EFFECTS OF RECOMMENDED COCOYAM PRODUCTION TECHNOLOGIES ON OUTPUT OF FARMERS IN ENUGU STATE, NIGERIA

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Abstract
The study assessed the effects of adoption of recommended cocoyam production technologies on the output of farmers in Enugu State, Nigeria. Five-stage sampling procedure was used to select 245 cocoyam farmers. Structured questionnaire was used to collect primary data which was analyzed using descriptive statistics and multiple regression analysis. The results obtained revealed that mean age of the farmers was 56 years and majority (84.1%) of them had formal education. More so, only 20.4% of the farmers had access to credit facilities while 48.6% had contact with extension agents. Most of the farmers adopted all the recommended cocoyam technologies such as fertilizer application (NPK 15:15:15) after planting (99.6%), timely planting between May–June (99.2%), planting method using internodes at 1-2cm thickness (98.8%) and harvesting by digging around cocoyam plant at about 30cm (98.8%).. Regression estimate for the effects of adoption of recommended cocoyam technologies on output of farmers revealed that almost all the technologies had positive and significant effects at varying levels of probability with the output, except fertilizer which was negative but significant ($P< 0.01$) probability level. Thus, it was concluded that the recommended cocoyam technologies had significant effects on the output of the farmers. The study recommends that more sensitization campaign should be carryout by the research institutions in order to scale-up the adoption of recommended cocoyam technologies in the region and beyond.
Keywords: Adoption, recommended technologies, cocoyam production, farmers

INTRODUCTION

Agriculture still remains substantially a family business in Nigeria. Inadequate use of modern agricultural technologies in addition to low resource status of the farmers have made Nigeria's agriculture to remain unimproved (Adeniji, 2002; Ajayi *et al.*, 2017). However, the challenges of inadequate food production and shortages in raw materials supply has led to development of improved technologies to enhance food production and living standard of farmers. In spite of the various food crop production programmes embarked upon by Federal Government of Nigeria (FGN), there has been concern about the capability of Nigeria's agriculture to meet the food requirement of her fast-growing population (International Institute for Tropical Agriculture (IITA), 2013; Muhammed *et al.*, 2019).

In recent years, emphasis have been placed on production of root and tuber crops like cocoyam, which has the potentials of alleviating poverty by improving the income earning capacity and food security of farmers in Nigeria (Ephraim *et al.*, 2021). According to Olaniyan *et al.* (2013), tuber crops are among the most important staple food crops in manny tropical African countries and constitute one of the largest source of calories in the case of Nigeria. The average production figure in Nigeria is 5.4 metric tonnes which accounts for about 37% of total world's output of cocoyam (Food and Agriculture Organization (FAO), 2014). Chukwu *et al.* (2012) posited that cocoyam is nutritionally superior to yam in terms of its digestibility, crude protein contents and some important minerals like phosphorus, Calcium and Magnesium.

However, there has been decline in the yields of cocoyam which could be attributed to the use of low-impact technologies available to the farmers, inadequate improved planting materials, weed problems and poor soil conditions which resulted into reduced cocoyam productivity (National Agricultural Extension and Research Liaison Services (NAERLS), 2011; Nwakor *et al.*, 2015). The National Root Crops Research Institute (NRCRI), Umudike as a research agency saddled with the responsibility of providing research-based information on improved or recommended cocoyam production technologies for adoption has developed and extended frontier through various extension teaching methods to educate farmers (NRCRI, 2013). Therefore, it becomes imperative to examine the extent to which the recommended cocoyam technologies have been adopted and its effects on farmers' output. It was against the backdrop of aforementioned this study was conceived and the following research objectives were put forward to describe the socio-economic background of cocoyam farmers; examine the adoption level of recommended cocoyam production technologies and determine the effects of recommended cocoyam technologies adoption on output of the farmers in the study area.

METHODOLOGY

Study Area

The study was conducted in Enugu State of Nigeria. The State lies between Latitude 7° 29' and 8° 55' North of the equator and Longitude 6° 26' and 7° 28' East of the Greenwich meridian. It has 17 Local Government Areas (LGAs) divided into three Agricultural zones (Enugu-North, Enugu-East and Enugu-West) and covers an estimated land area of 7,161kilometre square (Enugu State Ministry of Information (ESMI), 2019). Enugu State has a population of 3,267,837 (National Population Commission (NPC), 2006) but the projected population as at 2020 using 3.2% growth rate (World Bank, 2019) was 5,078,975. The State experiences annual rainfall of between 1500mm – 2100mm and mean temperature of 30.6°C (ESMI, 2019). The rural people of Enugu State are predominantly farmers.

Sampling Procedure and Sample Size

A five-stage sampling technique was used to select respondents for the study. In the first stage, Enugu-North agricultural zone was purposively selected due to the presence of a large number of cocoyam farmers in the zone. There are six LGAs and eight extension blocks in the zone. In the second stage, four LGAs were randomly selected. Third stage involved selection of one extension block from each of the LGAs selected. The fourth stage was random selection of two extension cells from each of the extension blocks to get eight extension cells. The fifth stage was proportionate selection of two hundred and forty-five (245) cocoyam farmers using Taro Yamane (1967) formula based on the list of registered cocoyam farmers obtained from Enugu State Agricultural Development Programme (ENADEP).

Method of Data Collection and Analysis

Primary data used for the study were collected using semi-structured questionnaire complemented with an interview schedule to obtain information on socio-economic characteristics of the farmers, the recommended cocoyam production technologies adopted and effects of recommended cocoyam production technologies on output of the cocoyam farmers. Data collected were analyzed using descriptive statistics (such as the mean, standard deviation, frequency distribution count and percentage) and multiple regression analysis.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Respondents

As revealed in the Table 1, about half (49.8%) of the respondents were within the age bracket of 51–70 years with a mean age of 56 years. This implies that most of the cocoyam farmers were aged but still able to undertake farming activities. This finding is in contrast with the work of Uwandu *et al.*, (2018) who reported that majority of farmers in their study area were within the youthful and middle age. More so, more than half (55.1%) of the respondents were males, while 44.9% of them were females implying that males were more involved in cocoyam farming than female which could be due to the tedious nature of farming. Majority (82.4%) of the respondents were married which implies that cocoyam production in the study area was mainly undertake by married individuals this could be attributed to the need to pro-create and provide cheap family labour required for farming activities. This finding agrees with Odoemekun and Anyim (2019) who reported that majority of farmers married purposely for pro-creation of young ones. More than half (56.3%) of the respondents had household size between 5–10 people with a mean of 6 persons. This implies that the farmers had fairly large household size which is an advantage in terms of farm labour supply.

Table1: Distribution of respondents based on their socio-economic background (n = 245)

Variables	Frequency	Percentages (%)	Mean
Age (years)			
< 31	9	3.7	56
31 – 50	84	34.2	
51 – 70	122	49.8	
> 70	30	12.3	
Sex			
Male	135	55.1	
Female	110	44.9	
Marital status			
Married	202	82.4	
Widowed	32	13.1	
Single	4	1.6	
Divorced	7	2.9	
Household size			6
< 5	98	40.0	
5 – 7	87	35.5	
8 – 10	51	20.8	
> 10	9	3.7	
Educational status			9
Primary	102	41.6	
Secondary	79	32.2	
Tertiary	25	10.3	
Non-formal	39	15.9	
Experience (years)			24
< 11	55	22.4	
11 – 20	66	26.9	
21 – 30	54	22.0	
31 – 40	48	19.6	
> 40	22	9.1	
Farm size (hectares)			0.82
< 1.1	217	88.6	
1.1 – 2.0	28	11.4	
Access to credit			
Yes	50	20.4	
No	195	79.6	
Extension contacts			
Yes	119	48.6	
No	126	51.4	
Cooperative membership			
Yes	64	26.1	
No	181	73.9	

Source: Field Survey, 2022

Table 1 further revealed that majority (84.1%) acquired formal education (primary, secondary and tertiary) with a mean of 9 years of formal schooling. This implies that the farmers were literate which could help them to make better decisions as regards adoption of technologies. Most (68.5%) of the respondents had farming experience between 11 – 40 years with a mean of 24 years of farming. This implies that the farmers had been into farming for long period of time which could enhance their favourable perception about adopting recommended cocoyam technologies. This agrees with Olaosebikan *et al.* (2019) who reported that majority of the respondents in their study area had long years of farming experience which help them to make informed decisions about their farms. Majority (88.6%) of the respondents had farm size of less than one hectare with a mean of 0.82 hectare. This implies that majority of the cocoyam farmers were operating on a small-scale which could be attributed to competitive nature of farmland in the study area.

Just a few (20.4%) had access to credit. This implies that majority of the farmers had no access to credit which could negatively affect their adoption of recommended technologies. About half (48.6%) of the respondents had contact with extension agents, while 51.4% had no contact. This implies that some of the respondents had contact with extension agents which could influence their decision to adopt recommended cocoyam technologies. More so, majority (73.9%) of the respondents were not members of cooperatives, while only 26.1% were members. This implies that there was poor participation of the farmers in cooperative societies which could play a significant role in adoption of recommended cocoyam technologies in the study area.

Adoption of recommended cocoyam technologies by the respondents

The result in Table 2 presents the recommended cocoyam technologies adopted by the respondents in the study area. It revealed that there was higher adoption of all the recommended cocoyam technologies by majority of the farmers. The top most recommended technologies adopted among others are fertilizer application (NPK 15:15:15) after planting (99.6%), timely planting between May – June (99.2%), planting method using heap and ridge top (98.8%) and harvesting by digging around cocoyam plant at about 30cm (98.8%). This implies that the farmer adopted all the recommended cocoyam technologies in the study area. This is in corroboration with the report of National Root Crops Research Institute (NRCRI) (2013) that farmers adopted recommended cocoyam technologies developed and transferred to them to boost production.

Table 2: Distribution of respondents based on recommended cocoyam technologies adopted

Recommended cocoyam technologies*	Adopted (%)	Not Adopted (%)
Fertilizer application (NPK 15:15:15) after weeding	244 (99.6)	1 (0.4)
Timely planting between May – June	243 (99.2)	2 (0.8)
Planting method using heap and ridge top	242 (98.8)	3 (1.2)
Harvesting by digging round Cocoyam Plant at about 30cm	242 (98.8)	3 (1.2)
Pest control by pesticides	240 (98.0)	5 (2.0)
Weed control by herbicides	240 (98.0)	5 (2.0)
Cocoyam intercropping technique	228 (93.1)	17 (6.9)
Use of Cocoyam mini-sets of about 25g	224 (91.4)	21 (8.6)
Mulching using crop residues	222 (90.6)	23 (9.4)
Plant spacing of 1m x 1m	204 (83.3)	41 (16.7)

Source: Field Survey, 2022

Note: * Multiple Responses and numbers in parentheses are the percentages

Recommended Cocoyam Technologies Adoption on Respondents' Output

The result of regression estimate as presented in Table 3 revealed coefficients of determination (R^2) value of 0.7728 which implies that 77% variation in the output of the respondents were explained by the independent variables included in the model, while the remaining 23% unaccounted could be due to error or other variables not captured in the model. The F–statistic value of 16.84 was significant at 0.01 probability level implying perfect fit of the model and goodness at predicting the observed data. The result also revealed that out of eighteen (18) variables included in the model, thirteen (13) variables were significant at 0.01 and 0.05 probability levels, respectively. Twelve variables such as farm size, labour usage, agrochemical, timely planting, planting method, cocoyam inter-cropping, cocoyam mini-sett, weed control, mulching, extension contact, membership of cooperative and access to credit were positive and significant, therefore had direct influence on the output of cocoyam farmers, while fertilizer usage was negative and significant, thus had inverse influence on the output of cocoyam farmers.

The coefficient for farm size (0.1150) was positive and statistically significant ($P<0.05$) probability level. This implies that a unit increase in farm size as a result of adoption of recommended cocoyam production technologies will lead to 11.5% increases in the output of cocoyam farmers. This meet the a priori expectation because it is anticipated that complete adoption of the cocoyam recommended production technologies package will boost farmers' returns which will invariably lead to the expansion of farm land and thus increase in the output of farmers.

The coefficient for labour usage (0.0020) was positive and significant ($P< 0.05$) probability level. This implies that a unit increase in labour usage as a result of the adoption of recommended cocoyam production technologies will lead to about 0.2% increases in the output of cocoyam farmers. This meet the apriori expectation. As a result of the adoption of recommended cocoyam production technologies, it is envisaged that farmers may likely increase the size of farm land to accommodate increase in returns. This will necessitate more labour, which if properly utilized, will increase farmers output.

The coefficient for timely planting (0.7086) was positive and significant ($P<0.01$) probability level. This implies that a unit increase in timely planting will leads to about 71% increase in the output of cocoyam farmers. Timely of planting is a crucial cultural farming practice that can significantly affect crop performance and yield. This meet the a *priori expectation* because timely planting is expected to improve cocoyam's strong establishment, giving them ample time to grow to their full potential and lessen other environmental stress.

Table 3: Regression estimates on effects of recommended cocoyam technologies on output

Variables	Coefficient	Standard error	t-values
Farm size	0.1150	0.0560	2.05**
Labour usage	0.0020	0.0009	2.39**
Seed rate	3.15e-07	5.99e-07	0.53
Inorganic fertilizer application	-0.0001	0.0002	-2.04**
Agrochemical application	0.0644	0.0206	3.13***
Timely planting	0.7086	0.1015	6.98***
Planting spacing 1mx1m	-0.1393	0.0576	-2.42**
Planting method	0.2943	0.1399	2.10**
Cocoyam inter-cropping	0.1300	0.0610	2.13**
Cocoyam mini-sett 25g	0.1209	0.0592	2.04**
Organic fertilizer application	-0.1140	0.0989	-1.15
Weed control	0.2874	0.0717	4.01**
Mulching	0.2129	0.0643	3.31**
Pest control	0.0249	0.1356	0.18
Harvesting method	0.1466	0.1022	1.44
Extension contacts	0.2158	0.0541	3.99***
Cooperative membership	0.1527	0.0697	2.19**
Access to credit	0.1601	0.0761	2.10**
Constant	5.0223	0.2242	22.40***
R-squared	**0.7728**		
Adj R-squared	**0.7388**		
F-statistics	**16.84*** **		

Source: Field survey, 2022

Note *, ** and * implies significant at 1%, 5% and 10% probability level, respectively**

The coefficient for cocoyam mini-set (0.1209) was positive and significant (P<0.01) probability level. This implies that a unit increase in cocoyam mini set adoption will leads to about 12% increases in the output of cocoyam farmers. This meet the a *priori* expectation because adopting the recommended cocoyam mini-sett techniques will help the farmer to produce large quantities of planting materials in the shortest possible time, which lessen the competition for cocoyam corms as food and planting materials. This is expected to improve their productivity.

The coefficient for cocoyam inter-cropping (0.1300) was positive and significant (p<0.01) probability level. This implies that a unit increase in cocoyam inter-cropping adoption will leads to about 13% increases in the output of cocoyam farmers. Adoption of recommended intercropping practice will help the farmers to diversify their sources of income while maintaining same level of output per hectare.

The coefficient for weed control (0.2874) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in weed control will leads to about 29% increases in the output of cocoyam farmers. This meet the a *priori* expectation because weed competes with planted crop for nutrient, soil air and water as well as harbouring pest. Therefore, adoption of recommended weed control strategies by cocoyam farmers is expected to improve sanitary condition towards pests and diseases thereby improving the productivity of the farmers.

The coefficient for mulching (0.2129) was positive and significant (P< 0.01) probability level. This implies that a unit increase in mulching will leads to about 21% increases in the output of cocoyam farmers. Mulch on cocoyam is expected to enhance the activity of soil organisms and reduce evaporation of water from the soil. Thus, the result is in line with the expected *a priori,* because adoption of recommended mulching practices is expected to create favourable condition for cocoyam optimal growth.

The coefficient for extension contacts (0.2158) was positive and significant (P<0.01) probability level. This implies that a unit increase in extension contact will leads to an increase of about 22% in farmers' output. Extension agent facilitates the dissemination of recent innovation in agriculture to farmer in order to improve their productivity. As expected, increase in extension contact can bring the result or method demonstration of cocoyam production technologies to farmer is expected to enhance the adoption of the technology which will invariably improve the output of farmers.

The coefficient for membership of cooperative (0.1527) was positive and significant (P<0.01) probability level. This implies that a unit increase in membership of cooperative will leads to about 15% increases in the output of cocoyam farmers. This shows that cooperative membership could positively influence adoption decisions of a farmer in relation to improved technologies dissemination. Cooperative society is an instrument which facilitates access to credit and extension linkages that could help in adoption of recommended cocoyam production technologies.

The coefficient for access to credit (0.1601) was positive and significant (P< 0.01) probability level. This implies that a unit increase in access to credit will leads to about 16% increases in the output of cocoyam farmers. It is a general fact that access to credit by farmers is one of the most important means of improving farm productivity. Credit provide the means for innovation adoption, thus the higher a farmer has access to credit, the higher the capacity to adopt recommended cocoyam production technologies for increase output.

The coefficient for inorganic fertilizer usage (-0.0001) was negative and statistically significant at 0.01 probability level. This implies that a unit increase in inorganic fertilizer usage as recommended cocoyam production technologies will leads to about 0.01% decrease in the output of cocoyam farmers. Excessive fertilizer application especially inorganic fertilizer tends to have significant effects on crop under production, thus the need to strictly follow the recommended rate in order to realize the expected output.

CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study, it was concluded that the cocoyam farmers were aged but still active in production, married and educated with at least secondary education. However, there was poor access to credit, fair contact with extension agents and poor cooperative membership. The farmers adopted all the recommended cocoyam production technologies with little variation. Thus, adoption level was high. There was significant effects of the recommended cocoyam production technologies on output of the farmers. It was recommended that drastic sensitisation should be carried out by relevant research institutes and extension agencies to scale-up adoption of recommended cocoyam technologies for increased output in Enugu Nigeria at large. The farmers should organize themselves into cooperative societies in order to harness the benefits accrued from cooperative participation such as access to credit, extension services and training in relation to cocoyam production.

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