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Analysis of selected Production Variables in yam Production in Northern Agricultural Zone, Cross River State, Nigeria

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ABSTRACT

This study examined selected production variables that affect small-scale yam farmers in the Northern Agricultural Zone, Cross River State, Nigeria. The objectives were to determine how selected production variables affect yam production, identify the constraints in yam production, and describe strategies used by yam farmers to improve yam production. A multistage sampling technique was employed to select a total of one hundred and eighty-nine (189) small-scale yam farmers. Data were gathered using a well-structured questionnaire. The collected data were examined through the application of descriptive statistical methods and regression analyses. Regression analysis revealed that the major resources that significantly affected yam production were fertilizers, herbicides, and farm size. The primary yam production constraints identified by farmers were the high cost of agrochemicals, inadequate access to credit facilities, high cost of labour, poor transportation networks, inadequate capital, and low prices for the yam produced. The findings revealed that early weeding, planting of healthy seedlings, and early harvesting to obtain additional yam crowns were strategies adopted by farmers to improve yam production. The study recommends that yam farmers join cooperatives for better loan access, expand cultivation areas to increase yield, reduce excessive herbicide use, increase fertilizer application, and collaborate with the government and private sector to improve infrastructure and market linkages and reduce postharvest losses.

INTRODUCTION

Agriculture is not only a vital source of income for Nigeria's population, but it also serves a vital role in the country's economy, providing sustainable livelihoods and employment opportunities for over 55% of Nigeria's active labour force (Adejoh, Edoka, Isibor, 2023). The food sector constitutes the largest subsector of Nigeria's agriculture, with root and tuber crops being among the key staple foods for the population.

Yam originated in Southeast Asia and is classified under the family *Dioscoreaceae* and genus *Dioscorea*. Of the 600 species, only six can be considered principally edible, such as water yam (Dioscorea alata), white yam (Dioscorea rotundata), Chinese yam (Dioscorea esculenta), yellow yam (Dioscorea cayanensis), aerial yam (*Dioscorea bulbifera*), and trifoliate yam (*Dioscorea dumenterum*) (Zaknayiba and Tanko, 2013, Aliyu and Shelleng, 2019 and Adejoh, Edoka, Isibor, 2023). The National Root Crops Research Institute (NRCRI) categorized yams into ware yams (> 11 g), seed yams (259 g – 1 kg), and minisets (< 50 g) (NRCRI, 2013). The centre of origin of yam is West Africa, which is also grown in Latin American and Caribbean nations, including Jamaica, Haiti, Brazil, Colombia and Cuba (FAO, 2013).

Yam is a very important staple food and a significant source of dietary energy for humans, especially in yam-growing zones (Aighewi, Maroya, Kumar, Balogun, Aihebhoria, Mignouna, and Asiedu, 2021). (Ariyo, Usman, Olorukooba, Olagunju, Oni, Suleiman, Adetunji, and Ariyo, 2020) observed that yams supply over 200 calories every day for over 150 million in West Africa and can be cooked, fried, roasted, or made into pounded yam. (FAO, 2012 and Adeshina, Ologbon, Idowu, Oyebanjo and Saliu 2020). The average daily per capita yam consumption in Nigeria was 252 calories (Verter and Bečvářová, 2015). Yam grows well in fertile soil under good physical conditions. It grows best on light- or medium-loamy soils with good soil aeration. They can also grow on slightly acidic and alkaline soils but do better in neutral soils. Yam requires a temperature of 15ºC-25ºC and well-distributed rainfall of 3000 mm per annum for optimum production. In yam production, inputs include land, labour, capital, yam seeds, fertilizers, and management.

The major area of production in Nigeria is the humid zone, which is usually intercropped with other arable and vegetable crops such as cassava, maize, okra, pumpkin, and green. Although Nigeria is the leading yam producer, yet production has not consistently met demand for the commodity, resulting in scarcity of the commodity in some periods of the year, thus making it unaffordable for the common man. IITA revealed that the high cost of production makes the per calorie cost of yam almost four times the cost of maize. Efforts aimed at increasing local food production and reducing reliance on imports have been substantial, owing to rising population demands (Nwogwugwu et al. 2023).

Cross River State is noted for the production of yam, especially in the central and northern regions of the state. The major local government areas in which yams are cultivated are Yala, Ogoja, Bekwarra, Obanliku and Obudu in the Northern part and Etung, Boki, Ikom, Obubra, Abi and Yakurr in the Central part of the state. Yams in these regions are cultivated either as sole or cultivated alongside other crops, including cassava, maize, okra and vegetables and so on.

Yala, Ogoja, Bekwarra, Obanliku, and Obudu local government areas are noted for cultivation of yams on a small-scale basis, mostly by small-scale farmers. There are ready markets for yams, but the demand for the commodity often exceeds the supply of yam output. Despite the critical contribution of yam production to food security and economic stability, several factors impede optimal yam production. While studies have shown that access to farm resources such as land, labour, capital, and farming inputs such as fertilizers and seedlings are pivotal to enhancing agricultural productivity (Oniah and Osim, 2024), small-scale farmers in the area have not been able to use their available agronomic potential and a favourable environment to produce yams on a large scale to bridge the demand-supply gap and to raise income. This study examines whether the selected variables affect yam production among small-scale yam farmers. The objective was to analyze selected production variables affecting small-scale yam farmers in Northern Agricultural Zone of Cross River State, Nigeria

The study aimed to:

i. determine how some selected production variables (land, labour, capital, farm credit, fertilizer, herbicides, farm income) affect yam production in the area
ii. determine the challenges affecting yam production in the area
iii. identify strategies used by yam farmers in enhancing yam production in the area.

The null hypothesis (H_{Oi}) stated that farm productive variables have no significant effect on yam production in the Northern Agricultural Zone of Cross River State, Nigeria.

METHODOLOGY

This study was conducted in the Northern Agricultural Zone of Cross River State, Nigeria, which includes five local government areas: Bekwarra, Obanliku, Obudu, Ogoja, and Yala. The zone covers 4527 km², approximately 22% of the total land area of the state, and has a population of 944,157 ((National

Population Commission, NPC, 2006). It shares borders with Benue State in the north, Boki LGA in the south, Cameroon State in the east, and Ebonyi State in the west. It lies between Latitudes 5°45'N and of the Equator and Longitude 8°30'E and of the Greenwich Meridian. The region has a humid tropical climate. Farming is the primary occupation, with crops such as yams, cassava, rice, maize, garden eggs, and groundnuts.

Sampling method and data collection: This study employed a multi-stage sampling technique. In the initial stage, four LGAs (Yala, Ogoja, Bekwarra, and Obudu) were chosen due to their significant engagement in yam production. In the second stage, 17 major yam-producing villages were selected based on their farming intensity. A total of 189 farmers, representing 10% of the 1889 yam farmers, were randomly selected. The primary data were collected using questionnaires.

Analytical Techniques:

Descriptive statistics, including frequency counts, percentages, and means, were employed to characterize the constraints in yam production and strategies used by yam farmers to improve yam production in the zone (Objective ii and iii).

Regression analysis was conducted to assess how some of the selected production variables affected yam production (Objective i).

Implicit form of the regression model: $Y = f(X_1, X_2, X_3, X_4, X_5, X_6)$----- (i)

In addition, the explicit forms of the equation are expressed as:

Linear form: $Y = \beta_o + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \ldots + \beta_6X_6 + \varepsilon_i$ ---------- (ii)

Semi-log form: $Y = \beta_o + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \ldots + \beta_6 \ln X_6 + \varepsilon_i$ ---------- (iii)

Double-log form: $\ln Y = \beta_o + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \ldots + \beta_6 \ln X_6 + \varepsilon_i$ ------- (iv)

where:

Y = output of yam (Kg), F = function, X_1 = Farm capital (₦), X_2 = Farm credit (₦), X_3 = Fertilizer (Kg), X_4 = Labour used (man-days), X_5 = Herbicide (Litre), X_6 = Farm size (hectare), β_o and β_i are the constant and the regression coefficients respectively

e = Error term

A t-test embedded in multiple regression analysis was used to test the hypothesis of the study.

RESULTS AND DISCUSSION

The descriptive statistics of the farm-related variables among yam farmers in the Northern Agricultural Zone are presented in Table 1.

Sources of capital: Table 1 shows that 83.6% of farmers financed their farms with personal savings, 8.5% through cooperatives, 6.9% through friends and family, and only 1% through commercial banks. This reliance on personal savings likely limits farmers' ability to invest in modern equipment, hindering farm expansion and reducing yam output. A previous study by Agbaje *et al.* (2005) revealed that 66% of the farmers depended on their own capital, 29% on farmer cooperative groups, and only 1% benefited from bank loans to sustain yam production in south western Nigeria.

Table 1: Distribution of respondents according to farm related variables

Variables	Frequency	Percentage (%)	Mean
Sources of capital			
Personal saving	158	83.6	
Friends and Family	13	6.9	
Cooperatives	16	8.5	
Commercial bank	2	1	
Access to credit			
Yes	10	5.3	
No	179	94.7	
Use of Herbicide			
Yes	179	94.7	
No	10	5.3	
Sources of Labour			
Hired Labour	77	40.7	
Family Labour	51	27	
Both Labour	61	32.3	
Use of Fertilizer/Manure			
Fertilizer	113	59.8	
Manure	2	1	
None of the Above	74	39.2	
Farm Size (hectare)			
<1	166	87.8	1ha
1 - 2	23	12.2	
2.1 - 3	0	0	
>3	0	0	

Source: Field Survey Data, 2022

Access to credit facilities: According to Table 1, the majority (94.7%) of farmers in the area do not have access to credit, while only 5.3% of farmers in the study area have access to credit. This indicates that yam farmers are likely to operate at an inefficient profit level. Access to credit is expected to enhance farmers' profit efficiency (Edem and Oniah 2024). Migap and Audu (2012) found that 100% of yam farmers and traders have no access to credit facilities.

Use of Herbicides: Table 1 also indicates that 94.7% of the yam farmers used herbicides on their yam farms, while only 5.3% did not use herbicides. A greater number of farmers (94.7%) used herbicides because of the high costs of manual weeding.

Sources of labour: Table 1 shows that 40.7% of farmers used hired labour, 32.3% used both hired and family labour, and 27% used only family labour. This suggests that yam farmers rely more on hired labour due to the demanding nature of yam cultivation. This is in agreement with Kathryn et al. (2012), who asserted that labour accounts for the largest share of yam production costs in Nigeria.

Use of Fertilizer: Table 1 indicates that 59.8% of the yam farmers used fertilizer, 39.2% used neither fertilizer nor organic manure, and only 1% used manure. A greater number of people (59.8%) used fertilizers to improve soil fertility for better production. Ahmed et al. (2017) in their study observed that the yield of crops in China exceeded that of Nigeria, attributed to the greater use of chemical fertilizers.

Farm size: Table 1 shows that 87.8% of farmers had farm sizes of less than 1 hectare, while 12.2% had between 2.1–3 hectares. This indicates that most yam farmers are small-scale, subsistence-level producers, possibly due to the land tenure system or rising population. Larger farm sizes could boost production.

However, Waziri *et al.* (2014) reported that the adoption of crop-based technologies may be minimally affected by farm size, as farmers with fragmented land often seek to optimize the use of their plots.

Regression analysis of farm productive inputs on yam output

Ordinary least squares (OLS) regression analysis was employed to investigate the impact of farm production resources on yam production in the study area. The collected data were applied to three functional forms of the regression model: linear, semi-log and double-log.

Table 2: Result of regression analysis of the farm productive resources on yam output

Variables	Linear	Semi-log	Double-log
Constant	296.872(4.858)***	7.344(12.626)***	4.391(12.498)***
Farm Capital (X_1)	56.280 (2.416)***	0.295 (1.330)^{NS}	-0.213 (-0.550)^{NS}
Farm Credit (X_2)	-72.073 (-2,732)***	-0.020 (-0.079)^{NS}	-0.038 (-0.105)NS
Fertilizer (X_3)	66.936 (9.648)***	0.300 (4.546)***	0.532 (4.373)***
Labour (X_4)	-0.383 (-0.488)^{NS}	-0.003 (-0.340)^{NS}	0.028 (0.242)^{NS}
Herbicide (X_5)	230.970 (5.540)***	0.486 (1.226)^{NS}	-1.070 (-1.874)*
Farm Size(X_6)	32.912 (-0.930)^{NS}	-2.488 (-7.388)***	3.770 (8.101)***
R^2	0.425	0.523	0.520
F-Value	22.395	33.283	32.902

*Source: Field Survey Data, 2022, * 10%, ** 5%, *** 1%, NS = not significant. Values in parentheses are t-statistics.*

Although the semi-log model demonstrated a marginally higher R^2, the double-log model presented a more balanced and theoretically robust representation of the relationships among the variables, making it the most appropriate choice for this analysis, with relatively high R^2 values, F-values, and statistical significance of the coefficients for key variables that align with the theoretical expectations. The coefficient of multiple determination (R^2) was 0.52, indicating that approximately 52% of the variation in the yam output was explained by the predicted variables in the area. The remaining 48% was attributed to environmental factors that affected the productive variables or error terms.

Farm capital: Table 2 shows a negative (-0.213) and insignificant coefficient for farm capital. This is possibly due to farmers relying on personal savings, which may be inadequate for sustaining yam production in the area. This result contradicts the findings of Oniah and Edem (2021), who found that farm capital has a positive and significant relationship with farm output in Central Agricultural Zone of Cross River state, Nigeria.

Farm credit: Table 2 shows that farm credit has an inverse relationship with yam output in the study area, and is not significant. This implies that inadequate and limited access to loan facilities by most farmers affects the level of yam production in the study area. Edem and Oniah (2024) posited that access to farm credit enhances farmers' ability to purchase the essential farm inputs required for yam production. This result is contrary to that of Bello (2019) in Ogun State, who found that access to credit exerted a positive and statistically significant influence on the adoption of Improved Rice Varieties (IRVs).

Fertilizer: Table 2 also shows that the fertilizer coefficient was positive (0.532) and significant at the 1% level, indicating that a 1% increase in the quantity of fertilizer, other things being equal, leads to an increase in the yam output. This finding aligns with the work of Edem and Oniah (2024), who posited that applying fertilizer at the recommended rate with an appropriate nutrient combination can increase yam yield by 0.634% per hectare. These results align with Abdullahi (2015), who reported a positive and significant relationship between fertilizer and yam production.

Labour: As shown in Table 2, the coefficient of labour was positive (0.028) with the output of yams, although the difference was not significant. The positive value suggests that, all things being equal, a 1%

increase in labour would lead to a 0.028% increase in yam output. The non-significant coefficient could be attributed to the extensive use of hired labour in yam production by farmers. Hired labourers might not be as motivated or skilled as those who have a direct stake in the farm's success. In the studies of Abdullahi (2015) and Oniah and Edem (2021), labour was observed to have a positive and significant effect on farmers' output.

Herbicide: Table 2 shows that the estimated coefficient of herbicide -1.070 was negative and statistically significant at the 10% level of probability. A coefficient of -1.070 implies that a 1% increase in the use of herbicides would lead to a 1.070% decrease in yam output. This negative value suggests that if herbicides are used more than expected, it will negatively affect yam production. The study conducted by Abdullahi (2015) and Edem and Oniah (2024) in Niger and Cross River State, Nigeria, documented that the overuse of agrochemicals to control weeds can lead to adverse effects on farm yield. Edem and Oniah (2024) further stated that increased use of chemicals can also cause soil acidity and have a negative effect on farmers' output.

Farm size: As shown in Table 2, the farm size coefficient is positive (3.770) and significant at the 1% level. This suggests that an increase in farm size results in a corresponding increase in the yam output. In other words, output increases by 3.77% for every 1% increase in farm size. This result is in accordance with the findings of Oniah and Edem (2021), who observed that larger farm sizes would enhance output, given the cropping systems and favourable conditions in the region. Binuyo et al. (2016) and Idumah and Owombo (2019) also find that farm size positively influences the technical efficiency of farmers, indicating that expanding farm size leads to greater farm output.

Hypothesis testing: The null hypothesis (H_{Oi}) states that farm production variables have no significant effect on yam production in the Northern Agricultural Zone of the Cross River State, Nigeria. Based on the multiple regression results presented in Table 2, farm productive variables such as farm size, fertilizer, and herbicides had a significant influence on yam output. Thus, the null hypothesis stated above is rejected and its alternative form is accepted, implying that farm productive variables have a significant influence on yam output in the study area.

Constraints faced by yam farmers in yam production

Table 3: Constraints faced by yam farmers in yam production in the study area

Constraints	VSC	SC	MC	LC	NC	Sum	Mean	Rank
High cost of agrochemicals	136	37	11	2	3	868	4.59	1st
Lack of access to credit facilities	115	57	14	2	1	850	4.49	2nd
High cost of labour	116	60	7	2	4	849	4.49	3rd
Poor transportation network	104	36	29	19	1	790	4.17	4th
Inadequate capital	97	34	53	4	1	789	4.17	5th
Low price of yam produced	95	25	62	0	7	768	4.06	6th
Lack of improve varieties	64	45	39	31	10	689	3.64	7th
Poor storage and processing facilities	94	19	22	19	35	685	3.62	8th
Post-harvest losses	39	60	38	35	17	636	3.36	9th
Poor extension services	76	27	19	8	59	620	3.28	10th
Attack by pests and diseases	52	21	40	59	17	599	3.16	11th
Poor soil fertility	56	21	32	17	63	557	2.94	12th
Irregular rainfall	33	17	62	36	41	532	2.81	13th

Source: Field Survey Data, 2022

Key: VSC= very severe constraints; SC= severe constraints; MC=moderate constraints; LC= low constraints; NC= no constraints.

The results in Table 3 show the constraints on the yam production in the study area. This result shows that the major constraints are the high cost of agrochemicals, lack of access to credit facilities, high cost of labour, poor transportation network, inadequate capital, and low price for yam produced with mean values of 4.59, 4.49, 4.49 4.17, 4.17, and 4.06, respectively, and lack of improved varieties, poor storage and processing facilities, post-harvest losses, poor extension services, and pest and disease attacks with mean values of 3.64, 3.62, 3.36, 3.28, and 3.16, respectively, while poor soil fertility and irregular rainfall are the minor constraints with mean values of 2.94 and 2.81, respectively faced by the farmers. These results are in agreement with those reported by Kleih et al. (2012) and Emmanuel (2017). Moreover, according to Idachaba et al. (2014), the instability in the price of petroleum motor spirit (PMS) in Nigeria may contribute to higher yam transportation costs. Additionally, constraints such as the high cost of labour and planting seeds, as well as limited access to credit facilities, further impede the optimization of crop production (Oniah and Edem, 2021).

Strategies to improve on yam production

Table 4: Strategies to improve on yam production by the respondents

Variables	Frequency	Percentage (%)	Ranking
Early weeding	189	100	1st
Planting of healthy seedlings	180	95.2	2nd
Staking of yam	160	84.7	3rd
Early harvesting to get additional yam crown	151	79.9	4th
Application of fertilizers	113	59.8	5th
Early harvesting to avoid rotting	113	59.8	6th
Planting of yam on fallowed land	98	51.9	7th
Mulching of yam farm	80	42,3	8th

Source: Field Survey Data, 2022.

Table 4 shows that out of the 189 respondents, 100% had early weeding, 95.2% planted healthy seedlings, 84.7% stake their yams, and 79.9% performed early harvesting to obtain additional yam crowns, and among others were used as strategies to improve yam production in the study area.

CONCLUSION AND RECOMMENDATIONS

Based on the findings of this study, it can be concluded that the yam farmers in the study area were small-scale farmers and cultivated less than two hectares of land. Farmers still have the potential to increase their farm size to maximize their output and profit. Farmers face challenges, such as high agrochemical costs, inadequate access to credit, high labour costs, poor transportation networks, insufficient capital, and low yam prices. To enhance yam production, farmers employ strategies, such as early weeding, using healthy seedlings, staking, and early harvesting. The study concluded that addressing constraints and increasing input use (e.g., fertilizer and farm size) by farmers could improve yam production in the region.

In light of the study's findings, the following recommendations are proposed to enhance yam production in the study area:

i. Yam farmers should increase their hectares of yam cultivation to increase yield, as this has been found to positively and significantly influence output.

ii. Farmers should reduce their use of herbicides because they are overused more often than expected, which negatively affects yam production.

iii. Fertilizers have a significant positive impact on yam production; thus, farmers should increase their usage, but at recommended and appropriate nutrient combinations, along with the intensive use of farm size to increase output.

iv. The problems of high transportation cost, storage, high cost of fertilizers, high cost of herbicides, and the high cost of labour can be reduced if a greater number of farmers join cooperative associations enabling them to consolidate their resources and reduce the cost of these items.

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