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Adoption of Improved Sweet Potato Production Technologies among Small-scale Farmers in South East, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author MNO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MCM and HUN managed the analyses of the study. Author ENM managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The study was carried out to determine adoption of improved sweet potato production technologies among small-scale farmers in South East, Nigeria. Data were collected from a sample of 100 respondents using questionnaire. Percentage, mean score and multiple linear regression were used for data analysis. Results showed that majority (64.0%) of the respondents were male, married (85.0%) with a mean age of 55 years, having 81.0% of the respondents with a farming experience of 10-19 years. A greater percentage of the sweet potato producers sourced information on time of planting (55.0%), planting spacing (46.0%) and weeding (37.0%) from research institute while

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36.0% sourced information on fertilizer application from fellow farmers. Adoption of improved sweet potato production technologies by producers in the study area included use of improved varieties (79%), planting spacing/distance used (81%), vine cutting (81%), fertilizer application (400 kg/ha, NPK 15:15:15) (91%), pest control (66%), harvesting (77%) and storage method (51%). The study recommended the need for awareness campaign by extension agents, public health agencies, nutritionists and non-governmental organizations on the availability of these sweet potato varieties that produce high yields for better returns. Efforts of government and non-governmental organizations are needed in encouraging sweet potato producers to adopt improved technologies through conduct of practical oriented training programmes, provision of suitable and necessary incentives and technologies in order to increase production and income.

Keywords: Adoption; sweet potato; production; technologies; South East; Nigeria.

1. INTRODUCTION

Sweet potato (Ipomoea batatas) has different names in different languages such as Nduko in Igbo, Dankali in Hausa, Dun odunkun in Yoruba, batata or chaco in Spanish, Patatedouce in French, Patataamericanain Italian, Batate in German, among others. It is a herbaceous warm weather creeping plant belonging to the family Convolvulaceae and genusipomomia [1]. Sweet potato originated from South America [2]. Sweet potato is a food and nutrition security crop grown in almost all Asian countries, Latin America, Spain, Philippines and Portugal, India, Indonesia, among others. It has about one thousand species and only Ipomoea is of economic importance to man and animal [3].

Sweet potato is one of the world's most important staple carbohydrate foods. Sweet potato is the fifth most important food crop on a fresh weight basis in developing countries after rice, maize, cassava and wheat [4]. Sweet potato is high in nutritive value, outranking most carbohydrate foods in vitamins, minerals, protein and energy content [5]. Depending on the cultivar, it is high in carotenoids, particularly, the hydrogen carotenoid, and the B-carotenoid which is a potent pro-vitamin A which is very important in nutrition and health of humans.

According to United Nations International Children's Emergency Fund (UNICEF) [6], sweet potato is an important root crop in Nigeria, not just because of its adaptability in slightly loose soil (marginal soil), but also its broad agro-ecological adaptability. Sweet potato is regarded as a second root crop in Nigeria but due to poor agronomic practices adoption of sweet potato by the farming population, its tremendous potentials as a Vitamin A and Food security powerhouse is still in doubt.

However, the processing of sweet potato into chips, snacks are not common in Nigeria due to inadequate information on processing technologies and various characteristics of products utilization [7]. The poor quality of traditionally dried crop that has retained moisture for too long results from poor processing. This traditionally dried crops result in mouldiness, micro toxin contamination and early insect infestation which leads to low or outright rejection of products [8]. Quality sweet potato processing has potential for production of primary products, preservation, conservation and helping or making a way for women and youths in Nigeria to be gainfully employed. In addition, quality processing holds an opportunity of creating market for sweet potato tubers such as potato chips, potato flour and a lot of confectionaries which will encourage more rural farmers to go into sweet potato production, processing and marketing and invariably lead to increase in production, cost minimization and profit maximization.

The minimal utilization of sweet potato in Nigeria is clear due to non- availability of appropriate sweet potato based recipes that satisfy the food habits of Nigerians [9]. Sweet potato is grossly under-exploited as food in Nigeria [10]. However, factors influencing the adoption of agricultural innovation was classified by Agbamu [11] as personal characteristics of farmers, characteristics of the innovation, psychological factors, and situational constraints. In order to disseminate sweet potato technologies to farmers and processors for uptake and subsequent use, NRCRI programmed the sweet potato production and processing technologies into the technology review meetings of the Agricultural Development Programmes (ADPs) in the South East zone of Nigeria through the Research-Extension-Farmer-Input-Linkage System (REFILS) [12].

Despite the growing importance and known potential such as food, animal feed and raw material; records of sweet potato production and processing in Nigeria's food system are scanty. There is urgent need to improve and document sweet potato production, processing and marketing activities and factors militating against them in order to increase output due to increase in population and urbanization rate so as to meet the micro nutrient requirement of children, lactating mothers and adults especially at this time when different policies for food scarcity are being taken by the Federal government of Nigeria. It was against this backdrop that this research determined adoption of improved sweet potato production technologies among in South-east, Nigeria. This raised the following research questions. What are socio-economic characteristics of the respondents? What were the sources of information on sweet potato production technologies? Were the recommended sweet potato production technologies adopted by the respondents?

The specific objectives were to:

i. Describe socio-economic characteristics of the respondents;
ii. Ascertain sources of information on sweet potato production technologies; and
iii. Determine actors' adoption of the recommended sweet potato technologies.

1.1 Statement of Hypothesis

The following hypothesis were empirically stated and tested:

Ho1: There was significant relationship between socio-economic characteristics of the producers and adoption of sweet potato production technologies.

2. METHODOLOGY

The study was carried out in South-East, Nigeria. Abia and Anambra States were selected out of the five states in South-East, Nigeria because of existence of National Root Crops Research Institute, Umudike and Federal Research Institute, Igbariam. Also, sweet potato is mainly produced in these States.

Abia State is one of the five states in the South-East geo-political zone of Nigeria with Umuahia as its capital. Abia State is made up of seventeen (17) Local Government Areas which are grouped into three agricultural zones namely; Aba, Ohafia and Umuahia. It is located between latitudes 04º45 and 06º07N and longitudes 07º10 and 08º10 E. The state is bordered by Imo, Anambra and Rivers State in the West, North West and South West respectively. To the North, North East, East and South East, it is bordered by Enugu, Ebonyi, Cross Rivers and Akwa Ibom States respectively. It has a population of 2,833,999 people comprising 1,808,357 male and 1,189,621 female with 70% living in the rural/ sub-urban areas [13]. It covers a land area of 776,720 square kilometres. The climate is tropical with dry and rainy season which starts in March and lasts to the end of November, with a peak period in June while dry season starts from December to February. Abia State has an annual rainfall of about 668 mm. A large proportion of the people are engaged in farming and they produce mostly yam, cassava, cocoyam, banana, maize, sweet potato, rice, plantain, oil palm, cocoa, rubber, cashew, garden egg, among others. They also engage in the rearing of livestock such as poultry, goats, sheep and rabbits. Umudike is in Abia State which is the seat of the National Root Crops Research Institute that began as a provincial farm in 1923, up-graded to Commodity Research institute in 1975 and renamed as National Root Crops Research Institute in 1976. The institute is mandated to research into the genetic improvement, production, processing, utilization, storage and marketing of root and tuber crops in Nigeria which include yam, cassava, sweet potato, Irish potato, ginger and minor root crops as well as research into the total farming systems of South- East agro-ecological zone comprising Abia, Anambra, Ebonyi, Enugu and Imo State.

The activities of sweet potato production and processing in the states particularly at NRCRI include careful development of new populations with higher probability of combining traits in a genotype through hybridization and this has been adopted for the sweet potato value chain programme of the Federal Ministry of Agriculture and Rural Development, selection of varieties with high root yield, identifying and duplicating parents that flowers for inclusion in the germplasm for crop improvement, soil management and agronomic technologies that are necessary for the improved varieties of sweet potato and farming systems.

Anambra State is one of the 36 States of Nigeria situated in the South- Eastern part of Nigeria. The State is made up of twenty one (21) Local Government Areas (LGAs). The State is divided

into four agricultural zones namely; Aguata, Anambra, Awka and Onitsha with five, four, five and seveen extension blocks, respectively. The state is located between latitude 5º38 N and 6º47N and longitude 6º36E and 7º21E. It has Abia, Delta, Enugu, Imo and Kogi State as its neighbouring states. Anambra State occupies an area of 4,416 km^2 and has a population of 4,177,828 out of which 2,117,984 are male and 2,059,844 are female [14]. It has 70% available land and less than 55% of the available land is under cultivation. The number of farm families was reported by ASADEP [15] as 338,721 with an average size of 8 persons per household. It has two main seasons, the dry and the rainy seasons with annual rainfall between 2000 and 2300 mm. The soil type and climate of the area are suitable for sweet potato production in many parts of the State making it to stand out as one of the largest producers of sweet potato in Nigeria with production figure of 159 mt [16].

The population of the study comprised all sweet potato actors (producers) in Abia and Anambra States, South-Eastern Nigeria. A total of 100 respondents were selected using a multi-stage sampling procedure. Stage 1 involved random selection of five local governments each from Abia and Anambra States. The LGAs selected were Ikwuano, Bende, Aba North, Aba South and Ohafia in Abia state; Anambra West, Ogbaru, Awka North, Anambra East and Ayamelum in Anambra State. Stage 2 involved a random selection of two communities from each LGA to give a total of 10 communities. Stage 3 involved random selection of 10 producers from each selected communities using simple random sampling technique. This gave a total of 100 respondents used for the study.

Questionnaire was used to collect data for the study. Data were analysed using percentage, mean score and multiple linear regression.

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of the Respondents

3.1.1 Age

Table 1 shows that greater proportion (33.0%) of the producers fell within the age bracket of 50-59 years, 31.0% were within the age of 60-69 years, 20.0% were within the age range of 40-49 years, among others. The mean age was 55 years. It implied that aged people were mostly involved in sweet potato production in the study area. This finding is in agreement with Ministry of Agriculture Awka [17] which reported that sweet potato farmers were between the age ranges of 41 and 50 years. This age class according to Okoro and Ajieh [18] was often conservative to technology adoption as well as not being able to withstand the vigour and strains in farming. Age could influence farmers' ability to perform tasks requiring physical strength because farming in developing countries is mostly done manually through the use of physical strength and could influence producers' willingness to adopt innovations.

3.1.2 Sex

Results in Table 1 showed that majority (64.0%) of sweet potato producers were male while 36.0% were female. This indicated that more men were engaged in sweet potato production. This is in line with [19] who reported that greater proportion of sweet potato producers were male.

3.1.3 Marital status

Findings on marital status of the respondents is shown in Table 1 which revealed that the majority (85.0%) of the producers were married, 9.0% were widowed, 4.0% were widowers, among others. The findings implied that there were more married sweet potato producers. This is in line with [19] who reported that the majority of sweet potato farmers were married. The findings showed that marriage was an important institution in the study areas as marriage encourages synergy among farm families which could be used to accomplish certain farm activities and thus promotes the spread of innovations on sweet potato production. Marriage encourages division of labour among farm families thus reducing the cost of labour resulting in profit maximization [20].

3.1.4 Educational level

Findings in Table 1 showed that a greater percentage (54.0%) of the producers had primary school education, 38.0% acquired secondary education, 6.0% obtained vocational education and 2.0% did not receive any formal education. These findings showed that producers in the study area were appreciably literate showing that they can read and write by having obtained formal education. Acquisition of formal education could enhance decision making ability among farmers. Educated farmers can access agricultural information from an array of sources.

This is in line with Kanu, et al. [21] who opined that the level of education attended by a farmer not only increases his/ her farm productivity but also enhances his/her ability to understand and evaluate new production/ processing technologies. Again, a literate farmer is less sceptical of new ideas and is able to respond rationally to new technologies. Also, Nwaobiala [22] opined that education enhances farmers' ability to communicate, explore, access and adopt improved technologies.

3.1.5 Household size

Majority (75.0%) of the producers had household size of 6-10 persons, 20.0% had 1-5 persons and 5.0% had 11-15 persons (Table 1). The mean household size was 7 persons. This implied that the producers have relatively large household size. Household size have proved to be a source of cheap farm labour to farmers thereby reducing costs incurred in farming operations, also, enabling them to easily adopt new practices and extension packages. This is in line with [23] who indicated that rural households are characterized by large household size with high dependency ratio.

3.1.6 Farming experience

Table 1 revealed that the majority (81.0%) of the producers had 10-19 years of farming experience, 10.0% had 20-29 years farming experience, 7.0% had 1-9 years farming experience, 2.0% had 40-49 years farming experience while none represents 30-39 years farming experience. The mean sweet potato farming experience was 13.34 years. This is a clear indication that producers had enough farming experiences that could improve agricultural production. All things being equal, they must have acquired a reasonable wealth of knowledge over the years which impacted positively on their productivity and income. This is because farmers with many years of farming experience know the problems involved in agricultural production and are in a better position to overcome them and improve on their yield through the adoption of improved technologies. This finding corroborated with the earlier studies carried out by Uzuegbunam, et al. [24] that women cooperative in cassava processing in Anambra State had enough processing experience which serves as an advantage in their participation and adoption of improved cassava processing technologies. Experience also enables the farmers to set realistic targets.

3.1.7 Farm size

Results in Table 1 indicated that half (50.0%) of the producers had farm holdings of 0.1-1.0 hectares, 34.0% of them had 1.1-2.0 hectares, 16.0% of the producers had 2.1-3.0 hectares. The mean farm size was 1.21 hectares. This implied that the producers cultivated small hectares of land in the study area. This finding concurred with that of Ajani and Ajani [25] who reported that the majority of the farmers in Nigeria cultivated between 0.8 and 1.3 hectares of land scattered and small for mechanization. This could be attributed to land tenure system and nature of land acquisition that encourages land fragmentation. This corresponds with [26] report that African male dominate on matters concerning land making it impossible for women to own land in their own right. Similarly, small land holding could negatively influence farmers' productivity resulting in reduced profit, culminating in inability to adopt innovations.

3.1.8 Sources of farm labour

Entries in Table 1 revealed that greater percentage (49.0%) of the producers use family labour. This was followed by 39.0% who depended on a combination of family and hired labour for sweet potato production while 12.0% of the producers depended on hired labour only. This could be attributed to high cost of labour due to youths' migration to cities in search of white collar jobs. This is in line with [27] who observed that rural farmers are financially poor. This statement is supported by Akpabio [28] who reported that non- mechanized tools are discouraging factors which impede youth's readiness and willingness to participate in farming due to drudgery, tediousness and frustrating low income associated with the traditional methods of farming.

3.1.9 Estimated annual income

A greater proportion (33.0%) of the producers earned ₦300,001- ₦400,000 as annual income from sale of produce while 24.0% indicated ₦200,001- ₦300,000, 23.0% indicated ₦100,001- ₦200,000, 16% got between ₦400,001 and ₦500,000 and 4.0% of the respondents indicated ₦500,001-₦ 600,000. The mean annual income was ₦291,463.98. This implied that the respondents in the study area realized relatively high income even though they were operating in a small scale as a result of farming risks and systems of land tenure in the

area which discourages farm expansion, mechanization and in accessibility of farmers to formal credits.

3.2 Sources of Information on Sweet Potato Production Technologies

Table 2 showed that the majority of the producers did not have any source of information in the following sweet potato production operations, namely; land selection (76.0%), land preparation (75.0%), harvesting (73.0%) and storage (84.0%). Results also revealed that greater percentage of the sweet potato producers sourced their information on time of planting (55.0%), planting space (46.0%) and weeding (37.0%) from research institute while 36.0% sourced information on fertilizer application from fellow farmers (Table 2). This implied that many of the producers did not obtain information from any source but depended on their personal knowledge and experience. This was an indication that no single source of information could effectively deliver extension message to producers, rather, all sources of information are needed to effectively deliver information to the actors. Information as a factor of production has become a very important feature in the Nigerian agricultural sector in contemporary times. Therefore, farmers' accessibility to various sources of information needs to be enhanced in order to increase the level of adoption of improved varieties of sweet potato. This is in line with the findings of Madukwe [29] which reported that information is a key issue in this information age, it is vital for increased production and opens windows of sharing vital experiences, best practices, sources of financial aids and new market.

3.3 Adoption Levels of Improved Sweet Potato Production Technologies

Entries in Table 3 showed the adoption levels of some improved sweet potato production technologies by producers in Abia and Anambra States. These included the use of improved varieties, planting spacing/ distance used, vine cutting, fertilizer application (400 kg/ha, NPK 15:15:15), pest control, harvesting and storage method.

3.3.1 Use of improved varieties

Table 3 showed that the use of new improved varieties, Ex- Igbariam had the highest mean adoption score of 4.79, butter milk had 4.55, UMUSPO/2 had 3.73, UMUSPO/1 had 3.19 and TIS-87/0087 had mean adoption score of 2.86. The grand mean adoption score was 3.95 with adoption index of 0.79. This implied that 79% of the producers adopted the use of improved varieties of sweet potato in sweet potato production. This is confirmed by BNARDA [30] which reported that several improved systems of small holder farmers in Benue State with approximately 212,840 hectares were subjected to sweet potato production.

3.3.2 Planting spacing/distance used

Data in Table 3 revealed that 30cm x 100cm on ridges had mean adoption score of 4.22 and spacing at 25 cm x 100 cm on mounds had mean adoption score of 3.92. The grand mean adoption score was 4.22 with adoption index of 0.81. This implied that 81% of the producers adopted planting spacing/ distance used for sweet potato production technology.

3.3.3 Vine cutting

Entries in Table 3 showed that the mean adoption score of 4 node cuttings and 2 node inserted into the soil was 4.07 while 8 node cuttings and 4 nodes inserted into the soil had mean adoption score of 4.01. The grand mean score was 4.04 while the adoption index was 0.81. This meant that 81% of them were involved in the adoption process of vine cutting. This was an indication that the majority of the producers are aware of the benefits of using accurate/ adequate sweet potato vine cutting technique. This is in line with Onunka [31] who notes that processing vine at both 6 and 10 weeks after planting was recommended for increased generation of planting material and is a worth-while venture for sweet potato farmers.

3.4 Fertilizer Application (400 kg/ha, NPK 15:15:15)

Table 3 also showed that the mean adoption score of fertilizer application at 4-6 weeks of planting was 4.53. The grand mean score of fertilizer application was 4.53 while the adoption index was 0.91. This implied that 91% of them were involved in the adoption process of the fertilizer application. The high adoption is an indication that the majority of the producers apply fertilizers in their farms even though the producers may apply different dosages of fertilizer as a result of unavailability and high cost of fertilizer. This is in line with the findings of Tewe, et al. [32] who reports that all the

respondents apply chemical fertilizers to their sweet potato.

3.4.1 Pest control

Results in Table 3 revealed that the mean adoption score on the level of adoption on pest control on planting of sweet potato vines 4 weeks after cutting was 4.28, planting of the sweet potato vine with apical end was 3.72, foliar insecticides was 2.81 and soil insecticides was 2.47. Also, the grand mean score was 3.32 while the adoption index score was 0.66. This implied that 66% of them were involved in various adoption processes of pest control. This corresponds with the findings of Anukworji, et al. [33] that the major economic losses of crops (roots and tubers) occur from plant diseases.

Table 1. Distribution of respondents according to socio- economic characteristics (n=100)

Socio-economic characteristics	Percentage	Mean($\bar{x}$)
Age (years)		
30-39	12.0	
40-49	20.0	
50-59	33.0	55.52
60-69	31.0	
70 and above	4.0	
Sex		
Male	64.0	
Female	34.0	
Educational level		
Non- formal education	2.0	
Primary	54.0	
Secondary	38.0	
Vocational education		
Marital status		
Married	85.0	
Single	0.0	
Widow	9.0	
Widower	4.0	
Divorced	2.0	
Separated	0.0	
Household size (numbers)		
1-5	20.0	
6-10	75.0	6.66
11-15	5.0	
Farming experience (years)		
1-9	7.0	
10-19	81.0	
20-29	10.0	13.34
30-39	2.0	
Farm size (hectares)		
0.1-1.0	50.0	
1.1-2.0	34.0	1.21
2.1-3.0	16.0	
Source of farm labour		
Family	49.0	
Hired	12.0	
Both	39.0	
Estimated Annual Income (Naira)		
1,000-100,000	23.0	
101,000-200,000	24.0	
201,000-300,000	33.0	₦204,500
301,000-400,000	16.0	

Table 2. Sources of information on sweet potato production technologies

Production technologies	Personal experience (%)	Radio (%)	TV (%)	EA (%)	ADP/ LGA (%)	Fellow farmers (%)	Research institute (%)	Cooperative societies (%)
Use of improved varieties	10.0	3.0	3.0	3.0	28.0	-	56.0	-
Sources of planting material	-	-	-	-	7.0	28.0	61.0	4.0
Land selection	76.0	3.0	-	9.0	4.0	-	8.0	-
Land preparation	75.0	3.0	-	7.0	4.0	-	11.0	-
Time of planting	9.0	-	-	-	18.0	12.0	55.0	6.0
Planting space	11.0	-	-	-	21.0	16.0	46.0	6.0
Fertilizer application	4.0	-	-	4.0	16.0	36.0	33.0	3.0
Weeding	14.0	-	-	7.0	36.0	29.0	37.0	3.0
Harvesting	73.0	-	4.0	3.0	29.0	-	13.0	3.0
Storage	84.0	-	-	3.0	-	-	7.0	6.0
Total	356	6.0	7.0	36	-	121	327	31

3.4.2 Harvesting

Table 3 also showed that use of hoe, digger and hand fork for harvesting of sweet potato had mean adoption score of 4.67, 4.32 for time of harvesting (3-4 months after planting), 3.07 for careful harvesting of the roots to avoid injury or bruises and 2.18 for allowing the bruises to heal before storage. Also, the grand mean score was 3.56, while the adoption index was 0.71. This implied that 71% of them were involved in the various adoption processes of harvesting sweet potato. The high adoption score shows that the majority of the producers are aware of the benefits of harvesting technology recommended apart from allowing the bruises to heal before storage that was at interest stage. The implication of this was that mechanical harvesting technology which takes care of large scale harvesting was not available.

3.4.3 Storage method

Table 3 also revealed that sweet potato storage pattern had 3.35 mean adoption score for harvesting after leaving it on ground for 1 month and 2 months, 3.17 for uncured treatment and 1.69 for cured treatment. The table further reveals that the grand mean score was 2.55, while the adoption index of the producers was 0.51. This implied that 51.0% of the producers were involved in these various adoption processes of storage pattern of sweet potato. This indicated that cured and uncured sweet potato treatment technology were not widely adopted in most part of the study area or by most respondents partly because producers engage in piece meal harvesting of storage roots to avoid low prices associated with the peak of the harvesting. Storage can be improved by adopting careful harvesting of the roots to avoid injury or bruises but when damaged or bruises occur, it can be cured to allow the bruises to heal before storage. According to Onifade [34], sweet potato can be left on the ground for 2 months, in ground storage methods, the sweet potato plant should be defoliated and the ridges or mounds earthen up to close the cracks that could create access for weevils.

3.5 Relationship between Producers' Socio-economic Characteristics and Adoption of Sweet Potato Production Technologies

Results of regression analysis of the relationship between the independent variables (age, educational level, farming experience, social organization belonged, access to extension services and annual income) and adoption of sweet potato production technologies in Abia and Anambra State showed that a strong correlation (R=0.857) exists between dependent variables and independent variables. These variables were able to explain 77% of the variation in adoption of sweet potato production technologies among producers (R^2= 0.769). Adjusted R^2 also supported the claim with a value of 0.676 or 67.6%. This shows that the independent variables explain the behaviour of the dependent variable at 67.0% level of confidence. Out of the twelve variables investigated, six variables were found to be statistically significant as regards to the adoption of sweet potato production

technologies. They included were age, educational level, farming experience, social organization belonged, access to extension service and annual income.

Age was one of the socio-economic determinants of adoption of sweet potato production technologies in the study area. Age of the producers was positive and significantly influenced the adoption of sweet potato production technologies. This implied that any increase in age will lead to a corresponding increase in the adoption of the improved sweet potato production technology. Education showed a positive relationship with adoption of sweet potato production technology. A unit increase in the level of education increased the probability of the adoption of sweet potato production innovations. Producers are more disposed to understand new ideas and concepts provided by extension workers and other informants. This underlines the importance of human capital development in increasing the level of the improved sweet potato production technologies. This agreed with [35] who pointed that education is very essential in the development process.

Years of farming were positive and significantly influenced adoption of sweet potato production technologies in the study areas. This showed that the contribution of explanatory variables is proportional to dependent variables. This implied that the more farming experience producers had, the higher the productivity of sweet potato in the

Table 3. Adoption levels of improved sweet potato production technologies

Improved sweet potato production technologies	Mean adoption score	Grand mean adoption score	Adoption index
Use of improved varieties			
TIS- 87/0087	2.86		
UMUSPO/I	3.19		
UMUSPO/2	3.73	3.95	0.79
UMUSPO/3	4.07		
UMUSPO/4	4.48		
Ex- Igbariam	4.79		
Butter milk	4.55		
Planting spacing/distance used			
30cm x 100cm on ridges	4.22		
25cm x 100cm on mounds	3.92	4.07	0.81
Vine cutting			
8 nodes cuttings and 4 nodes inserted into the soil	4.01		
4 node cuttings and 2 nodes inserted into the soil	4.07	4.04	0.81
Fertilizer application(400kg/ha, NPK 15: 15: 15)			
Applied at 4-6 weeks after planting	4.53	4.53	0.91
Pest control			
Planting of sweet potato vine 4 weeks after cutting	4.28		
Planting of the sweet potato vine with apical end	3.72	3.32	0.66
Soil insecticides (field sanitation, use of resistance varieties)	2.47		
Foliar insecticides	2.81		
Harvesting			
Time of harvesting (3-4 months after planting)	4.32		
Use of hoe, digger, hand fork	4.67	3.56	0.71
Careful harvesting of the roots to avoid injury or bruises.	3.07		
Allowing the bruises to heal before storage	2.18		
Storage pattern			
Cured treatment	1.69		
Uncured treatment	2.00	2.55	0.51
Defoliation and earthen up in ground storability	3.17		
Harvest after 1 month and 2 months leaving it in the ground	3.35		

Table 4. Regression model for the relationship between producers' socio-economic characteristics and adoption of sweet potato production technologies

	Unstandardized		Standardized coefficient	
Variables	**B**	**SD error**	**Beta**	**T**
Constant	1.976	0.881	-	2.654*
Age	1.343	0.246	0.824	8.911*
Sex	-0.700	3.630	-0.020	-0.193
Educational level	1.578	0.517	0.529	4.023*
Household size	0.170	1.661	0.017	0.102
Marital status	-2.284	1.735	-0.141	-1.316
Farm size	0.045	0.029	0.238	1.731
Farming experience	1.627	0.337	0.294	3.941*
Sources of fund for take-off	0.053	0.346	0.023	0.245
Sources of farm labour	0.047	0.276	0.015	0.175
Membership social organization	0.955	0.341	0.307	3.066*
Access to extension service	1.732	0.533	0.518	4.035*
Annual income	1.512	0.305	0.372	2.791*

$P \leq 0.05$, $R = 0.857$, $R^2 = 0.769$, Adjusted $R^2 = 0.676$

area. Years of experience could mean practical knowledge acquired especially through trial and error and having established the best method. This is in line with the findings of Okoye, et al. [36] which stated that the more experienced a farmer is, the more efficient he/ she will be in decision- making processes and he/ she would be willing to take risks associated with the adoption of innovations.

Membership of social organization was the fourth variable perceived by the producers as the determinants of adoption of sweet potato production technologies. It had a positive influence which implies that it is directly related to the dependent variable. Therefore, the higher the number of those that did not belong to a social organization, the lower the rate of adoption of improved sweet potato production technologies. Thus, for adoption rate to be maintained as regards to sweet potato production, Membership of social organization has to be effective.

Extension contact had a positive influence on the adoption of sweet potato production technologies in the study area. This implied that frequent contact with extension agents by the producers gives them opportunity to know about the use of improved sweet potato production techniques/ innovations to increase their production while negative contact with extension agents will affect their production due to the fact that they have missed information on the basic inputs needed for production. Therefore, regular contact with extension agents makes producers aware of improved innovations and how they can apply them to improve their livelihood. This is in line with Nwachukwu [37] who noted that it is only through an effective communication pattern that the behaviour of the receiver will change to the desire of the source.

Annual income had a positive influence on the adoption of sweet potato production technologies in the area. This implied that the more income realized by the producer, the higher the productivity leading to high adoption rate of sweet potato production innovations provided that all things being equal. On the other hand, it also showed that the lesser the annual income, the lower the productivity of the crop, thus low adoption of the technologies. Similarly, the positive relationship was in agreement with [38] because as capital increases, the scales of production are also being enlarged and this translates to more increase in output.

4. CONCLUSION AND RECOMMENDATIONS

Results indicated that majority of the respondents were male, married, middle –aged and literate. A greater percentage of the sweet potato producers sourced information on time of planting, planting space and weeding from research institute while information on fertilizer application was sourced from fellow farmers. In addition, majority of the respondents adopted the use of sweet potato production technologies such as improved varieties of sweet potato, planting distance, vine cutting, fertilizer application, pest control, time and method of harvesting as well as storage method.

The study recommended the need for awareness campaign by extension agents, public health

agencies, nutritionists and non-governmental organizations on the availability of these sweet potato varieties that produce high yields for better returns. It also highlighted that government and non-governmental organizations should encourage sweet potato producers to adopt improved technologies through conduct of practical oriented training programmes, provision of suitable and necessary incentives and technologies in order to increase production and income.

CONSENT

As per international standard, respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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