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Determinants Affecting Input-Output Relationship in Yam Production in Ikom Agricultural Zone of Cross River State, Nigeria

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ABSTRACT: *The study was carried out in the Ikom Agricultural Zone of Cross River State, Nigeria, to examine the relationship between the inputs and outputs of yam. A multistage sampling technique was used for the study. A total of 240 respondents were randomly selected from thirteen villages. Questionnaires were administered to the respondents by the interview method. The data collected were analyzed using regression analysis from STATA v17. The double-log result showed that inputs that significantly influenced yam output in the study area were quantity of fertilizer, seedlings, labour, access to credit, and farm size, at 1% and 5%, respectively. It is recommended that yam farmers increase their farm sizes in cultivation, fertilizer usage, and yam seedlings to increase yam output.*
KEYWORDS: Yam farmers, yam production, input-output relationship, determinants, Ikom Agricultural Zone, Cross River State.

INTRODUCTION

Agriculture is Nigeria's primary economic sector, contributing about 40% of GDP and employing two-thirds of the labour force. It provides livelihoods for 90% of the people living in rural areas. Small-scale farmers dominate the agricultural sector and are scattered across the country, operating within traditional, low-capital farming systems characterized by relatively lower yields per hectare.

Yams (a member of the genus *Dioscorea*), are a staple food in many tropical and sub-tropical countries, contributing over 200 dietary calories per capita daily for over 150 million people in West Africa (Ariyo, Usman, Olorukooba, Olagunju, Oni, Suleiman, Adetunji, and Ariyo, 2020). Extensively, yam is cultivated in humid rain forests and guinea savannas, with Nigeria, Ghana, Togo, Ivory Coast, Benin Republic, Central African Republic, Chad and Columbia being major producers. The most cultivated species are white yam (*Dioscorea rotundata*), yellow yam

(*Dioscorea cayenesis*), and water yam (*Dioscorea alata*). Among the countries in the world, Nigeria is the world's largest producer accounting for approximately 70% of the world's output, with an annual production volume reaching about fifty million metric tonnes (Tridge, 2023; The Republic, 2023). Major production areas in the country include the middle belt (Benue, Nasarawa, Kwara, Kogi and Niger), south eastern (Abia, Anambra, Ebonyi, Enugu and Imo), and south-western regions. Other producing areas include Taraba, Kaduna, Oyo, and Cross River States. However, farmers in the Northern regions grow fewer yams due to the region's arid climate, which is unsuitable for yam production.

Traditionally, yam tubers can be used in various culinary practices, including boiling, roasting, frying, pounding, or serving as soup thickeners. They can also be processed into yam flour, livestock feed, and starch. In some parts of the country, yam is associated with ceremonies and cultural festivals. For instance, the Leboku, Boki, Yala, and Obudu New Yam Festivals are prominent celebrations in Cross River State, where communities come together to mark the harvest season.

Cross River State, Nigeria, is one of the major yam-producing states due to its favourable climate and fertile soils. Ikom, Obubra, Yakurr, and Ogoja have a rich tradition of yam cultivation, particularly with white and water yams deeply embedded in their cultural heritage. Despite yam being a major staple food crop in the region, there exists a gap in understanding the determinants influencing the input-output relationship in yam production. While the land under yam cultivation is increasing and inputs such as land, seed yams, herbicides, fertilizers, and labour, increases, the output has not been proportional to the inputs. The lack of research on the input-output relationship in yam production in this region may hinder informed decision-making and policy formulation, leading to inefficiencies in resource allocation, potential waste, and productivity challenges within the region. This study aims to investigate and identify the major determinants affecting the input-output relationship of yam production by assessing the impact of inputs such as labour, fertilizer, capital, credit, farm size, yam seedlings, and herbicides on yam yields.

This research aims to enhance productivity in the yam farming sector within the Ikom Agricultural Zone by identifying the most effective input combinations, which would in turn lead to increased yields and potentially higher profits for farmers.

The hypotheses of the study are stated in the null form: there is no significant relationship between the inputs (fertilizer, capital, credit, farm size, yam seedlings, labour and herbicide) and output of yam production in the Ikom Agricultural Zone of Cross River State, Nigeria.

METHODOLOGY

Six Local Government Areas (LGAs) constitute the Ikom Agricultural Zone: Abi, Yakurr, Obubra, Ikom, Etung and Boki. It shares an international boundary with the Republic of Cameroon to the

East; Obanliku and Obudu to the North; Ebonyi State to the West; and Biase and Akamkpa to the South. The zone has an estimated land mass of 7,666km^2, about 38% of the State's total land mass of 20,156km^2 (Oniah and Edem, 2022). The coordinates of the zone are Latitudes 5°32'N and 4°27'N of the Equator and Longitudes 7°50'E and 9°28'E of the Greenwich Meridian. The zone has an estimated population of about 1,016,818 people according to National Population Commission (National Population Commission, NPC, 2006). The zone has an average annual temperature of 27°C-33°C, with rainfall between 1500mm and 2000mm. The zone experiences two distinct seasons; the rainy season, and the dry season. The economic activities of most people are majorly arable crop farmers and are complemented by traders. Yam cultivation is one of the major staple foods grown in the zone. Other crops cultivated are rice, potatoes, maize, pineapples, melon, cassava, plantains and so on. Some farmers also cultivate tree crops like cocoa and oil palm.

Sampling procedure

Multi-stage sampling technique was adopted in selecting the respondents. The first stage was the purposive selection of four Local Government Areas (LGAs) from the six LGAs in the zone based on the large-scale production of yam. They are Obubra, Yakurr, Ikom, and Boki LGAs. The second stage was the purposive selection of thirteen villages from the selected LGAs. The villages were selected due to the high concentration of yam farmers in the area. In the third stage, a list of the major yam farmers in the thirteen (13) villages was obtained from the Extension Agents in the various Local Government Areas. A total of 240 farmers were randomly selected using 15% proportionality ratio of the number of farmers in the sample frame (1606).

Data for this study was collected primarily from primary sources. The primary data was collected through the use of structured questionnaires. The secondary sources were obtained from journals, the internet, and other relevant literature.

Analytical Technique

The Ordinary Least Square (OLS) estimation procedures were used to determine the farm inputs influenced yam output. The implicit form of the regression model is shown as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7) \quad \text{-----------------} \quad (i)$$

Also, the explicit forms of the equation are stated as:

i. Linear form: $Y = \beta_o + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \ldots + \beta_7X_7 + \varepsilon_i$ ------------ (ii)

ii. Semi-log form: $Y = \text{Ln}\beta_o + \beta_1\ln X_1 + \beta_2\ln X_2 + \beta_3\ln X_3 + \ldots + \beta_7\ln X_7 + \varepsilon_i$ -------- (iii)

iii. Double-log form: $\text{Ln}Y = \ln\beta_o + \beta_1\ln X_1 + \beta_2\ln X_2 + \beta_3\ln X_3 + \ldots + \beta_7\ln X_7 + \varepsilon_i$ ------ (iv)

where:

Y = Output of yam (kg)
X_1 = Quantity of seedlings (kg)
X_2 = Quantity of Fertilizer (kg)
X_3 = Labour used (Man-days)
X_4 = Farm size (ha)

X_5 = Herbicides (litre)
X_6 = Access to credit (dummy)
β_o and β_i are the constant and the regression coefficients respectively
ε_i = error term

The model with the highest adjusted R^2, many statistically significant and highest F-values was adopted. The apriori expectation is that the value of each of the variables will be positively related to the output of yam in the area, implying that the higher the quantity of these variables, the higher the output of yam.

RESULTS AND DISCUSSION

The regression analysis results of the relationship between inputs and output of yam among yam farmers in Ikom Agricultural Zone are presented on Table 1. The functional forms applied in this work are linear, semi-log and double-log forms. The double-log functional model was chosen as the lead equation (LE) to explain the effect of the variation in yam output (Y) as affected by the independent variables (quantity of fertilizer, labour, farm size, access to credit, agrochemicals and seedlings). The double-log functional form gave the best fit and has the highest R^2 value, F-value and highest significant variables (five).

The coefficient of multiple determination (R^2) value of 0.325 indicates that the independent variables accounted for 32.5% of the total variation in yam output (Y) by the small-scale yam farmers. The F-ratio is greater than 5, which is acceptable and shows the overall significance ($p<0.01$) of the model.

Table 1: Regression analysis results of the relationship between inputs and yam output

Factors	Linear	Semi log	Double log
Constant	721.3 (1.04) NS	5.728 (9.66) ***	0.107 (0.11) NS
Quantity of yam seedlings (X_1)	-0.790 (-4.09) ***	0.000 (-1.52) NS	0.364 (2.80) ***
Quantity of fertilizer (X_2)	4.010 (4.11) ***	0.005 (5.85) ***	0.634 (5.03) ***
Labour (X_3)	3.750 (1.16) NS	0.007 (2.47) **	0.481 (5.35) ***
Farm size (X_4)	856.4 (5.14) ***	0.541 (3.78) ***	0.481 (2.00) **
Herbicides (X_5)	-168.4 (-4.27) ***	-0.068 (-2.02) **	-0.075 (-0.63) NS
Access to credit (X_6)	60.92 (0.20) NS	0.028 (0.11) NS	1.001 (2.14) **
R^2	0.250	0.231	0.325
Adj. R^2	0.231	0.211	0.308
F-value	12.98***	11.65***	18.74***

Source: Field survey, 2022 t-statistics in parentheses; * p = 0.1, ** p = 0.05, *** p = 0.01
NS =Not significant

As shown on Table 1, the results show that yam seedlings have a positive coefficient of 0.364 and are statistically significant at 1%. This means that increasing the number of yam seedlings planted by a certain per hectare will result in a 0.364 percent increase in yam production in the study area.

Farmers who cultivate improved yam seedlings had higher yields than farmers who planted local seed varieties. Therefore, the quantity of yam produced depends on the number of yam seedlings sown per hectare. A study by Ishani, Hazarika and Nivedita (2016), Idumah and Owombo (2019) and Oyibo, Oyibo, Iyegbuniwe, and Uchegbu (2021) also found that a percentage increase in the quantity of seed sown resulted in an increase in farmers output. The findings contradict previous findings by Ekunwe, Henri-Ukoha, and Emmanuel (2018) and Ndubueze-Ogaraku, Adeyoola, and Nwigwe (2021), who discovered a negative relationship between yam seedlings and yam output, thus increasing the use of planting materials would result in a low yield. A possible reason for their negativity is as a result of increased plant population. Overcrowding in yam farms would cause competition for available nutrients, resulting in a lower yield.

The result on Table 1 shows that fertilizer has a positive coefficient of 0.634 and is statistically significant at 1%. This means that increasing the amount of fertilizer used will increase yam output in the study area. In other words, a 1% increase in fertilizer use at the recommended rate and nutrient combination increases yield by 0.634% per hectare. Farmers in China increased their crop yields by using chemical fertilizers (Ahmed, Iheanacho, and Ater, 2017). The findings are consistent with those of Abdullahi (2015), Ishani *et al.* (2016), Buhari, Yahaya, and Hashim (2018), and Gbigbi (2019), who found a positive and significant relationship between fertilizer and farm productivity. However, it contradicts Aung's (2011) findings that fertilizer use had a negative impact on farmer output in Myanmar. The negativity could be due to a poor combination of different fertilizer nutrients and that the fertilizers applied by farmers were lower than the recommended rate.

Table 1 shows that labour had a positive coefficient of 0.481 and is statistically significant at 1%. This implies that there is a direct relationship between labour and yam output. As labour used in the farm increases, output also increases. In other words, a farm family with several adult members will have a lower cost of labour because they can supplement hired labour. Labour was found to be positively significant to farmers' output in the studies of Ume, Ezeano, Agu, and Josphine (2016), Abdulrahman, Yusuf, Sanni, and Ayinde (2018), Olalekan (2019), and Oniah and Edem (2022). Conversely, the findings of Iroegbu, Okidim, and Ekine (2021) found labour to be negatively correlated with farm output.

The results as contained on Table 1 show that farm size has a positive coefficient of 0.481 and is significant at 5%. This means that there is a direct relationship between farm size and yam output. The size of the farm used in farming has an impact on output (Olalekan, 2019). The greater the cultivated land area, the greater the crop output, and vice versa. In other words, a 1% increase in farm size results in a 0.481 percent increase in yam output in the Ikom Agricultural Zone, Cross River State. The findings are consistent with those of Tiku and Enoibor (2012), Amaechina and Eboh (2016), and Idumah and Owombo (2019), discovered that farm size was significant and positively related to output. The study does not corroborate the findings of Popoola, Ogunsola, and

Salman (2015) who asserted that there was a negative relationship between land area cultivated and the technical efficiency of cocoa farmers in Southwest Nigeria.

According to the findings as contained in Table 1, the estimated herbicide coefficient was negative (-0.075) and not statistically significant at 10% probability level. This implies that a 1% increase in herbicide use on the farm reduces yam output by 0.075 percent. This could be due to the overuse of herbicides to control weeds. Similarly, increased use of chemicals causes soil acidity, and can negatively affect the crop yield. This result collaborates with the findings of Nimoh, Tham-Agyekum, and Nyarko (2012), Nwafor, Anyaegbunam, Olojode, and Nzeakor (2016), and Edet, Udoe, and Ifang (2018). The authors discovered that agrochemical applications were negatively related to crop yield, implying that increased agrochemical use would reduce crop output. This finding, however, contradicts the work of a group of researchers (Awunyo-Vitor, Wongnaa, and Aidoo, 2016; Yusuf and Wuyah, 2015; and Buhari *et al.*, 2018) who reported a positive relationship between the use of plant protection and crop yield in their studies in Ghana and Nigeria (Kaduna and Kebbi states).

The result on Table 1 indicates that credit has a positive coefficient of 1.001 and is significant at 5%. This also implies that credit has a direct relationship with productivity. An increase in the availability and accessibility of credit to farmers will result in increased output. Credit will increase the farmer's likelihood of purchasing the necessary farm inputs needed for yam production. This result conforms to the study of Lawal, Adedeji, Bwala, Umaru, and Joel (2017), which found that access to credit significantly decreased the technical inefficiency of farmers in sesame production in Niger State, Nigeria. Farmers who have access to credit are more technically efficient than those without (Konga, Franklin, Mabe, and Alhassa, 2019).

From the findings, the null hypothesis which states that "there is no significant relationship between the inputs and output of yam production in the Ikom Agricultural Zone of Cross River State, Nigeria" is therefore rejected and its alternative form accepted. Significant ($p = 0.01$) relationship was found between the quantity of fertilizer, quantity of yam seedlings, labour, access to credit, farm size and output of yam in the study area. Similarly, the hypothesis was also tested using the F-test and the result was shown in the regression analysis. The F-calculated ratio of 18.74 (that is significant at 1%) was greater than the critical F-ratio of 2.175 and 2.956 at 5% and 1% respectively. Therefore, some productive resources such as quantity of fertilizer, quantity of yam seedlings, labour, access to credit and farm size significantly influenced output of yam in the study area.

CONCLUSION

Among the three functional forms employed in the regression analysis, the double-log had the highest R^2, F-value, and number of significant variables and was therefore chosen as the lead equation (LE) to explain the effect of socio-economic factors on yam output. The findings revealed that inputs that significantly influenced yam output in the study area were quantity of fertilizer, seedlings, and labour at 1% level of probability, while access to credit and farm size were significant at 5% level of significance. It is recommended that yam farmers in the zone should increase their farm sizes in cultivation, fertilizer usage, and yam seedlings to increase yam output, as they positively and significantly influenced output.

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