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Profitability And Determinants Of Profit Efficiency Among Small Scale Organic Vegetable (*Spinach*) Farmers In Niger State, Nigeria

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Abstract

This study assessed the profitability and determinants of profit efficiency among small-scale organic vegetable (spinach) farmers in Niger State, Nigeria, with the aim of generating evidence-based recommendations for improving productivity and returns. A multi-stage sampling procedure was used to select 148 farmers, and the data was analysed using descriptive statistics, farm budgeting techniques, a perception index, and the trans-log stochastic frontier profit function. Results revealed that the majority (82%) of farmers were male, with a mean age of 40 years, and 70% had some form of formal education. The average farming experience was five years, with 76.67% cultivating one hectare or less. Profitability analysis indicated that organic vegetable production was economically viable, with an estimated net farm income of ₦67,808.31 per hectare, a gross margin of ₦70,273.56, and a return on investment of ₦1.53 for every naira invested. The gross ratio (0.46) and operating ratio (0.44) further confirmed profitability. The stochastic frontier results identified planting material, organic manure, labour, depreciation on equipment, and farm size as significant determinants of profit efficiency, alongside socio-economic factors such as age, household size, farming experience, awareness, and access to information on organic farming. The study concludes that organic vegetable farming offers strong potential for income generation and environmental sustainability. Policy recommendations include improving farmers' access to information, strengthening extension services, and promoting cooperative structures to enhance economies of scale and bargaining power.

Keywords: Organic Vegetable, Profit Efficiency, Production, Farmer, Inefficiency Factors.

INTRODUCTION

Organic agriculture is increasingly recognised as a sustainable alternative to conventional farming, offering solutions to environmental degradation, declining soil fertility, and food safety concerns (Reganold & Wachter, 2016; Willer et al., 2023). In sub-Saharan Africa, over 75% of the farming population still engages in subsistence or traditional agriculture, with productivity levels two to three times lower than the global average (FAO, 2022). Limited access to modern inputs, low levels of technical knowledge, and degraded natural resources often contribute to these low yields. Organic farming—characterised by the avoidance of synthetic fertilisers, pesticides, and genetically modified organisms—has emerged as a viable pathway for improving environmental outcomes and farm profitability (Gomiero, 2018; Tanko et al., 2021).

In Nigeria, organic vegetable production is gaining momentum due to rising consumer demand for safe, environmentally friendly produce. Vegetables such as spinach are not only nutrient-dense but also have short production cycles, making them ideal for income generation among resource-constrained farmers

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(Ajewole & Osewa, 2020; Obuobie et al., 2019). However, despite these advantages, adoption remains limited due to perceived production risks, lack of structured market linkages, and insufficient empirical evidence on profitability and efficiency (UNCTAD, 2021).

Existing studies have tended to focus on agronomic benefits, with less emphasis on economic efficiency, particularly using frontier models that integrate both input prices and socio-economic characteristics (Ajebew et al., 2021; Obuobie et al., 2019). This knowledge gap constrains policy support for organic farming.

This study addresses the gap by analysing the profitability and determinants of profit efficiency among small-scale organic spinach farmers in Niger State, Nigeria. Specifically, it: (i) describes the socio-economic characteristics of organic vegetable farmers, (ii) examines perceptions towards organic production, (iii) estimates costs and returns, and (iv) determines the socio-economic and production factors influencing profit efficiency. The results aim to guide both policy interventions and farmer decision-making.

METHODOLOGY

The Study Area

The study was conducted in Niger State, which is located in the Guinea Savanna vegetation zone in the North Central part of Nigeria, which lies between Latitudes 3°20'1" and 7°40'1"N and Longitudes 8° and 11°31'E (NAMDA, 2013). The state is bordered by Zamfara State, Kebbi State, Kogi State, Kwara State, Kaduna State and the Federal Capital Territory (FCT) Abuja, respectively. The state shares a common boundary with the Republic of Benin along the Borgu Local Government Area (LGA). This gives rise to common cross-border trade with the state. Niger State is primarily called the “Power State” of Nigeria by virtue of the location of the three hydroelectricity dams in the state, namely, the Kainji, Shiroro and Jebba Dams. The state experiences two distinct climatic seasons in a year (rainy and dry season). Rainfall (1,100 mm – 1,600 mm per annum) is steady and is evenly distributed, falling usually between mid-April and November, peaking in August. Average monthly temperature ranges from 23°C to 37°C (NAMDA, 2012). The vegetation consists mainly of short grasses, shrubs and scattered trees; soils are predominantly light and well drained (NAMDA, 2013). According to the National Population Commission (NPC) (2006), Niger State has a population of about 3,950,249. Farming is the primary occupation of 85 per cent of the state’s population, while 15 per cent are engaged in industrial and other businesses or vocational jobs like crafts and arts. However, agriculture in Niger State is predominantly in the hands of rural dwellers. The major crops grown include rice, sugarcane, maize, millet, melon, yam, groundnut, sorghum and cowpea. Livestock reared include cattle, sheep, goats and poultry (NAMDA, 2013).

Sampling Procedure and Sample Size

Multi-stage sampling was used to select farmers for the study. In the first stage, one local government area (Chanchaga) was randomly selected. In the second stage, four communities were purposively selected (Barkin Sale, Mechanic Village, Mandella and Chanchaga), which are located at the river boundary channel across the LGA. These communities were selected because of the high concentration of organic vegetable farmers in the area. In the third stage, thirty-seven (37) organic vegetable farmers were selected from the selected communities because of the homogenous nature of the communities using simple random sampling techniques. A total of one hundred and forty-eight (148) organic vegetable farmers were selected and interviewed with the aid of a structured questionnaire.

Analytical Techniques and Model Specification

Descriptive statistics such as frequency distribution, percentages, mean and Likert-type scales were used to describe the socio-economic characteristics of the farmers and examine the farmers’ perception of organic vegetable production. The farmers’ perception towards organic vegetable production was determined using a 5-point Likert scale as follows. Strongly Agree (SA) = 5, Agree (A) = 4, Undecided (U) = 3, Disagree (D) = 2 and Strongly Disagree (SD) = 1. The weighted mean score value of 3.0 or higher means respondents agree that

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organic vegetable production contributed to the statement, while any weighted mean score value of less than 3.0 was regarded as respondents disagreeing with organic vegetable production not contributing to the statement.

Farm budgeting techniques were used to estimate the cost and returns of organic vegetable production. The model is specified in equations (1) and (2). Gross margin is the difference between the Gross Farm Income (GFI) and Total Variable Cost (TVC) as depicted in equation (1) following Olukosi et al. (2006).GM = GFI – TVC………..(1)
Where: GM = Gross Margin, GFI = Gross Farm Income, TVC = Total Variable Cost.
The net farm income is defined as: NFI = GM – TFC……………………………………………………….. (2)
Where: NFI = Net Farm Income, GM = Gross Margin, TFC = Total Fixed Cost.
The profitability of organic vegetable production was analyzed and compared using the various financial ratio as specified in equations (3), (4) and (5). Gross Ratio: This is a profitability ratio that measures the overall success of the farm. The lower the ratio, the higher the return per naira.

GR = $\frac{TFE}{GI}$ ....……………………(3)

Where: GR = Gross Ratio, TFE = Total Farm Expenses and GI = Gross Income.
Operating Ratio: The operating ratio is directly related to the farm variable input usage. The lower the ratio, the higher the profitability of the farm business. OR = $\frac{TOC}{GI}$ …………………………………………….……….(4)
Where: OR = Operating Ratio, TOC = Total Operating Cost and GI = Gross Income.
Return on Capital Invested: Is a profitability index defined as a measure of the amount that accrues to the enterprise as net income for every naira invested. The higher the return to investment, the more profitable the enterprise.

RI = $\frac{GM}{TVC}$ …………………………………………………(5)

Where: RI = Return on Capital Invested, GM = Gross Margin, and TVC = Total Variable Cost.
Trans-log Stochastic Frontier Profit Function was used to analyze the determinant of profit efficiency among organic vegetable farmers. Farm profit equals the difference between the Total Revenue (TR) and Total Cost (TC). That is,

GM (π) = Σ (TR – TVC) = Σ (PQ – WX) ……..………(6)
To normalize the profit function, farm π is divided by P which is the market price of the output (vegetable). It is represented as $\frac{\pi(p,z)}{P} = \frac{\sum(PQ - WX_i)}{P}$ ………(7)

= Q - $\frac{(WX)}{p}$ ……………………………....…………(8)

= f(Xi, Z) - Σ PiXi ……………………………..…………..9)
Where: TR represents total revenue, TC represents total cost, P represents price of output (Q), X represents the quantity of optimized input used, Z represents price of fixed inputs used, pi = W/P which represents normalized price of input Xi, while f (Xi, Z) represents the production function.
The Cobb-Douglas profit function in implicit form which specifies production efficiency of the farmers is expressed as follows: $\pi_i = f(p_i, z)\exp(V_i - U_i), i = 1,2,........n$ ……………………………………………………….…… (10)
Where: π, p_i and z is as defined above. The V_is are assumed to be independent and identically distributed random errors, having normal N(0, σ^2 v) distribution, independent of the U_is. The U_is are profit inefficiency effects, which are assumed to be non-negative truncation of the half-normal distribution N (μ,σ^2 u). The profit efficiency is expressed as the ratio of predicted actual profit to the predicted maximum profit for a best-practiced organic vegetable farmer and this is represented as follows: Profit Efficiency $((E\pi) = \pi / \pi^{\max}$ ………………………………(11)

$$= \frac{\exp[\pi(p,z)]\exp(\ln V)\exp(-\ln U) - \theta}{\exp[\pi(p,z)]\exp(\ln V) - \theta} \quad .... (12)$$

Firms specific profit efficiency is again the mean of the conditional distribution of U_i given by E π and is defined as: $E_{\pi} = E[\exp(-U_i)/E_i]$ …………………………… (13)
E_π takes the value 0 and 1. If $U_i = 0$, this means that farm is on the frontier, obtaining potential maximum profit given the price it faces and the level of fixed factors. If $U_i > 0$, the farm is inefficient and losses profit. The Cobb-Douglas Trans-log function model was estimated by a combination of the production and inefficiency factor in a single stage maximum likelihood estimation procedure to identify the determinants of profit efficiency. It is specified explicitly as:

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$$InY = \beta_o + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \beta_5 InX_5 + \frac{1}{2}\beta_{11} InX_1^2 + \frac{1}{2}\beta_{22} InX_2^2 + \frac{1}{2}\beta_{33} InX_3^2 + \frac{1}{2}\beta_{44} InX_4^2 + \frac{1}{2}\beta_{55} InX_5^2 + \beta_{12} InX_1 InX_2 + \beta_{13} InX_1 InX_3 + \beta_{14} InX_1 InX_4 + \beta_{15} InX_1 InX_5 + \beta_{23} InX_2 InX_3 + \beta_{24} InX_2 InX_4 + \beta_{25} InX_2 InX_5 + \beta_{34} InX_3 InX_4 + \beta_{35} InX_3 InX_5 + \beta_{45} InX_4 InX_5 + Vi - Ui \ldots\ldots\ldots (14)$$

Where:
π = Net profit (₦)
X_1 = Unit price of planting material (₦)
X_2 = Unit price of waste (organic manure) (₦)
X_3 = Unit price of labour (₦)
X_4 = Depreciation on farm equipment (₦)
X_5 = Farm size (ha)
X_1 – X_5 are factors assumed to affect the level of profit efficiency of the organic vegetable farmers and
β_0 =constant,
β_1- β_{45} = are maximum likelihood estimates to be measured,
In is natural Logarithm,
v_i and u_i = composite errors
The inefficiency model (u) for the stochastic profit frontier is expresses in equation (15)

$$U = \delta_0 + \delta_1 z_1 + \delta_2 z_2 + \delta_3 z_3 + \delta_4 z_4 + \delta_5 z_5 + (v_i - u_i) \ldots\ldots\ldots (15)$$

Where:
Z_1 = Age of the farmers (years),
Z_2 = Household size (number of persons),
Z_3 = Educational level measured in number of years Spend in formal school,
Z_4 = Extension contact (Number),
Z_5 = organic farming experience (years)
Z_6 = Awareness of organic farming (Dummy variables; Yes=1, No= 0)
Z_7 = Access to Information on organic farming (Dummy variables; Yes=1, No= 0)
δ_0 = constants
δ_1 – δ_7 = coefficient to be measured.

RESULTS AND DISCUSSION

Socio Economic Characteristics of organic vegetable farmers.

The socio-economic characteristics variables of the organic vegetable farmers in the study area are presented in Table 1. The results revealed that the majority (95%) of the organic vegetable farmers were male. This is a clear indication of the complete dominance of the male gender in vegetable production. This result affirms the popular belief in the study area that agricultural activities are dominated by male folks. This result is supported by Amos et al. (2006) and Ahmadu and Alufohai (2012), who in their separate study reported that crop production in Nigeria is dominated by males. Moreover, 62% of the sampled farmers were 50 years and below, with a mean of 40 years. This reveals that the majority of the farmers were still in their economically active age and are likely to be productive in farming and improving their income-earning capacities through the adoption of new technologies. Because age is an important factor to be considered in determining the quality of labour employed, and it's prevalent in any given enterprise. This result is in agreement with that of Lawal et al. (2014), who affirmed that as the age of farmers increases, the adoption of agricultural technology will likely decrease while sensitivity to risk will increase, as older farmers are more risk averse.

Table 1 further revealed that 58% of the organic vegetable farmers had some level of education, at least to primary school. The implication is that farmers with no formal education, who constituted 30%, might not be able to efficiently adopt new agricultural innovation and technology in organic vegetable farming. The mean farming experience was 5 years, with over 47% of the farmers having more than 6 years of experience in organic vegetable farming.The implication is that longer years of organic vegetable farming experience may enable them to have adequate knowledge that will enable them to make sound decisions that probably would increase their farm income as well as manage risk. Which might affect their level of adoption of improved technologies. This finding is corroborated by those of Tanko et al. (2011), who observed that farmers with more years of farming experience can cope with the complexity of the adoption of new technology. It enables the farmer to set realistic time and cost targets by identifying production risks and constraints with greater ease. The result in Table 1 also showed that the majority (81%) of the farmers were married and had a household size of between 4 and 10 members (84%), as well as an average household size of 8 members. The result could be explained by the fact that most vegetable farmers in the region used the proceeds from the organic vegetable production to augment family income and employed relatively large and cheap family labour in vegetable production. These have a positive implication on farmers'

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welfare, the sustainability of organic vegetable production and the cost minimisation objective of vegetable farms in the study area. This is in agreement with Olanipekun and Kuponiyi (2009), who observed that a large family may serve as incentive for engaging in livelihood diversification in order to meet the obligations of the family.

Table 1: Socio-economic Characteristics of Organic Vegetable Farmers

Variables	Frequency (n=148)	Percentage	Mean
Sex			
Male	142	95.95	
Female	6	4.05	
Age			
Less 31	38	25.68	
31-40	46	31.08	
41-50	47	31.76	
Above 50	17	11.48	40
Marital status			
Single	27	18.24	
Married	121	81.76	
Level of education			
No formal education	45	30.41	
Primary education	86	58.11	
Secondary education	9	6.08	
Tertiary education	2	1.35	
Adult education	6	4.05	9.0
Farming experience			
< 5	77	52.03	
6-10	55	37.16	
11-15	12	8.11	5
Above 15	4	2.70	
House hold size			
4-10	125	84.46	
11-15	18	12.16	
16-20	5	3.38	8
Farm size(ha)			
0.4 - 1.00	113	76.35	
1.1 - 2.00	30	20.27	
Above 2.00	5	3.38	
Number of extension visit			
No Visit	43	29.05	
1-2 Visit	75	50.68	
3-4 Visit	30	20.27	
Member of association			
Yes	91	61.49	
No	57	38.51	
Monthly Income (₦)			
< 10,000	11	7.43	
10,001 – 20,000	88	59.46	
20,001 - 30,000	31	20.95	
30,001 - 40,000	6	4.05	
40,001 – 50,000	5	3.38	
Above 50,000	7	4.73	

Source: Field survey, 2020.

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Furthermore, the majority (76%) of the farmers had not more than 1 hectare of farmland for the cultivation of organic vegetables. The result could be attributed to the continuous subsistence nature of the cultivation of organic vegetable crops in Niger State imposed by increasing land fragmentation and urbanisation. This means that the farm size possessed by a particular farm family is believed to determine the extent to which other resources (capital, labour, etc.) will be utilised for optimum productivity. This finding is in consonance with those of Akpan et al. (2007), Abdullahi (2012), and Abdullahi and Mohammed (2012), who opined that farm size affects adoption of technology and that determines whether a farmer will use improved seed or not. It was also found that most (61%) of the farmers belong to at least one farmer's association. These farmers' associations are sources/channels of communicating information that will increase farmers' knowledge and skills on organic farming. This is supported by the finding of Amos et al. (2014) that membership of an association is of immense benefit to members; it gives the opportunity for bulk purchases of inputs at discounted rates and encourages collective bargaining.

The result in Table 1 further shows that half (50%) of the sampled farmers had between 1 and 2 extension visits in a year, while over 29% of the sampled farmers in the study area had no access to extension agents at all. This implies that some of the organic vegetable farmers have no proper linkages with the extension services, and this situation can result in little or no access to information by the farmers, which will go a long way to affect their production skills in the study area. This accretion is in consonance with that of Oladele and Adu (2003), who are of the view that poor extension services may hinder farmer access to necessary information on production activities, which decreases their profit margin. In addition, the majority (87%) of the sampled farmers earned not more than N30,000 as monthly income.

Table 2 presents the distribution of farmers according to their perception of organic vegetable production in the area. The result shows that all the perceptional statements have their weighted mean equal to or greater than 3, which is the mean cut. The result reveals a high positive and favourable perception of farmers toward organic vegetable production. This means that organic vegetable (OV) has contributed to strengthening the use of indigenous knowledge, having ranked first with a mean of 4.57, followed by OV reduces input cost of production (4.30), then OV has no long-term effect on ecological health (4.16). Other responses were that OV increases farmers' income with low cost (4.06), OV provides social compatibility with its practices (3.96), OV reduces farmers' exposure to health hazards (3.87), OV reduces all forms of environmental pollution (3.71), OV is prone to soil erosion (3.70), OV improves soil fertility and structure (3.68), OV is efficient in reducing pest and disease infestation (3.64), OV is efficient in mitigating climate change effects (3.63), OV products enjoy a poorer taste than conventional products (3.62), and OV ensures biodiversity (3.57). This suggests the potential of organic vegetable practice in the maintenance of environmental biodiversity, mitigation of climate change effect and degradation, system stability and reduction of people's exposure to health hazards, which may be because of the consumers of organic vegetable products who want to reduce health care costs and increase their intake of minerals and vitamins void of pesticides and agrochemicals. This finding corroborates the assertion of Giiessman (2005), who reported that farmers practising organic agriculture have healthier soil, which can sustain plant growth and higher nutrient content, and it enables them to grow crops for longer periods with higher yields, and the conditions are marginal.

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Table 2: Perception of the farmers towards organic vegetable production (n=148)

Perceptional Statements	SA	A	U	D	SD	Weighted sum	Weighted mean	Ranking
Organic vegetable (O V) is prone to soil erosion	21	55	18	10	5	404	3.70*	8th
O V increase farmers income with low cost	40	52	6	6	5	443	4.06*	4th
O V is efficient in reducing pest and diseases infestation	20	54	13	20	2	397	3.64*	10th
O V has no long term effect on ecological health	52	40	6	5	6	454	4.16*	3rd
O V is efficient in mitigating Climate Change effects	15	55	26	10	3	396	3.63*	11th
O V reduces inputs cost of production	51	46	7	4	1	469	4.30*	2nd
O V product enjoys poorer taste to conventional products	12	65	18	7	7	395	3.62*	12th
O V provides social compatibility with its practices	34	51	11	11	2	431	3.95*	5th
O V ensures biodiversity	22	50	9	25	3	390	3.57*	13th
O V strengthens the use of indigenous knowledge	66	42	0	0	1	499	4.57*	1st
O V reduces all forms of environmental pollution	18	58	19	11	3	404	3.71*	7th
O V improve soil fertility and structure	13	63	21	10	2	402	3.68*	9th
O V reduces farmers exposure to health hazards	13	79	9	6	2	422	387*	6th

Source: Field survey, 2020
SD= Strongly disagree, D= Disagree, U= Undecided, A= Agree, SA= Strongly agree
*Significant

Profitability of Organic Vegetable (spinach) Production.

Table 3 presents the costs and returns of organic vegetable farmers in the study area. The result reveals that organic vegetable production is quite profitable, and it was also shown that labour cost accounted for almost 37 per cent of the cost of production. This implies that a high amount of labour is required for the production of vegetable crops. This is in agreement with the findings of Abdullahi et al. (2010), who reported that labour constitutes a large per cent of the cost of production. Per production cycle, a net farm income of N77,537.35 with an average gross margin of N89,371.58 was realised. The positive net farm income and gross margin show that returns exceeded the cost, and also the gross and operating ratios of 0.60 and 0.39 were obtained, respectively, with a return on investment of N1.53, which indicates that organic vegetable production is profitable in the study area. This result is in line with those of Abdullahi et al. (2010), Abdullahi and Mohammed (2012) and Abdullahi (2012).

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Table 3: Profitability analysis of organic vegetable (spinach) production

Cost Item & Revenue	Cost (₦ /production cycle) n=148	%of Total cost
Variable cost		
Family labour (opportunity cost)	17,573.43	25.05
Hired labour	8,327.07	11.87
Organic manure cost	11,945.30	17.04
Seed/planting materials	6,553.50	9.34
Fuel (for pump)	5,875.00	8.38
Pump Maintenance/repairs	4,234.43	6.03
Marketing/transp cost	3,793.00	5.40
Total variable cost(a)	**58,301.73**	83.13
Fixed cost		
Depreciation on farm tools	5,223.50	
Depreciation on pump	6,620,73	7.45
Total fixed cost(b)	**11,844.23**	9.43
Total cost (a and b)	**70,145.96**	
Returns		
Gross farm income	**147,673.31**	
Gross margin	**89,371.58**	
Net farm income	**77,537.35**	
Return on investment	**1.53**	
Gross ratio	**0.60**	
Operating ratio	**0.39**	

Source: Field survey, 2020.

Measurement of the Profit Efficiency of the Respondents Using the Stochastic Frontier Profit Model.

The maximum likelihood estimates of the stochastic frontier profit function are presented in Table 4 along with the interacting terms. The results reveal that the sigma-square (δ^2) was 0.3229 in the study area and significant ($P<0.01$), indicating a good fit and the correctness of the specified assumptions of the distribution of the composite error term. The estimated gamma parameter (γ) of 0.96 in Table 4 was highly significant at 1 percent level of significance. This implies that a one-sided random inefficiency component strongly dominates the measurements error and other random disturbances, indicating that about 96 per cent of the variation in actual profit from maximum profit (profit frontier) between farms mainly arose from differences in farmers' practices rather than random variability. Two out of five estimated coefficients of the parameters of the normalised profit function based on the assumption of a competitive market are positive.

The coefficient of planting material was negative and statistically significant at $P<0.01$, indicating an increase in the factor price of planting material will bring about a marginal decrease in profit efficiency of organic vegetable farmers. This implies that an increase in the cost of planting material could reduce the profit efficiency of the farmers, suggesting that good use of improved planting materials may increase the profit of organic vegetable production. The coefficient of organic waste (manure) was negative and statistically significant at $P<0.01$, which shows that the organic manure had a negative correlation with farm profit. This means that an increase in the factor price of organic manure, holding other variables constant, will bring about a marginal decrease in profit efficiency of

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organic vegetable production by 0.31% in the study area. The reason would likely be that manure being a critical input in organic vegetable production, farmers were spending more on the purchase of this commodity from the open market, resulting in an increase in the level of patronage and usage of the commodity. This result corroborates Paul (2011), who reported that the cost of organic material poses a negative and significant effect on farmers' profit level.

The coefficient of labour was negative and statistically significant at $P<0.01$, indicating an increase in the factor price of labour will bring about a marginal decrease in profit efficiency of organic vegetable farmers. This means that since most family labour is unpaid for, farmers were using it to the extent of what is called the economical visible point (overutilisation of labour) and getting to a point where returns to labour become negative. So, increasing the price of labour above these present levels will decrease profit efficiency significantly. A similar finding was observed by Olowa et al. (2016): the cost of labour and cost of transportation were negatively attached to the profit of organic vegetables.

The coefficient of depreciation on equipment was positive and statistically significant at ($P<0.01$). Implying a one per cent increase in the factor price of equipment will bring about a marginal increase in profit efficiency by 0.37%. The coefficient of farm size was positive and significant at $P<0.05$, indicating that an increase in farm size will lead to an increase in profit efficiency. This also implies that farmers with large farm sizes are likely to generate more output and probably make more profit than those with small farm sizes. The result agrees with the report of UNCTAD (2008) and FAO (2012) that farm size is one of the major determinants of profitability and efficiency of vegetable production and that farm size was positively correlated with farmer profit.

Table 4: Maximum likelihood Estimates of Translog Profit Frontier Function

Variables	Parameters	Coefficient	T- Value
Constant	β_0	3.8769	24.24***
Planting material	β_1	-0.3529	-3.01***
Organic Manure	β_2	-0.3116	-2.32***
Labour	β_3	-0.2053	-3.31***
Dep. on Farm Equipment	β_4	0.3739	2.59**
Farm size	β_5	0.5214	6.28***
Squared Terms			
Planting material × Planting material	β_{11}	0.0052	0.73^{NS}
Organic Manure × Organic Manure	β_{22}	0.0089	2.49**
labour ×labour	β_{33}	-0.0049	-0.22^{NS}
Dep. on farm Equipt × Dep. on farm Equipt.	β_{44}	0.1963	1.37^{NS}
Farm size ×farm size	β_{55}	0.2016	2.34**
Interaction Terms			
Planting material × Organic Manure	β_{12}	-0.1731	-3.67***
Planting material × labour	β_{13}	-0.0022	-0.58^{NS}
Planting material × Dep. on farm Equipt.	β_{14}	0.0010	0.31^{NS}
Planting material × farm size	β_{15}	0.1611	2.46**
Organic Manure r × labour	β_{23}	0.4148	5.12***
Organic Manure × Dep. on farm Equipt.	β_{24}	-0.0052	-0.62^{NS}
Organic Manure × farm size	β_{25}	0.0055	3.14***
labouur × Dep. on farm Equipt.	β_{34}	-0.3668	-3.49***
labour × farm size	β_{35}	-0.2543	-4.38***
Dep. on farm Equipt .× farm size	β_{45}	-0.0027	-0.36^{NS}
Diagnostic Statistics			
Sigma-Squared		0.3229	2.94***
Gamma		0.96	48.6395***

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Table 4 Cont

Log likelihood	Llf	37.014919	
	LRT	18.2146344	
Inefficiency effects			
Constant	δ_0	-2.2483	1.23^{NS}
Age	δ_1	-0.0038	-4.43***
Household Size	δ_2	-0.1316	-2.11**
Education	δ_3	0.0067	0.33^{NS}
Extension Contact	δ_4	0.3272	2.09**
Experience	δ_5	-0.1138	-3.34**
Awareness of organic farming	δ_6	-0.4724	-2.96***
Access to information on organic farming	δ_7	-0.3179	-2.58**

Note ***, **,*and NS implies statistically significant at (*P<0.01*), (*P<0.05*), (*P<01*) and Not Significant, respectively. Figures in parentheses are t-ratio

Source: Computed from Field survey, 2020.

The result of the inefficiency factors as shown in Table 4 further reveals that age was negative and statistically significant (P<0.01). The negative coefficient implies that an increase in age would reduce profit inefficiency in the study area. This is because age has a significant influence on the decision-making process of farmers with respect to risk aversion, adoption of organic agricultural technologies, and production-related decisions that could reduce farmers' profit inefficiency. This result is in agreement with the authors of Tanko et al. (2010) and NISR (2017), who found a negative coefficient of age and profit inefficiency and that older or aged farmers embraced organic farming technology readily and obtained a higher gross margin. Furthermore, the coefficient of the household size was negative and statistically significant (P<0.01), meaning an increase in household size will result in the reduction in profit inefficiency. The reason could be that households with many productive members could benefit from the use of family labour at the right time when labour is needed. The result agrees with the finding of Tanko et al. (2010), which states that household size could reduce labour constraints, thereby leading to an increase in productivity and an increase in profit efficiency.

The estimated coefficient associated with experience carries the expected negative sign and is statistically significant (P<0.01). The result implies that those with experience are better performers than those without. In other words, organic vegetable farmers with more years of experience tend to operate at a significantly higher level of profit efficiency. Experience in organic vegetable production could improve farmers' skills in farm operations, thereby reducing their profit inefficiency. The estimated coefficient associated with the extension contact is positive and significant (P<0.01). The positive sign does not conform to a prior expectation; the reason is that farmers in the study area had limited access to extension services, which reduces their profit efficiency. This means that limited extension contact with farmers hinders acquisition of new knowledge, skills and practices on improved technology by the farmers as well as their innovativeness. This result is also consistent with findings obtained by Ajibefun et al. (2002), who reported a positive coefficient of extension contact.

The estimated coefficient of awareness of organic farming is negative and significant (P<0.01), indicating a reduction in profit inefficiency. This means farmers' awareness of organic farming increases the tendency of farmers to practise and adopt the technology available to them, which could go a long way to increase their vegetable productivity, and this could have a positive effect on profit efficiency. Again, the coefficient of access to information on organic farming is negative and statistically significant (P<0.01). This means a reduction in profit inefficiency. Which implied that farmers' access to information on organic farming is likely to enhance their probability of practising it; hence, they adopt new technologies, which translates to high organic vegetable output, thereby leading to a reduction in profit inefficiency in the study area.

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The formulated hypothesis was subjected to empirical validation. Table 4 presents the result of maximum likelihood estimates from the inefficiency model for the stochastic frontier profit function for hypothesis. The result of maximum likelihood estimates from the inefficiency model for the stochastic frontier profit function revealed that explanatory variables included in the inefficiency model significantly explain the profit efficiency of organic vegetable farmers with estimated coefficients. The null hypothesis was therefore rejected, while the alternative hypothesis was accepted, and the study concludes that explanatory variables included in the inefficiency model significantly explain the profit efficiency of organic vegetable farmers.

CONCLUSION

The study revealed that in spite of the abundant potential of organic vegetable production in the Chanchaga Local Government Area of Niger State, available resources were not fully tapped. The farmers in the area were generally small-scale farmers that depended on small but scattered plots they acquired through rent/inheritance. It can be concluded that farmers had a positive perception towards organic vegetable production, finding it to be more beneficial to the environment and for human consumption. The study further concludes that the area has great potential to increase organic vegetable (spinach) production and farmer's income. This means that organic vegetable production is profitable with returns on investment of N1.53 in the study area.

The estimated parameters of the trans-log profit frontier indicate that only a few inputs have a positive sign on the profitability of organic vegetable farming in the area. The negative sign of prices of these inputs may be due to wrong or excessive application of such inputs by the farmers, thus leading to extra cost incurred on the part of the farmers. However, the study concluded that organic manure, labour, planting material, farm size, age, household size, education, farming experience, awareness of organic farming and access to organic vegetable information had significant effects on the profit efficiency of organic vegetable farmers in the study area. The policy implication of these findings is that inefficiency in organic vegetable production can be reduced significantly by improving the level of education among the farmers and awareness by extension agents. Most important are the extension services and the existing technological packages that need to be critically examined. The study therefore recommended that farmers in the study area should be encouraged by extension agents to form co-operative associations to enable them to share their knowledge and experience to facilitate their access to information on production technologies and credit facilities that will enable them to expand their organic vegetable (spinach) production. Since the study area has a great potential to increase organic vegetable production and farmers' income, the government needs to step out to beef up the awareness level of the farmers by intensive utilisation of appropriate technology. This can be achieved through extension agents, mass media, town/village cries, agricultural shows, symposiums and the like. This can be seen as a policy option for combating the endemic menace of unemployment among youths in the study area and the country at large, especially now that the present administration's change mantra is geared towards agriculture. Extension agents and other relevant stakeholders should also organise sensitisation programmes on the health and environmental benefits of organic vegetable production.

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