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ECONOMIES OF SCALE AND TECHNICAL EFFICIENCY OF SMALLHOLDER PEPPER (*CAPSICUM SPECIES*) PRODUCTION IN ABUJA, NIGERIA

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Abstract: This study examined the economies of scale and technical efficiency of smallholder pepper (*Capsicum species*) production in Abuja, Nigeria. The multi-stage sampling technique was adopted to obtain a total sample size of 100 smallholder pepper farmers. The primary sources of data were obtained from pepper farmers through a well-structured and well-designed questionnaire. The data obtained were analysed using descriptive statistics, gross margin model, financial analysis, stochastic production frontier model, the elasticity of production, return to scale, and principal component analysis. The results from the study showed that the mean age of pepper farmers observed was 38.3 years. The average household size was 5 persons. The gross margin was ₦ 167, 741.60 per hectare, the rate of returns of the investment in pepper production amounted to 0.89, and the operating ratio was 0.49. The gross margin ratio (GMR) was calculated to be 0.48, and this implies that for every naira that is invested in smallholder pepper production, 48 kobos would be used to cover profits, interest, expenses, taxes, and depreciation. Labour input ($P < 0.10$), seed input ($P < 0.01$), farm size ($P < 0.01$) were significant factors affecting output of smallholder pepper production. The mean technical efficiency was 0.79, leaving a gap of 0.21 for improvement. The returns to scale of 1.2363 imply increasing returns to scale. The study recommends that measures should be put in place to address the challenges of inadequate rainfall through proper irrigation policies.

Key words: economies of scale, stochastic production frontier model, pepper production, Abuja, Nigeria.

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Introduction

Pepper (*Capsicum species*) is an important agricultural food crop, firstly, because of its economic value and importance, secondly, due to the contents, nutritional and medicinal values of its fruits, as well because of being a good and excellent source of natural colours and anti-oxidant compounds (Horward et al., 2000). Pepper is recognised as the most widely and varied food for general populace in Africa and the entire world (Dipeolu and Akinbode, 2008). It is reported to be the world's most important fruit vegetable, which ranks second after tomatoes. Pepper provides essential minerals, vitamins and is the most widely produced type of spice flavouring and colouring for food (Bosland and Votava, 2000). In Nigeria, three major types of pepper are common: firstly, the large fruited sweet peppers (Tatashe); secondly, the medium corrugated fruited hot pepper (Rodo) and thirdly, the small-fruited with chilli/red pepper (Shombo) (Dipeolu and Akinbode, 2008). Peppers are rich in vitamins A, C and K. Vitamin A is reported to be good for eye sight, and vitamin C also prevents the common cold. All varieties are good and excellent sources of potassium, vitamins A and C, fibre, and folic acid.

Agriculture in a developing African country like Nigeria is dominated largely by smallholder farmers. They are involved in the production of the majority of food requirements like pepper needed for the country (Asogwa et al., 2006). Despite the fact that these smallholder farmers occupy an important and unique vital position, they can be observed to belong to the poorest class or group identified within the population and as such, they cannot invest anything in their farms (Asogwa et al., 2006). Smallholder farmers are reported to be driving force of many economies in Africa, even though their potentials are often not observed and brought forward. Smallholder or small-scale farmers can be defined in various ways depending on the context, region, country, and even ecological zone. Often the term 'smallholder' is sometimes interchanged with 'smallscale', 'marginal' 'peasant' and sometimes 'resource-poor'. Generally, smallholders only refer to their small and limited resource endowment compared to farmers in the other sectors. Smallholder farmers can be defined or explained as those farmers owning or having small-based plots on which they grow family or subsistence crops, and one, two or more cash crops, and they rely mainly on family labour. One of the major characteristics observed of production systems common to smallholder farmers is the fact that they are simple, use outdated technologies, they have low or small returns, and have high seasonal fluctuations in labour requirements. Smallholder or small-scale farmers significantly differ due to their individual or personal characteristics, sizes of farms, resource distributions between cash and food crops, off-farm activities and livestock farming, the way they use external inputs, obtain hired labour, the percentage of food crops sold and their patterns of expenditure on

households. According to Ajibefun and Daramola (2003), the vicious cycle of poverty prevailing among these farmers can lead to unimpressive and poor performance of the agricultural sector. Thus, resources must be efficiently used, which entails the total elimination of wastes, thereby leading to an increase in productivity, efficiency, and incomes. Rural farmers in Nigeria are resource-poor, operate on small scale, and lack of credit facilities, which translates to the inadequacy of working capital bringing about the vicious cycle of poverty (Kibaara, 2005). Demand for pepper can be created by both the end consumer, buying the product for their individual or personal food needs or requirements, and the corporate and international markets, that use spicy or pepper products in their production processes. Hotels, catering services and restaurants can be said to be the consumer segment of pepper. Ultimately, the demand for the products will depend largely on the wealth of the people and the population growth that are the end consumers of pepper. Studies on the efficiency and productivity of agricultural production in Nigeria have not focused on pepper despite its important role in the nutrition of the people. In order to achieve self-sufficiency in pepper production, there is an urgent need to assess the efficiency of pepper production.

Objectives of the study

The objective was broadly designed to evaluate the economies of scale and technical efficiency of smallholder pepper (*Capsicum species*) production in Abuja, Nigeria. Specifically, the study was designed to achieve the following objectives to:

(i) identify the socio-economic profiles of smallholder pepper producers;
(ii) estimate the costs and return analysis of smallholder pepper production;
(iii) evaluate factors affecting the output of smallholder pepper production;
(iv) evaluate factors influencing the technical efficiency of smallholder pepper production;
(v) determine the technical efficiency index of smallholder pepper producers;
(vi) determine the elasticity of production and economies of scale of smallholder pepper production, and
(vii) identify the problems or constraints facing smallholder pepper production.

Material and Methods

The study area

The study was carried out in Abaji Area Council in Abuja, Nigeria. The local government is located at latitudes 8.4747º North, and longitudes 6.9451º East.

Abaji is an area Council in the Federal Capital Territory with headquarters in the town of Abaji. Abaji is located north of Kogi State, with Gwagwalada, Kuje and Kwali Area Councils to the east and Niger State bounded to the north and the west. In Abaji, there are wet and dry seasons. The dry seasons are partly cloudy, humid, and hot all year round. The temperature varies from 64ºF to 94ºF and is rarely below 57ºF or above 100ºF. Abaji has a cover land area of about 999km² and a population of 58,642 persons at the 2006 national census (NPC, 2006). The council is the smallest, by population, of the six area councils in Abuja. Abaji Area Council is predominantly inhabited by the Ebira Koto, a sub- group of the larger Ebira ethnic group found in neighbouring Koton Karfe Local Government Area of Kogi State. Economic activities include: trading, animal rearing, food, vegetable and cash crop production. The occupation of the people is farming and they plant yam, maize, pepper, among others (Figure 1).

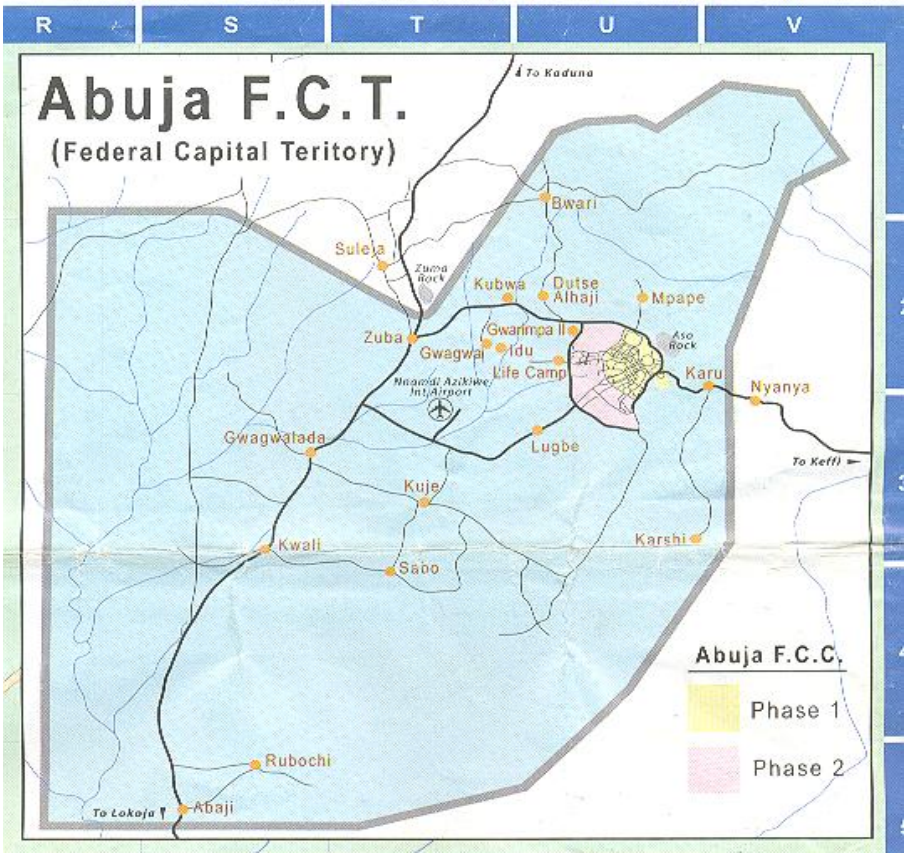

Figure 1. The map of Abuja, showing Abaji Area Council, Nigeria.

The method of data collection

Cross-sectional data from the primary source were collected from smallholder pepper farmers. Data were sourced through the use of a well-structured and, well-designed questionnaire which was administered through the use of personal interactions and interviews. Data were centered on the following: socio-economic profiles of smallholder pepper farmers such as household size, age, farm size, gender, educational level, farming experience, quantities of inputs, the quantity of output and their associated costs, and the value, and the constraints facing smallholder pepper producers.

Sampling techniques and sample size

The multi-stage sampling technique was used to select the sampled respondents, the smallholder pepper producers. In the first (1^{st}) stage, 5 wards out of 10 wards were randomly selected using the ballot-box raffle draw method including Abaji South East, Gawu. Yaba, Nuku and Gurdi. In the second (2^{nd}) stage, 2 villages were randomly selected per ward using the ballot-box raffle draw method making a total of 10 villages. In the third (3^{rd}) stage, 10 smallholder pepper farmers per village were randomly selected using the ballot-box raffle draw method to make a total sample size of 100 smallholder pepper farmers used for the study The purposive sampling method was used to select Abaji Area Council because of the predominant smallholder pepper production in the area.

The method of data analysis

The following statistical or econometric tools were adopted and used for achieving the stated specific and broad objectives: descriptive statistics, gross margin analysis, financial analysis, stochastic frontier model, elasticity of production, return to scale, and principal component analysis.

Descriptive statistics

This includes: - frequency distributions, mean, and percentages. This was used to have a summary statistic of data collected for achieving objectives of identification of the socio-economic profiles or characteristics of smallholder pepper farmers along with identification of constraints or problems faced by smallholder pepper producers.

Gross margin analysis

The gross margin model is stated thus:

$$GM = GI - TVC \quad (1)$$

where,
GM = Gross margin measured in naira,
GI = Gross income measured in naira,
TVC = Total variable cost (naira).

This was used to estimate the costs and returns of smallholder pepper production as stated in specific objective two (ii).

Financial analysis

In order to evaluate the strength and financial positions of smallholder pepper production, operating ratio, rate of return per naira invested, and gross margin ratios were considered. An operating ratio (OR) according to Olukosi and Erhabor (2005) is stated thus:

$$OR = \frac{TVC}{GI} \quad (2)$$

where,
OR= Operating ratio (units),
TVC=Total variable cost (naira),
GI=Gross income (naira).

An operating ratio that is less than one (1) implies that the total revenue obtained from smallholder pepper production was able to offset or pay for the cost of variable inputs used in the enterprise (Olukosi and Erhabor, 2005). The rate of return per naira invested (RoRI) in smallholder pepper production is stated thus:

$$RORI = \frac{NFI}{TC} \quad (3)$$

where,
RORI= Rate of return per naira invested (units),
NFI= Net farm income from pepper production (naira),
TC = Total cost (naira).

The gross margin ratio (GMR) following Ben-Chendo et al. (2015) is stated thus:

$$Gross\ Margin\ Ratio = \frac{Gross\ Margin}{Total\ Revenue} \quad (4)$$

The financial analysis was specifically used to achieve part of objective two (ii) which is to analyze the costs and returns of smallholder pepper production.

Net farm income (NFI) is stated thus:

$$NFI = \sum_{i=1}^{n} P_1 Y_i - \sum_{j=i}^{m} P_j X_j - \sum_{k=1}^{k} GK \quad (5)$$

NFI = Net farm income (naira per ha)

P_i = Unit price of product (naira/ha)
P_j = Price per unit variable input (naira/unit)
GK = Cost of fixed inputs (where k = 1,2,3, ……. k fixed input)
$\sum$ = Summation (Addition) sign

The stochastic production frontier model

The stochastic production frontier model is stated thus:

$$Y_i = f(X_i, \beta_i)e^{v_i - u_i} \quad (6)$$

$$l_n Y = \propto_0 + \beta_1 l_n X_1 + \beta_2 l_n X_2 + \beta_3 l_n X_3 + \beta_4 l_n X_4 + \beta_5 l_n X_5 + V_i - U_i \quad (7)$$

where,
Y_i = Output of pepper (kg)
X_i = Vector of variable inputs
β_i = Vector of estimated parameters
V_i = Error term, random variation in output
U_i = Error term due to technical inefficiency
X_1 = Labour input (mandays)
X_2 = Seed input (kg)
X_3 = Fertilizer input (kg)
X_4 = Chemical input (litre)
X_5 = Farm size (ha)

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 \quad (8)$$

where,
U_i = Error term associated with technical inefficiency
Z_1 = Sex (1, male; 0, otherwise)
Z_2 = Age (Years)
Z_3 = Marital status (1, married; 0, otherwise)
Z_4 = Level of education (0, non-formal; 1, primary; 2, secondary; 3, tertiary)
Z_5 = Household size (number)
Z_6 = Faming experience (years)
Z_7 = Access to extension officers or agents (number of meetings/week)
Z_8 = Access to credit facilities (1, access; 0, otherwise)
δ_0 = Constant term
$\delta_1 = \delta_8$ = Parameters to be estimated

This was specifically used to achieve objectives three (iii), four (iv), five (v), and six (vi)

The elasticity of production and return to scale

Return to scale of the farm operations can either be increasing, decreasing, or constant return to scale based on the value.

$$RTS = \sum EPI_S \quad (9)$$

where,
RTS = Returns to scale, and
EPI_S = Elasticity of production inputs (units)
This was used to achieve specific objective six (vi)

Principal component analysis (PCA)

The perceived constraints faced by smallholder pepper production were analyzed using principal component analysis (PCA). The model of principal component analysis (PCA) is stated thus:

$$x = x_1, x_2, x_3, \dots, x_p \quad (10)$$

$$\propto_k = \propto_{1k1}, \propto_2 K, \propto_3 k, \dots, \propto pk \dots \quad (11)$$

$$\propto_K^T x = \sum_{j=1}^{p} \propto_{KjXj} \quad (12)$$

$$Var = [\propto_K^T X] \; is \; Maximum \quad (13)$$

Subject to

$$\propto_K^T \propto_K = 1 \quad (14)$$

$$\text{and Cov} = [\propto_1^T \propto - \propto_2^T \propto] = 0 \quad (15)$$

The variances of each of the principal component are:

$$Var[\propto_k X] = \lambda_k \quad (16)$$

$$S = \frac{1}{n-1}(X - \bar{X})(X - \bar{X})^T \quad (17)$$

$$S_i = \frac{1}{n-1}\sum_{i=1}^{n}(X_i - \bar{X}_i)\,(X_I - \bar{X}_i) \quad (18)$$

where,
X = Vector of 'P' random variables
$\propto_k$ = Vector of 'P' constraints
$\succ_k$= Eigen value
T = Transpose
S = Sample covariance matrix
This was used to achieve specific objective six (vi)

Results and Discussion

Socio-economic profiles of smallholder pepper farmers

Table 1 shows the result obtained on the socio-economic profiles of the smallholder pepper farmers. From the result, about 82 % of the smallholder pepper farmers were between 31 and 50 years of age. This means that most pepper farmers were predominantly in their economically active age, with a mean age of 38.3 years. Pepper production has great potential for reducing the poverty level among

the populace and as well serves as a food security crop. This result agrees or in line with the findings of Alabi et al. (2013), Mohammed et al. (2016) who stressed that farmers within the ages of 31-50 years were relatively young and are within the energetic and active age in pepper production, thus productivity might be high. Educated young farmers'- gains more experiences and acquaint themselves with new technologies and are expected to adopt and use new technologies more efficiently.

Table 1. The socio-economic profiles of the smallholder pepper producers.

Variables			
Age (years)	Frequency	Percentage	Mean
< 30	18	18.0	
31 – 40	45	45.0	38.3
41 – 50	37	37.0	
Gender			
Male	80	80.0	
Female	20	20.0	
Marital status			
Single	17	17.0	
Married	74	74.0	
Divorced	04	04.0	
Widow/Widower	03	03.0	
Educational status			
Primary	18	18.0	
Secondary	13	13.0	
Tertiary	22	22.0	
Non-formal	47	47.0	
Occupation			
Farmer	94	94.0	
Formally employed	02	02.0	
Business	04	04.0	

Source: Field survey (2019).

About 80% of the pepper farmers were male, while 20% were female. The percentage of male to female pepper farmers indicates that pepper farming activities were gender-sensitive. This finding or result is in agreement with the findings of Alabi et al. (2014). The majority (74.0%) of the smallholder pepper farmers were married. This result is in agreement with those of Alabi (2012), Adeoye et al. (2014), who reported that family members serve as a readily available source of the farm labour force. About 53% of smallholder pepper producers had formal education, while 47% had non-formal education. Education enhances their responses in adopting innovations and new technologies. This agrees with Alabi et al. (2009), and Alabi et al. (2010a), who have reported that

education acquired is an important factor influencing management and the adoption of new technology. The majority of the smallholder pepper farmers had household sizes between 6 to 10 persons. The mean household size was 5 people per household. This has direct implications on labour supply to the farm because of the potential contributions to labour available for pepper production. The results agree with Sani et al. (2010) who reported that larger household sizes were observed to provide enough persons for family labour which means less or little money will be needed to pay for hired labour.

Table 1 (continued). The socio-economic profiles of the smallholder pepper producers.

Household size (units)			
≤ 5	35	35.0	
6 – 10	62	62.0	5.34
≥ 11	03	03.0	
Access to credit			
Yes	52	52.0	
No	48	48.0	
Extension contact			
Yes	70	70.0	
No	30	30.0	
Years of experience			
< 5	74	74.0	
6 – 10	23	23.0	4.7
11 – 15	03	03.0	
Member of cooperative			
Yes	74	73.0	
No	27	27.0	
Farm size (hectare)			
.50	18	18.0	
1.00	33	33.0	
1.50	06	06.0	
2.00	33	33.0	
3.00	06	06.0	
4.00	02	02.0	
5.00	02	02.0	
TOTAL	100	100.0	

Source: Field survey (2019).

Furthermore, 52% of smallholder pepper farmers had no access to credit. This implies that the smallholder pepper farmers may have to finance all their operating costs by themselves. This result indicates that agricultural loans were not easily accessible to smallholder pepper farmers. The high-interest rate charged by the commercial and other lending agencies in the country plus cumbersome administrative procedures could be related to poor access to credit (Ume et al.,

2010). This agrees with Alabi and Ajooku (2012), Ume and Ochiaka (2016), who reported that the majority of the sampled households do not have any access to credit facilities. The overwhelming majority, 97.5% of the smallholder pepper farmers, had less than 10 years of experience in pepper production. According to Olaoye et al. (2013), the number of years of experience could improve skills and better approaches to farming practices. Experience can help correct past errors and expand or contract the scales of the application of tested skills. Also, respondents with longer or many years of experience could be able to forecast future market situations in which they dispose of their products at higher prices to make better profits. This means that the smallholder pepper production in the study should be able to make relatively sound decisions regarding resource allocation and management of their farms. Table 1 reveals that 73% of sampled smallholder pepper farmers belonged to some form of cooperative society while 27% of the smallholder pepper farmers did not belong to any cooperative society. The membership of cooperative society affords the pepper farmers the opportunity of obtaining credit facilities, sharing information on modern production techniques, purchasing inputs in bulk and exchanging labour. The land is the most important input for agricultural production. Nigerian farms are classified into small-scale, medium-scale and large-scale. Farm sizes of less than 5 hectares are classified as small-scale, between 5 and 10 hectares as medium-scale, and more than 10 hectares as large-scale. Most pepper farmers (Table 1) had less than 5 hectares, hence, they are classified as small-scale farmers.

Costs and return analysis of smallholder pepper production

Table 2 shows the estimated costs and returns analysis of smallholder pepper production in Abaji Area Council, Abuja, Nigeria. The total revenue is the same value as gross income in this study and was calculated to be ₦348, 719.00. The total cost was ₦180, 977.40 which is a sum of the total variable cost (TVC) and the total fixed cost, which is the total sum of the total input costs, total labour costs, and rent on land. The gross margin was calculated to be ₦167,741.60. The net farm income (NFI) was calculated to be ₦160, 642.69. The rate of return on investment was 2.17. This means that smallholder pepper production was profitable. The total variable cost was 96.07% of the total cost. The total input cost was ₦55, 781.30, which makes up 30.8% of the total cost, on the other hand the total labour cost, was ₦78, 096.99, which results into 43.15% of the total cost. The operating ratio was 0.49, and the gross margin ratio was 0.481, which implies that for every naira invested in smallholder pepper production, 48 kobos would be used to cover profits, taxes, expenses, and depreciation. These findings are in agreement with Alabi and Ajooku (2012), Adeniyi et al. (2015); Edet et al. (2016); Njoku and Offor (2016).

Table 2. The average costs and returns of smallholder pepper production per hectare.

Items (annual)	Amounts (₦)	%of Total cost
Total revenue/ Gross income…. (A)	348, 719.00	
Input costs		
Seeds	16, 200	
Herbicides	4,908.51	
Fertilizers	20,829.79	
Insecticides	5,761.70	
Bags/Sacks	4,819.14	
Manure	3,262.16	
Total input cost……. (B)	55,781.30	30.8
Labour costs		
Land clearing	8,597.87	
Soil tillage	13, 379.79	
Planting	7, 807.38	
Manure application	2,709.57	
Chemical application	4, 397.87	
Weeding	8, 973.40	
Fertilizer application	3,707.87	
Harvesting	12,975	
Bagging	4, 305	
Transportation	4, 373.80	
Storage	2, 844.44	
Loading	4, 025	
Total labour cost ……... (C)	78,096.99	43.15
Rent on land …….(D)	40,000	
Total variable costs (B+C+D) …… (E)	173,878.29	96.07
Fixed cost		
Hoe	2, 985.19	
Cutlass	1,629.63	
Radio	2, 484.29	
Total fixed cost (depreciated and interest) …… (F)	7,099.11	
Total cost (E+F)	180, 977.40	
GM (A-E)	167, 741.60	
NFI (GM-F)	160,642.49	
OR	0.49	
RORI	0.89	
GMR	0.481	

Source: Field survey (2019).

The technical efficiency index of smallholder pepper farmers

Table 3 shows the result of the stochastic frontier production model function of smallholder pepper farmers. Labour input (P<0.10), seed input (P<0.01), farm size (P<0.01) were significant factors influencing the output of smallholder pepper production.

This implies that a 1% increase in the labour inputs holding other factors or variables constant will lead to about a 6.26% increase in the quantity of pepper produced. This result is in line with the findings of Alabi et al. (2010b), and Kasim et al. (2014). Seed input was significant and positive at the 1% probability level, which means that a 1% increase in the quantity of seed input used, holding other factors or variables constant, will lead to about a 32.14% increase in the quantity of pepper produced. The elasticity of production for seed input equalled 0.32 indicating the inelasticity of seeds in the production process. This is in line with the findings of Idris et al. (2015) and Alabi et al. (2010a).

A 1% increase in the farm size holding other variables constant, will lead to about a 69.85% increase in the quantity of pepper produced. Farm size had the highest elasticity, which was 0.69. The variance parameters estimated in the production model represented by sigma-squared (δ^2) were statistically significant at the 5% probability level. This signifies a good fit for the model estimated and the correctness of the distributional assumptions for both the U_i and the V_i which implies that a greater part of the residual variations in output is linked with technical inefficiency rather than with measurement errors which can be said to be linked with uncontrollable factors associated with the production process (Omonona et al., 2010). Based on the value of lambda (λ), we can derive gamma (γ). This means the effect of the technical efficiency in the variations of the observed output from the estimated gamma was 0.59, implying that 59% of variations in the smallholder pepper output were due to technical efficiency. The return to scale was 1.2363, indicating an increase in return to scale. The inefficiency model shows that the educational status or level attained (P<0.05), household or family size (P<0.01), and access to extension agents (P<0.01) were statistically significant. A unit increase in the educational level will lead to about a 0.45 unit decrease in technical inefficiency suggesting that as farmers acquire education, they will gain technical knowhow, develop mastery of resource allocations, and become more technically efficient. As farmers acquire education, it could lead to an increase in the adoption of improved technology and production techniques. Onumah et al. (2010) have noted that formal education enlightens pepper farmers about the technical aspect of production, enhancing efficiency and productivity. One-unit increment in the number of the household members involved in pepper production will lead to a 0.38 unit decrease in technical

inefficiency. This result agrees with the findings of Abdulakeem et al. (2019), Ajani and Olayemi (2011).

Table 3. The stochastic production frontier function for the smallholder pepper farmers.

Variables	Coefficient	Standard error	Z-score
Labour input (X_1)	0.0626	0.0357	1.78*
Seed input (X_2)	0.3214	0.0975	3.4***
Fertilizer input (X_3)	0.1003	0.0665	1.51
Chemical input (X_4)	0.0535	0.0632	0.85
Farm size (X_5)	0.6985	0.1118	6.39***
Constant	6.2121	0.2295	27.07
Inefficiency model			
Sex (Z_1)	-0.0964	0.4992	-0.19
Age (Z_2)	0.0241	0.0322	0.75
Marital status (Z_3)	0.1116	0.7031	0.16
Level of education (Z_4)	-0.4480	0.2215	-2.04**
Household size (Z_5)	-0.3875	0.1201	-3.24***
Farming experience (Z_6)	0.0006	0.0268	0.02
Access to extension agents (Z_7)	2.1275	0.6291	3.38***
Access to credit (Z_8)	2.1476	1.5241	1.41
Return to scale	1.2363		
Lambda (λ)	1.2120		
Sigma- squared (δ^2)	0.2502**		
Gamma (γ)	0.59016		

Source: Field survey (2019). *-Significant at 10% probability level; ** -Significant at 5% probability level, and *** - Significant at 1% probability level.

Distribution of technical efficiency of smallholder pepper farmers

Table 4 shows the distribution of smallholder pepper farmers at the different efficiency levels. The majority (32%) of the smallholder pepper farmers were between 71% and 80% efficiency levels implying that most farmers were technically efficient. Such efficiency distribution conforms to previous studies carried out by Alabi et al. (2010b), Alabi et al.(2010a), Ekunwe and Emokaro (2009); and Alawode and Jinad (2014), who pointed out that the technical efficiency index of pepper farmers was 79.7%, leaving a gap of 20.3% for improvement. The minimum technical efficiency was 31.5%, while the best performing farm had the maximum technical efficiency of 98.6%. If the average pepper farmers were to achieve the level of technical efficiency like most of its efficient counterparts, then the average pepper farmer could make 19.16% cost savings [1 – (79.7/98.6) x 100]. The estimates for the most technically inefficient farmer reveal a cost saving of 68.05% [1 – (31.5/98.6) x 100].

Table 4. The descriptive statistics of technical efficiency.

Efficiency score	Freq.	Percent	Cum.
0.00 – 0.49	03	03.0	03.00
0.51 – 0.60	05	05.00	08.00
0.61 – 0.70	15	15.00	23.00
0.71 – 0.80	32	32.00	55.00
0.81 – 0.90	22	22.00	77.00
0.91 – 1.00	23	23.00	100
Total	100	100	
Mean	0.7974286		
Standard deviation	0.1220531		
Minimum	0.3150281		
Maximum	0.9862165		

Source: Field survey (2019).

The principal component analysis of constraints facing smallholder pepper farmers

Table 5 shows the results of the constraints faced by smallholder pepper farmers. Principal component analysis (PCA) is reported to be a statistical technique that transforms interrelated data with many variables into few numbers of uncorrelated variables. The results shows that the number of principal components retained using the Kaiser Meyer criterion was nine based on the Eigen value greater than 1. The retained components explained 70.32% of the variations of the component included in the model. Kaiser-Meyer-Olkin (KMO), which measures sampling adequacy, gave an estimated value of 0.53, and the chi-square observed to be 560.260 was statistically significant at the 1 % level of probability. This demonstrated the feasibility of using the data set for factor analysis. The use of crude implements had an Eigen-value of 3.2351 and it ranked 1st in the order of importance based on the perceptions of the smallholder pepper farmers. The lack of fertilizers and improved seeds with Eigen-values of 2.31613 and 2.22658 ranked 2nd and 3rd, respectively. This is based on the order of occurrences and perceptions of the smallholder pepper farmers as the major constraints facing pepper farmers. Bad road infrastructure, pests, disease insurgence and infestation, and lack of credit facilities with Eigen-values of 1.84691, 1.7184 and 1.43801 follow the same order of their occurrences and importance respectively based on the perceptions of smallholder pepper farmers as other challenges faced by smallholder pepper farmers.

Table 5. Results of the principal component analysis of constraints facing smallholder pepper farmers.

Component mean (Std Dev)	Eigen value	Difference	Proportion	Cumulative
Crude implements	3.235	0.918974	0.1407	0.1407
Lack of fertilizers	2.3161	0.0895476	0.1007	0.2414
Lack of improved seeds	2.22658	0.379674	0.0968	0.3382
Bad road infrastructure	1.84691	0.128506	0.0803	0.4185
Pest and diseases infestation	1.7184	0.280386	0.0747	0.4932
Lack of credit facilities	1.43801	0.179065	0.0625	0.5557
Lack of extension services	1.25895	0.158646	0.0547	0.6104
Lack of access to farm land	1.1003	0.06629	0.0478	0.6583
Lack of iinformation	1.03401	0.137515	0.0450	0.7032
Bartlett test of sphericity				
Chi-square	560.260***			
Rho	1.0000			
KMO	0.5262			

Source: Field survey (2019).

Conclusion

Based on the findings from of this study, it can be concluded that smallholder pepper farmers were young, energetic, and resourceful with a mean age of 38.3 years. The household or family sizes were large, with an average of 5 people per household, having considerable experience in pepper farming, with an average experience of 4.7 years. Pepper farming is a profitable enterprise with a gross margin and the net farm income of 167,741.60 nairas and 160,642.69 nairas respectively. The gross margin ratio of 0.481 revealed that for every naira incurred or invested in pepper enterprise, 0.48 covered expenses, taxes, interest, profits, and depreciation. Labour input, seed input, and farm size were positive and statistically significant factors affecting the productivity of smallholder pepper production. The level of education attainment, household or family size, and access to extension agents were statistically significant factors in the technical inefficiency model, and the technical efficiency index was 79.7%, leaving a gap of 20.3% for improvement. The elasticity of production for seed input was inelastic. The return to scale for smallholder pepper production was increasing return to scale. Major constraints faced by smallholder pepper farmers were the use of crude implements, lack of fertilizers, lack of improved seeds, bad roads, lack of credit facilities, lack of access to farm land, lack of extension services, pest and disease infestation, and lack of information based on the perceptions of smallholder pepper farmers.

The following were policy recommendations basically arising from the findings of this study:

(i) Extension officers should be employed to disseminate research findings to smallholder pepper farmers. Extension agents will effectively mobilize rural farmers for full participation in the production of pepper through the use of community leaders in the study area.

(ii) Farm inputs such as fertilizers, improved seeds, and credit facilities should be provided and made available to smallholder pepper farmers to boost their production by increasing their efficiency.

(iii) Farm land with irrigation facilities should be made available to farmers to encourage them to increase pepper production.

(iv) Feeder roads should be constructed to evacuate produce from farms to market centres along with transportation facilities to provide easy transportation of farm produce to nearby market centres to avoid spoilage and bruises to farm produce.

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EKONOMIJA OBIMA I TEHNIČKA EFIKASNOST MALIH GAZDINSTAVA USMERENIH NA PROIZVODNJU PAPRIKE (*CAPSICUM SPECIES*) U ABUDŽI (NIGERIJA)

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R e z i m e

Ovim istraživanjem se ispituje ekonomija obima i tehnička efikasnost malih gazdinstava usmerenih na proizvodnju paprike (*Capsicum species*) u Abudži (Nigerija). Tehnika višeetapnog uzorkovanja je usvojena da bi se dobila ukupna veličina uzorka od 100 malih poljoprivrednih proizvođača paprike. Primarni izvori podataka dobijeni su od proizvođača paprike putem dobro struktuiranog i dobro osmišljenog upitnika. Dobijeni podaci su analizirani korišćenjem deskriptivne statistike, bruto marže, finansijske analize, modela stohastičke granice funkcije proizvodnje, elastičnosti proizvodnje, povraćaja u odnosu na obim i analize glavnih komponenti. Rezultati studije su pokazali da je prosečna starost posmatranih proizvođača paprike bila 38,3 godine. Prosečna veličina domaćinstva bila je 5 osoba. Bruto marža iznosila je ₦ 167.741,60 po hektaru, stopa povraćaja investicije u proizvodnju paprike 0,89, a koeficijent poslovanja 0,49. Koeficijent bruto marže je izračunat na 0,48, a to implicira da bi se za svaku nairu koja je uložena u proizvodnju paprike malih gazdinstava, 48 koboa koristilo za pokrivanje profita, kamata, troškova, poreza i amortizacije. Uloženi rad ($P < 0,10$), uloženo seme ($P < 0,01$), veličina farme ($P < 0,01$) bili su značajni faktori koji su uticali na proizvodnju paprike na malim gazdinstvima. Srednja tehnička efikasnost bila je 0,79, ostavljajući prostora od 0,21 za poboljšanje. Povraćaj u odnosu na obim od 1,2363 implicira povećanje povraćaja u odnosu na obim. Ovim istraživanjem preporučuje se uvođenje mera za rešavanje izazova neadekvatnih padavina kroz odgovarajuće pristupe navodnjavanju.

Ključne reči: ekonomija obima, model stohastičke granice funkcije proizvodnje, proizvodnja paprike, Abudža, Nigerija.

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