8$ = **Regression Coefficients**
α_0 = **Constant Term,**

This was used to achieve specific objective four (iv) which is to evaluate the socio-economic factors influencing the allocative efficiency of the small-scale tomato production in the study area.

Principal Component Analysis: The constraints facing the small-scale tomato farmers and militating against tomato production were subjected to a principal component analysis. This was used to achieve specific objective five (v).

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Tomato Farmers

The result in Table 1 indicates that 72.5% of tomato farmers were males, while 27.5% were females. This is an indication that tomato farming was a male dominated business in the study area. This may not be unconnected with the limited access of women to productive resources in many cultures and traditions. This is in agreement with the findings of Haruna *et al.* (2007). About 38% of tomato farmers were singles, 18% were divorced and 44% were married. In their study of gender differentials in technical efficiency among maize farmers in Essien Udim Local Government, Area-Nigeria, Simonyan & Omolehin (2012) observed that the marital status was positive and significant in relation to the productivity of the male farmers. Table 1 also revealed that 18% of the resource tomato farmers were within the age range of 31-40 years, 56% were within the age range of 41-50 years, 27% were within the age range of 51-60 years, while the mean age of resource tomato farmers was 46 years. The role of age is very critical in agricultural production.

In their estimation of the technical and allocative efficiency analysis of Nigerian rural farmers, Asongwa *et al*. (2011) observed that the age of farmers had a positive effect on the technical inefficiency effects. The result further indicates that 86% of the respondents had one or another form of formal education, while 14% had no formal education.

Table 1: Socio-Economic Profiles of Small-scale Tomato Producers

Variables	Frequency	Percentage	Mean
Gender			
Male	87	72.50	
Female	33	27.50	
Marital Status			
Single	45	37.50	
Divorced	22	18.33	
Married	53	44.17	
Age (Years)			
31 – 40	21	17.50	
41 – 50	67	55.83	46
51 – 60	32	26.67	
Level of Education			
Non-Formal	17	14.17	
Tertiary	14	11.67	
Secondary	56	46.66	
Primary	33	27.50	
Household Size (Units)			
1 – 5	41	34.17	7.0
6 – 10	48	40.00	
11 – 15	31	25.83	
Extension Contact			
Yes	81	67.50	
No	39	32.50	
Farming Experience (Years)			
1 – 5	24	20.00	9.0
6 – 10	56	46.66	
11 – 15	27	22.50	
16 – 20	13	10.84	
Memberships of Cooperative			
Yes	92	76.67	
No	28	23.33	
Farm Size (Hectares)			1.17
Less than 1.0	67	55.83	
1.1 - 2.0	35	29.17	
2.1 – 3.0	11	09.17	
3.1 – 4.0	07	05.83	
Total	**120**	**100.00**	

Source: Field Survey (2022)

According to Imonikhe (2004), education would significantly enhance farmers' ability to make accurate and meaningful management decisions, it could also enhance the knowledge of improved techniques such as reading and interpreting recommended packages. The result in Table 1 also shows that 34% of the respondents had a household range of 1-5 persons, 40% - of 6-10 persons, while 26% - of 11-15 persons, with the mean household size of 7 persons. The implication is that the farming households have a good source of family labor for doing farm business by providing the needed cheap and available manpower all-round the year. Amos (2007) in his study of productivity and technical efficiency of smallholder cocoa farmers in Nigeria found that the family size was a significant variable which greatly influenced the technical efficiency of farmers. The result further indicates that 67.5% of the respondents had extension contacts, while 32.5% had none. According to Umar *et al.* (2007), the higher extensions contact was reported to increase the adoption of improved farm production technologies. They further observed that the frequency of the extension contact is very essential as it guides the farmers from awareness to the adoption stage. About 20% of the respondents had farming experience of 1-5 years, 46.6% - 6-10 years, 22.5% had 11-15 years of experience, while 10.8 % had 16-20 years. Adebayo (2006) observed that the longer a person stays on a particular job, the better the job performance tends to be. The result also indicates that 77% of the respondents were members of cooperative organizations, while 23% of the respondents were not. The membership enables farmers to interact with one another, share their experiences and assist themselves in a bulk purchase of inputs. Similarly, Gashaw *et al.* (2013) and Folorunso & Bayo (2020) found that the membership in cooperatives enhances members' efficiency by easing access to productive inputs and facilitating extension linkage compared to those who were not members. Also, the result in Table 1 shows that 56% of the respondents had a resource farm size range of less than 1 ha, 29% had a resource farm size range of 1.1-2.0 ha, and 9% of the tomato farmers had a resource farm size range of 2.1-3.0, while 6% of the respondents had a resource farm size range of 3.1-4.0 ha. The implication of this result is that all tomato farmers operate small-scale farms based on Olayide's classification of farms (1980): 0.1-5.0 hectares (small-scale); 5.1-10 hectares (medium-scale); and 10 hectares and above (large-scale). Since the majority of respondents had farm holdings between 0.1 and 5.0 hectares, these farmers cannot achieve economies of scale production. This is consistent with Onuche & Oladipo (2020) whose findings revealed that the majority of the respondents operated on farmland sizes between 1-2 ha, thus suggesting the smallholder nature of agriculture.

Profitability of Tomato Production

The results in Table 2 indicate that the total cost of tomato production incurred per hectare was ₦302, 810. The cost includes variable costs per hectare such as cost of seeds (₦45,000), representing 15% of the total cost of production, fertilizer (₦105,000) representing 35% of the total cost of production, insecticides (₦17,240) representing 6% of the total cost of production, herbicides (₦13,350) representing 4% of the total cost of production and labour costs (₦68,450) (land clearing and preparation, planting, weeding, fertilizer application, chemicals application, harvesting, transportation, and loading and offloading), representing 27% of the total cost of production. Table 2 also indicated that the total revenue (TR) generated per hectare was ₦800, 000. The result also indicated that the total variable cost (TVC) was ₦249, 040 per hectare representing 82%. Finally, the budgetary analysis per hectare indicated that tomato farming was profitable as shown by the gross margin (₦550, 960) per ha and the net farm income (₦497, 190) per ha.

The gross margin and operating ratios were 0.69 and 0.28 respectively, indicating that 69% of the gross revenue accruing to tomato production constituted the gross margin, while 28% of the gross income was committed to the total variable cost of tomato production. The operating ratio was less than unity and is an indication that their operations were inefficient. This report is similar to the findings of Busari & Okanlawon (2015) and Folorunso *et al.* (2023) who pointed out that the profits depend on the scale of production. The implication for the poverty status of tomato farmers in the study area is that the increased and sustained profitability of this enterprise will enable farming households to have economic access to basic amenities and thereby aid in poverty alleviation. This study is similar to the findings of Adenuga et al. (2013) who investigated economics and technical efficiency of the dry season tomato production in selected areas in Kwara State, Nigeria and obtained a gross margin of 18, 956.75 Naira per hectare. Also, Ahmed and Oyewole (2012) evaluated the profitability and resource use efficiency in tomato production in Kano State, Nigeria and obtained a net farm income of 46, 499.00 Naira per hectare.

Table 2: Profitability Analysis of Small-scale Tomato Production per Hectare

Items	Amount (Naira)	% of Total Cost
Total Revenue	**800,000**	
Yield (Kg) = 4000		
Price per Kg	200	
Gross Income	800,000	
Variable Cost		
Seeds	45,000	15.00
Fertilizer Input	105,000	35.00
Insecticides	17,240	06.00
Herbicides	13,350	04.00
Labour Cost:		
(i) Land Clearing and Preparation	21,760	07.00
(ii) Planting	6,980	02.00
(iii) Weeding	11,670	04.00
(iv) Fertilizer Application	9,310	03.00
(v) Chemical Application	3,270	01.00
(vi) Harvesting	6,430	02.00
(vii) Transportation	4,280	01.00
(viii) Loading and Offloading	4,750	02.00
Total Labour Cost	68,450	27.00
Total Variable Cost	**249,040**	**82.00**
Fixed Cost		
Estimated Depreciation Value on Tools (Hoes, Machetes)	24,560	08.00
Rent on Land	29,210	10.00
Total Fixed Cost	**53,770**	**18.00**
Total Cost	**302,810**	**100.00**
Gross Margin	**550,960**	**0.69**
Gross Margin Ratio (GMR)	**0.69**	
Net Farm Income (NFI)	**497,190**	
Operating Ratio (OR)	**0.28**	

Source: Field Survey (2022)

Farm Level Allocative Efficiency Scores of Tomato Farmers

The frequency distribution of the allocative efficiency (AE) estimates of tomato farmers as obtained from the stochastic frontier analysis is presented in Table 3. The result indicates that the minimum and the maximum allocative efficiency score of the farmers were 0.02 and 0.91 respectively, which means that the minimum tomato farmers had 2% allocative efficiency and had a maximum of 91% allocative efficiency. The distribution table further revealed that most (45%) of the tomato farmers in the study area were in the allocative efficiency range of 0.21- 0.40, followed by farmers with the allocative efficiency range of 0.00-0.20 (19.17 %); followed by 14.17% within the allocative efficiency range of 0.41-0.60. The last in the allocative efficiency range were the farmers (8.33%) within the range of 0.81-1.00. As implication of this result for the farmers with the best production practices, the tomato production cost will rise by 9% $\left[1-\left(\frac{0.91}{1.00}\right)\times 100\right]$ from the maximum possible level of 100% due to allocative inefficiencies, while for the tomato farmers with the least practices, the cost will raise by 98% $\left[1-\left(\frac{0.02}{0.91}\right)\times 100\right]$ from the maximum 100% due to allocative inefficiencies. Also, the result indicated that 45% of the tomato farmers operated within 0.21-0.40 allocative efficiency range, which means that the majority of the tomato farmers operated far from their production frontier. In the short-run therefore, there is a scope for reducing the production costs by adopting techniques and technologies employed by the most efficient tomato farmers. This study is in line with Mwangi et al. (2020) who evaluated the technical efficiency in tomato production among the smallholder farmers in Kenya and obtained an average technical efficiency of 39.55%. This study is in consonance with the findings of Adenuga et al. (2013) who investigated the economics and the technical efficiency of the dry season tomato production in selected areas in Kwara State, Nigeria and obtained an average technical efficiency of 78.94%. Also, Ogaji et al. (2013) analyzed the technical efficiency in tomato production in Zaria local government area of Kaduna State, Nigera and obtained an average technical efficiency of 60.4% leaving a gap of 39.1% for improvement.

Table 3: Summary Statistics of Technical, Economic and Allocative Efficiency Scores

	Allocative Efficiency		**Economic Efficiency**		**Technical Efficiency**	
Efficiency Score	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
0.00 – 0.20	23	19.17	21	17.50	10	08.34
0.21 – 0.40	54	45.00	46	38.33	49	40.83
0.41 – 0.60	16	13.33	27	22.50	42	35.00
0.61 – 0.80	17	14.17	12	10.00	07	05.83
0.81 – 1.00	10	08.33	14	11.67	12	10.00
Total	120	100.00	120	100.00	120	100.00
Mean	0.40		0.42		0.44	
Std Deviation	0.2402		0.2463		0.2113	
Minimum	0.02		0.03		0.02	
Maximum	0.91		0.93		0.89	

Source: Field Survey (2022)

Resource Inputs, Socio-Economic Factors of Farmers and Allocative Efficiency

With the aid of the Tobit regression model, the relationships between allocative efficiency, resource factors and the socio-economic traits of farmers was evaluated as displayed in Table 4. The pseudo R^2 is 63%, indicating an absolute relationship between the explanatory variables and allocative efficiency in the study area, and 63% of the variation in the variables was explained by the model. The likelihood function is positive (115.79), the Chi-squared value is positive (79.87***) and significant at 1%. Age of the farmer, farm size, household size, gender, marital status, education and access to extension services all significant and would increase the likelihood of the household as being allocative efficient in tomato production.

Age: It was discovered that the age of the farming households had a positive coefficient (0.0130), was significant at the 1% level of probability, and was not what one would have predicted a priori. This suggests that as respondents' ages increase, there is a greater chance that resource wastage will decrease, according to the variable's coefficient. It is common knowledge that farmers tend to have more experience in the agricultural process the older they get. This result is in line with Kolawole & Ojo (2007), who discovered that age was positively correlated with inefficiency in their research of the small-scale oat growers in Nigeria.

Farm Size: Small farm size is a barrier to agricultural mechanization because it will be challenging to control weeds using farm equipment like tractors. Farmers' ability to grow their crops depends on a variety of factors, including population pressure, family size, labor productivity, financial situation, and level of experience (Imonikhe, 2004). In line with a priori expectation, the coefficient (0.020*) of the farm size was found to be positive as expected and significant at 1% level of probability. The farm size determines the availability of supply to the markets. Therefore, an increase in the farm size will increase the probability of an increase in economic efficiency.

Household Size: It was discovered that the household size coefficient was significant at 1% and positive (0.055) as expected. Significant households require significant amounts of output to feed their members, which means that as the household size rises, so does the demand for food. The household size also affects the availability of family labor. The cost of food and other household requirements must go up as families grow, which ultimately leads to an increase in food insecurity. This suggests that agricultural families have a reliable source of family labor for their farming operations. A good sign is that there will be more family manpower available for farm work and that the size of the farm would consequently increase. The family size was shown to be a significant variable that had a substantial impact on the technical efficiency of farmers by Amos (2007) in his research of the productivity and technical efficiency of the smallholder cocoa farmers in Nigeria.

Gender: The coefficient (0.0372) of gender is significant and positive at 1% level of probability. It means that the likelihood of increasing allocative efficiency increases with the proportion of a certain gender engaged in tomato production. This could be ascribed to the area's traditional system of land ownership, which exclusively entitles male members of the community to inheritance and possession of land. This favors male farmers rather than their female counterparts. This might also be a result of the distribution of resources discriminating against women. According to Funminiyi *et al.* (2020), farmlands are typically owned by husbands or other male family members rather than by the women who work on them. This supports the claim made by Adebayo & Ojogu (2019) that families in rural areas typically make a living by growing both cash and food crops.

Marital Status: The coefficient of this variable was found to be positive (0.2466856) and significant at 1% level of probability. This means that marital status is an important variable in the probability of farmers being able to maximize their profit. A change in the marital status of the respondents will increase the probability of reducing underutilization of resources by the coefficient of the variable.

Educational Level: The coefficient (0.0182) of this variable was found to be positive, significant at the 1% level, and consistent with a priori expectations, which means that as one's educational level rises, the likelihood of underutilizing resources and wastages also rises by 0.0182. Education facilitates farmers' acquisition and application of new technologies (Onyenweaku *et al*., 2005; Dey *et al*., 2005; Nwaru, 2004). This suggests that people's ability to produce more to maximize their profits will likely increase the longer they spend in school.

Access to Extension Services: The coefficients of the extension contact (0.101) are positive, consistent with the a priori expectation and significant at 5% level of probability. This means that having extension agents introducing innovation and training was not enough to significantly cause a farmer to attain higher levels of allocative efficiency if he cannot afford the technology or put the training to use. This is supported by (Fuminiyi *et al* 2020) that the presence of extension services can increase greatly the awareness and adoption level of innovations. This also agrees with Salisu, (2022) who stated that inadequate extension workers and services relations were key barriers to the adoption across all of the research villages, ranking high in the literature and seen as a barrier to Climate Smart Agricultural Practices adoption during the farmers' interview.

Table 4: Maximum Likelihood Results of the Tobit Dichotomous Regression Model

Variables	Parameters	Coefficient	Standard Error	t-Value
Constant	α_0	0.7544***	0.0560	13.48
Age	α_1	0.0130***	0.0042	3.11
Farm Size	α_2	0.020***	0.006	3.26
Household Size	α_3	0.055***	0.017	3.280
Gender	α_4	0.0372**	0.0154	2.421
Marital Status	α_5	0.1981***	0.0677	2.923
Level of Education	α_6	0.0182*	0.0087	2.094
Access to Extension Services	α_7	0.101**	0.04	2.74
Member of Cooperative Organization	α_8	0.071**	0.031	2.74
Sigma	0.1283			
LR Chi^2	79.87***			
Pseudo R^2	-0.6343			
Log Likelihood	115.79			

Source: Data Analysis (2022) *Significant at ($P < 0.10$)., **Significant at ($P < 0.05$), ***Significant at ($P < 0.01$).

Principal Component Analysis of Resource and Infrastructures Constraints Facing Smallholder Tomato Farmers

Table 5 shows the results of the resource constraints faced by the small-scale tomato farmers. PCA is a statistical technique that transforms interrelated data with many variables into few numbers of uncorrelated variables. From the result the number of principal components retained using the Kaiser Meyer criterion are five based on the Eigen value greater than 1. By demonstrating the viability of employing the data set for principal component analysis, the Kaiser-Meyer-Olkin measures of sampling adequacy (KMO) of 0.7107 and Bartlett test of sphericity of 793.01 were significant at 1% level of probability. According to the perception of the small-scale tomato farmers for challenges faced in tomato production in the country, the lack of credit facilities had an Eigen value of 2.7904 and ranked first, inadequate extension services had an Eigen value of 2.6108 and ranked second, bad road infrastructure had an Eigen value of 1.9806 and was ranked third, high labour costs had an Eigen value of 1.9006 and was ranked fourth, and high input costs had an Eigen value of 1.8290 and was ranked fifth.

Table 5: Principal Component Model of Constraints Encountered by Tomato Producers

Constraints	Eigen-Value	Difference	Proportion	Cumulative
Lack of Credit Facilities	2.7904	0.1796	0.1145	0.1145
Inadequate Extension Services	2.6108	0.6302	0.1179	0.2324
Bad Road Infrastructures	1.9806	0.0800	0.1305	0.3629
High Labour Cost	1.9006	0.0716	0.1429	0.5058
High Cost of Farm Input	1.8290	0.0629	0.1538	0.6596
Bartlett Test of Sphericity				
Chi Square	793.01***			
KMO	0.7107			
Rho	1.00000			

Source: Field Survey (2022)

CONCLUSION AND RECOMMENDATIONS

Based on these findings, it is concluded that tomato production was profitable going the both profitability and financial indices. Similarly, the wide variations in the efficiencies were indicative of the inefficiencies of tomato farmers. Age of farmers, farm size, household size, gender, marital status, education status and access to extension services were the resource and socio-economic determinants of allocative efficiency. Lack of credit facilities, inadequate extension services, bad road infrastructures, high cost of labor and high cost of farm inputs based on the perceptions of the small-scale tomato farmers were the challenges faced in tomato production. It is therefore recommended that:

(i) Government should develop policies to facilitate tomato farmers' access to production inputs at a cheaper price, e.g. land input, fertilizer input, improved seeds, and chemical input.

(ii) The cumbersome administrative procedures must be removed and the interest rates must be reduced to facilitate tomato farmers' access to agricultural credit.

(iii) The government at federal and state levels and private sectors should strengthen the capacity of the extension service delivery mechanism and advisory services to disseminate research findings, innovations, and new technologies to farmers.

(iv) Feeder roads should be constructed for easy access or movement of farm produce to nearby centers.

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