Analysis of Constraints to Adoption of Sweet Potato Processing Technologies among Actors 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 MNO and ENM managed the analyses of the study. Author ETY managed the literature searches. All authors read and approved the final manuscript.

Review Article

ABSTRACT

The study was conducted to analyze constraints to adoption of sweet potato processing technologies among actors in South East, Nigeria. Questionnaire was used to collect data from a sample of eighty (80) respondents used for the study. Data were analyzed using mean score, standard deviation, factor analysis and multiple linear regression analysis. Results indicated that sex, educational level, marital status, processing experience and access to extension service had a positive influence on the adoption of sweet potato processing technologies in the study area. The respondents were highly constrained by inadequate processing machines/equipment ($\bar{x}$ =2.88), high cost of processing produce ($\bar{x}$ =2.86), inadequate knowledge of modern sweet potato

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processing techniques ($\bar{x}$ =2.84), inadequate capital for start-off ($\bar{x}$ =2.84), high cost of labor ($\bar{x}$ =2.83), poor credit facilities ($\bar{x}$ =2.80) and scarcity of processing materials like sweet potato tubers ($\bar{x}$ =2.43). These variable constraints were further subjected to factor analysis and the variables were named technical and infrastructural factors. It is recommended that processors should be encouraged to form cooperative society to enable them to pool their resources together to obtain credit facilities and sweet potato labour saving processing technologies in order to increase productivity. There is also a need for creation of awareness by extension agents, public health agencies, nutritionists and non-governmental organizations on the usefulness of orange fleshed sweet potato in addressing Vitamin A Deficiency Syndrome.

1. INTRODUCTION

Sweet potato (*Ipomoea batatas*) is a perennial crop grown as an annual crop in tropical and sub-tropical lowland agro-ecologies. It is well adapted to other zones and can be grown over widely different environment. It has large, fleshy and edible storage roots that are formed on the underground stem nodes [1]. Sweet potato is a short duration crop with high yield and economic returns [2]. It is the only root and tuber crops that can be grown and harvested within four months in Nigeria. Specifically, sweet potato can be grown two to three times in a year with supplementary irrigation [3]. It has low soil fertility requirement and better opportunity cost relative to the other root and tuber crops such as cassava, yam and cocoyam. Sweet potato is highly adaptable to relatively marginal soils and erratic rainfall, has high productivity per unit of land and labour and guarantees some yield even under the most adverse conditions [4].

Sweet potato is a good source of vitamin C and pro-vitamin A which can be substituted for maize in livestock production. *Ipomoea batatas* does not have the problem of anti-nutritional factors such as cyanides and oxalates that exist in cassava and cocoyam respectively [5]. Furthermore, its high yield potentials and short life cycle of less than 20 weeks make crops like yam (*Dioscorea spp.*) relatively poor competitors for general industrial starch.

Interest in sweet potato production in Nigeria is on the increase. This report is confirmed by FAO production year statistics (2009- 2011) which showed volume of sweet potato production (2,725mt); percentage of the total sweet potato grown in Nigeria (14.5%), sweet potato production per capita of 16.8 (kg/person), population density in 2011 (persons/sq. km) = 178, Area (1,000 ha)= 943 and estimated yield (tons/ ha)= 2.9. A research carried out in Africa shows that average yields on farmers' field (cultivable land size) are very low at 4-6 mt/ha and 2.9 mt/ha in Nigeria [6]. This can be attributed to increasing population, poor agronomic management practices, use of varieties with low yield potential, failure to plant on time, poor quality planting material, weevil infestation and rodents among others. International Potato Center [7] reported that sweet potato can easily yield in excess of 15 tons/ hectare under rain fed conditions if key recommended practices are used. This report is in line with Harvestplus [8] who reported that commercial growers of sweet potato in South Africa using best management practices produce 50mt/hectare.

Different varieties have been developed and being selected for different agro-economic conditions and uses. Sweet potato varieties differ from each other in many ways, including leaf shape and colour, vine structure, root shapes, root skin colour, flesh colour, taste, texture, dry matter content yield and resistance to pests and diseases [9]. According to [10], sweet potato has two broad categories: the staple type with white fresh and white or purple skin with high starch and dry matter content and the dessert type with orange flesh and orange skin with a high sugar and beta-carotene content among others. Investing in orange- fleshed sweet potato to improve food security resulted in a holistic approach to combating Vitamin A deficiency which also serves as food access among rural and urban consumers [11].

Sweet potato is traditionally used as boiled root tubers eaten with stew, boiled and pounded with either boiled or fermented cassava as dough or boiled or pounded yam. It is also dried and milled for sweetening of gruel (ogi) porridge, sliced into chips, dried and boiled with beans or vegetables,

sliced into chips and fried in vegetable oil and can also be processed into flour for sweetening kunu or pap. In addition, root tubers are boiled, sliced, sun-dried and used later as snacks, processed into flour for making buns, chin-chin, doughnut, noodles, alcoholic beverages, protein-enriched pulp and canned foods. Fawole [12] confirms that 72.2% of sweet potato farmers processed sweet potato into flour in Kwara State, Nigeria.

However, the National Root Crops Research Institute (NRCRI) since 1996 embarked upon regular and intensive campaigns aimed at training and educating farmers on the benefits of sweet potato production and processing to ensure their widespread and adequate adoption. The NRCRI programmed this in collaboration with the state ministries of agriculture through their respective ADPs, with farmers in the South-east agro-ecological zone as the initial targeted clients. The criteria used for breeding and selection of sweet potato roots have been based on parameters related to food preferences such as taste, texture, water and fiber content. Selection for industrial uses emphasizes canopy structure, root size and dry matter content. These research efforts have led to the introduction of improved varieties which are high yielding and tolerant to prevalent pests, notably sweet potato weevil (*Cylas spp.*) Technologies developed and disseminated for sweet potato processing include processing of sweet potato into dough flour under standardized practices, processing of unfermented sweet potato into flour and processing of sweet potato into starch [13].

Despite the growing importance and known potential such as food, animal feed and raw material; records of sweet potato processing in Nigeria's food system are scanty. There is urgent need to improve and document sweet potato 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.

This gave rise to these research questions that are necessary for this study. What is the relationship between socio- economic characteristics of processors and adoption of sweet potato processing technologies? What are the constraints to adoption of recommended sweet potato processing technologies?

Specifically, the study sought to:

i. Determine the relationship between socio-economic characteristics of processors and adoption of sweet potato processing technologies; and
ii. Identify constraints to adoption of sweet potato processing 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 04^0 45 and 06^0 07N and longitudes $07^0$10 and 08^0 10 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 AkwaIbom States respectively. It has a population of 2,833,999 people with 70% living in the rural areas [14]. 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 668mm. 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 seven extension blocks, respectively. The state is located between latitude $5^0$38N and $6^0$47N and longitude $6^0$36E and $7^0$21E. 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. It has 70% available land and less than 55% of the available land is under cultivation. The number of farm families was reported by [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 2300mm. 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 159mt [16].

The population of the study comprised all sweet potato processors in Abia and Anambra States, South-Eastern Nigeria. A total of 80 respondents were selected using a multi-stage sampling procedure. Stage 1 involved random selection of five local government areas 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 20 communities. Stage 3 involved random selection of 4 processors from each selected communities using simple random sampling techniques, giving a total sample size of 80 respondents used for the study.

Questionnaire was used to collect data for the study. Data were analyzed using mean score, standard deviation, factor analysis and multiple linear regression analysis.

3. RESULTS AND DISCUSSION

3.1 Relationship between Socio-Economic Characteristics of Processors and Adoption of Sweet Potato Processing Technologies

The regression of the independent variables (sex, educational level, marital status, processing experience and access to extension services) on adoption of sweet potato processing technologies by processors shows that a strong correlation (R=0.775) exists between dependent variables and independent variables (Table 1). These variables were able to explain 69% of the variation in adoption of sweet potato processing technologies among processors (R^2= 0.686). Adjusted R^2 also supported the claim with a value of 0.598 or 59.8%. This shows that the independent variables explain the behaviour of the dependent variable at 60.0% level of confidence.

Out of the eleven variables investigated, five variables were found to be statistically significant. They were sex, educational level, marital status, processing experience and access to extension services.

Sex: Sex had a positive influence on the adoption of sweet potato processing technologies in the study area. The implication of this could be that sweet potato processing activities is labour intensive and requires a substantial energy and time of which the majority of men could not cope with thus, confirming with the findings of [17] which described cassava processing as a token of femininity and contradicts the findings of [18] which described sweet potato processing as a token of masculinity.

Educational level: Education was another determinant of adoption of sweet potato processing technology and it was positively significant. Level of education increased the probability of adoption of sweet potato processing technologies. The level of education attained by a farmer not only increases his farm productivity but also enhances his ability to understand and evaluate information on new processing technologies [19].

Table 1. Regression analysis of the relationship between processors socio-economic characteristics and adoption of sweet potato processing technologies

	Unstandardized	Standardized Coefficient		
Variables	B	SD Error	Beta	T
Constant	67.034	20.382	-	3.289*
Age	-0.096	0.286	-0.038	-0.336
Sex	-0.733	0.166	-0.194	2.808*
Educational level	0.226	0.091	0.197	2.614*
Household size	-2.539	1.500	-0.191	-1.692
Marital status	3.242	1.648	0.238	1.967*
Processing experience	1.674	0.356	0.297	3.944*
Source of fund for take-off	0.470	0.503	0.112	0.935
Source of farm labour	1.635	0.407	0.462	3.908
Annual income	0.047	0.276	0.015	0.175
Membership of organization	-0.001	0.449	0.000	-0.003
Access to extension service	1.747	0.395	0.388	2.113*

$P \leq 0.05$, $R = 0.775$, $R^2 = 0.686$, Adjusted $R^2 = 0.598$

Marital status: Marital status was positive and significantly influenced adoption of sweet potato processing technologies in the study area. This implies that the contribution of explanatory variables is inversely proportional to dependent variables. Therefore, the more the number of married processor the higher the processing output thus, high adoption of improved technologies. On the other hand, it also shows that the lesser the number of married processors, the lower the sweet potato processing output and lower adoption. This is in agreement with the findings of [20] which stated that marital status of the respondents could mean that respondents are responsible, stable and have financial duties towards their family members more so, their family members could be vital sources of information on agricultural and non-agricultural activities that could be tapped by the respondents.

Processing experience: Years of processing experience was positive and significant in the study area. The high level of experience among the processors in Abia and Anambra States is expected to have a positive influence on adoption. This is in agreement with [21] who stated that the greater the years of processing experience, the greater the processors ability to manage general and specific factors that affect the processing business.

Access to extension services: Extension contact had a positive influence on the adoption of sweet potato processing technologies in the study area. This signifies that frequent contact

with extension workers by the processors helps them acquire more knowledge/ skills about the use of improved processing techniques to increase their production. Thus, frequent contact with extension workers aids processors to be aware of improved innovations and how to apply the stipulated standard to improve productivity.

3.2 Constraints to Adoption of Sweet Potato Processing Technologies

Data in the Table 2 indicate that the processors were mostly constrained by inadequate processing machines ($\bar{x}$ =2.88), high cost of processing produce ($\bar{x}$ =2.86), inadequate knowledge of modern sweet potato processing techniques ($\bar{x}$ =2.84), inadequate capital for start-off ($\bar{x}$ =2.84), high cost of labor ($\bar{x}$ =2.83), poor credit facilities ($\bar{x}$ =2.80), scarcity of processing materials like sweet potato tubers ($\bar{x}$ =2.43), low level of formal education ($\bar{x}$ =2.14), poor processing skill ($\bar{x}$ =1.80) and difficulty in formation of cooperatives ($\bar{x}$ =1.61). The minor constraints included poor extension delivery ($\bar{x}$ =1.45) and lack of markets for produce ($\bar{x}$ =1.09). The major constraints associated with adoption of sweet potato processing technologies as indicated by the processors is a clear indication that these factors constrained the processors from adopting improved processing technologies in the study area. Therefore, provision of affordable and appropriate sweet potato processing machines can lead to reduction in food wastage, enhanced food

security, improvement in livelihood of low income groups and empowerment of women in the study area. This is because absence of efficient processing machine/ equipment, poor knowledge of modern processing technique among others results in disposing of products immediately after harvest. This assertion is in agreement with [22] who reported that beside the low production, the low use of processing technologies affects women processors in Nigeria. This buttressed the previous study of [23] that inadequate finance and processing equipment were the major problems that affected women cooperatives in cassava processing in Anambra State, Nigeria.

3.3 Factor Analysis of Constraints to Adoption of Sweet Potato Processing Technologies

Table 3 shows the results of the rotated factor analysis indicating the extracted factors based on responses of the respondents on constraints to adoption of sweet potato processing technologies. The constraints to adoption of sweet potato processing technologies were factor 1 and factor 2 which were named technical and infrastructural factor respectively.

Table 2. Distribution of respondents according to constraints to adoption of recommended sweet potato processing technologies

Constraints	Mean ($\bar{x}$)	Standard Deviation
Inadequate processing of machines/equipment	2.88*	0.333
High cost of processing produce	2.86*	0.347
Inadequate knowledge of modern sweet potato processing techniques	2.84*	0.371
Inadequate capital for start-off	2.84*	0.371
High cost of labour	2.83*	0.382
Poor credit facilities	2.80*	0.403
Scarcity of processing materials like sweet potato tubers	2.43*	0.839
Low level of formal education	2.14*	0.978
Poor processing skills	1.80*	1.163
Difficulty in formation of cooperatives	1.61*	0.879
Poor extension services delivery	1.45	0.501
Lack of markets for products	1.09	1.105

*$\bar{x}$ ≥1.5 major constraint**

Table 3. Factor analysis of constraints to adoption of sweet potato processing technologies

Processing constraints	Factor 1 (Technical factors)	Factor 2 (Infrastructural factors)
Low level of formal education	0.457	0.641
Inadequate capital for start-off	0.956	0.104
Inadequate knowledge of modern sweet potato processing techniques	0.956	0.104
Inadequate processing machines/ equipment	-0.316	0.923
High cost of labour	0.924	0.126
High cost of processing produce	-0.308	0.914
Poor credit facilities	0.910	0.094
Poor extension services delivery	-0.534	-0.639
Difficulty in formation of cooperatives	-0.161	-0.789
Poor markets for products	0.645	-0.203
Poor processing skill	0.737	0.106
Scarcity of processing materials like sweet potato tubers	-0.341	0.107

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

Technical constraints included inadequate capital for start-off (0.956), inadequate knowledge of modern sweet potato processing techniques (0.956), high cost of labour (0.924), poor credit facilities (0.910), lack of markets for products (0.645) and poor processing skills for start-off as a barrier in adopting sweet potato processing technologies in the study area. This is in line with [24] who stated that adoption of any crop-based technologies require substantial amounts of funds to purchase the needed equipment/ machines. However, there is no doubt that this constraint is responsible for poor adoption of sweet potato processing technologies observed in the area.

Infrastructural constraints included inadequate processing machines/equipment (0.923), high cost of processing produce (0.914) and difficulty in formation of cooperatives (0.789). This implies that poor infrastructural development affects the processors' decision to adoption of sweet potato processing technologies. The implication of this result is that the processors have no access to credit facilities which enhance their adoptive capacity to sweet potato processing technologies disseminated by extension agents in the study area. This finding is not in accordance with [25] who stated that farmers belonging to a cooperative society will likely be exposed to the adoption of new technologies in their area.

4. CONCLUSION AND RECOMMENDA-TIONS

Findings of the study revealed that sex, educational level, marital status, processing experience and access to extension services had significant relationship on adoption of sweet potato processing technologies. Constraints to adoption of sweet potato processing technologies were inadequate processing machines/equipment, high cost of processing produce, inadequate knowledge of modern sweet potato processing techniques, inadequate capital for start-off, high cost of labour, poor credit facilities and scarcity of processing materials like sweet potato tubers.

The study recommended that processors should be encouraged to form cooperative society to enable them to pool their resources together to obtain credit facilities and sweet potato labour saving processing technologies in order to increase productivity. There is also a need for creation of awareness by extension agents, public health agencies, nutritionists and non-governmental organizations on the usefulness of orange fleshed sweet potato in addressing vitamin A Deficiency Syndrome.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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