Direct Research Journal of Agriculture and Food Science
Vol.7 (8), pp. 215-221, August 2019
ISSN 2354-4147
DOI: https://doi.org/10.5281/zenodo.3361292
Article Number: DRJAFS3390115742

https://directresearchpublisher.org/drjafs/

Full Length Research Paper

Socio-economic determinants of yam post-harvest losses among farmers in Wukari local government area of Taraba State, Nigeria

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Received 2 July 2019; Accepted 29 July, 2019

The study determines yam post-harvest losses among farmers in Wukari, Taraba State, Nigeria and specifically the objectives were to describe the socio-economic characteristics of the respondents and determine the factors that cause yam post-harvest losses in the study area. Data were collected through primary sources and analyzed using descriptive statistics and multiple regression. The respondents socio-economic characteristics showed that all the respondents had one form of education or the other, 94% of them were less than 60 years of age, 91% of them were households head, 67% had less than 5 members in their households and 66% were male. The results of the multiple regression showed that R-Squared value was 0.85 indicating that the explanatory variable explained 85% of changes in the dependent variable. The F-ratio was high and significant at 1% depicting goodness of fit of the model used. Household size, education level, years of experience, number of yam tubers stored and methods of yam storage were positive and significant at 1% level, while duration of yam storage was negative and significant at 1% level. It is recommended that research institutes should be encouraged to research into ways by which the natural phenomena causing deterioration in yam could be prevented and controlled, modern storage facilities should be made available for the farmers in order to reduce level of loss in yam storage and prices of yams should be standardized based on measurable scale.

Keywords: Determinants, post-harvest, losses, yam, storage

INTRODUCTION

Yam tuber is a major food crop in many tropical countries in which Nigeria is one, world production of yam is averagely 20 million tons per annum, about half of this total being derived from the *"Yam Zone"* of West Africa. This belt extending over both high forest and Guinea savannah countries from the central Ivory Coast to the Cameroon mountains and the remaining from various parts of South East Asia; India, Indonesia, Oceania and the Caribbean area (Coursey, 1968). The author added that like many other tropical food crops, yam is still cultivated largely by peasant farmers, usually in small quantities, using the traditionally crude methods; use of local tools and family labour. Although some varieties of yam are capable of yielding heavily; (10 or more tons/acre) but under these crude methods, yields are extremely poor with about only three tons//acre and even below. The cost of yam production, in terms of labour requirement is exceedingly high, when compared, with potato production in European axis of the world.

Production of yam using existing crude, traditional techniques, involving small capital investment is only economical where the labour force's standard of living is low. It may be noted that in Trinidad, where yam have long been a staple food, it can no longer compete in price with potatoes imported from Europe during the greater part of the year (Chapman, 1965). The author also reveals that, from this trend it appears likely that a similar situation could develop in West Africa in the near future. Already, yam in urban markets in both Ghana and Nigeria fetch a price comparable with that of potatoes in Europe.

Also, if yam production is to continue to be feasible in the changing socio-economic matrix (economic diversification) of the present day, much is needed to be done in the area of improvement in traditional cultural techniques, the selection and breeding of better varieties, other agricultural changes, in particular through scale mechanization and modern technology.

The varieties of yam cultivated in Africa are mostly *Dioscorea rotundata* (white yam), *Dioscorea cayenensis* (yellow yam) and *Dioscorea alata* (water yam). Yams reach maturity after about 6 to 9 months of planting and have a dormant period of about 3 to 6 months, depending on variety, yam have high moisture content of about 90% . This cumbersome product, fragile and variable in shape, is damaged at all stages in the post-harvest handling chain, causing losses of up to 30% within three months. These constraints linked to the characteristics of yam make it difficult to process and market fresh products in urban areas. Despite several attempts at processing, often crude method, the technology for adding value to these products remains under exploited (Aliou, 1995). According to Aliou (1995) the conditions of temperature and humidity are practically the same as the ambient air outside and thus, are not really favourable for storage. Literature reveals that there is a designed ventilated cellar for yam storage. The cellar measures 2.9 m long by 1.3m wide and 1.5m deep in which the roof is in the shape of a cupola, protects the cellar against penetration of rain water. Grilled openings and a chimney in the centre, improve the ventilation level. The chimney accentuates air movement.

In every method of yam post-harvest handling, there are various damages that are involved. Yam can be kept for long periods without elaborate precautions or pest control measures, under the conditions of a tropical peasant's farm, without total loss occurring. Meanwhile, some experiments Anon, (1937) and Coursey (1967) reveals that very substantial losses in weight of the yam occur during storage, even when any form of physical damage does not afflict the tubers. These weight losses, although arising in part from simple moisture losses through transpiration, also involve a major destruction of dry matter of food material as a result of the natural metabolic processes of the dormant tuber.

Recently a pre-harvest disease caused by a virus, has been reported in Barbados as causing lesions in the tubers which become progressively more severe during post-harvest storage (Harrison, 1966). Therefore, other damages that confronts yam post-harvest which result to economic implication on peasant farmer’s storage are transportation, treatment, processing, conservation and marketing of food products (Davies, 2009).

Post-harvest storage losses have been of concern even to the United Nations that brought it to international focus when it was declared in 1975 that “further reduction of post-harvest food losses in developing countries should be undertaken as a matter of priority” (Food and Agricultural Organization and United Nations Environmental Protection, 1981). This led to many national governments to take more seriously the problems of storage of agricultural produce. The losses associated with this crop limit the potential income of farmers, threatens food security and exacerbates conditions of poverty among rural households, whose income streams depends on the ability to store excess farm produce for off season supplies (Ntiokwana 1999). Although farmers have been known to practice indigenous storage of farm produce, these have been known to be less effective compared to modern storage methods. According to Tyler (1982), farm produce stored under the traditional system has the potentials for greater post harvest losses.

Nahanga and Vera, (2014) in their study of yam production as a pillar of food security in Logo Local Government Area, Benue State, Nigeria reveals that the socio-economic characteristics of the respondents in respect to their age, gender, marital status, household size, educational status, farm size, years of farming, access to finance, access to inputs were major factors influencing yam storage in the study area. Characteristics of the household head such as age and farming experience imply farming knowledge gained over time (Martey *et al*., 2012) and are important in post-harvest handling. Babalola *et al*. (2010) argued that age is a very important demographic characteristic because it determines both the quantity and the quality of the labour force. Martey *et al*. (2012) further argued that older farmers are expected to use their farming experience to decide to adopt better technology. More experienced farmers are expected to have minimal post-harvest losses as compared to the inexperienced individuals.

The intended final use of yam produce is a principal factor in the determinants of the type of storage system to be used. The structures used for the storage of yam tubers are numerous. Some of the storage structures include trench or clamp silos, underground pits, barns of various designs, shelves in specially constructed or improvised sheds, raised huts, and assorted platforms. The popularity of these structures varies from one region to another, and the choice made depends on the volume to be stored and what the farmer can afford (Mijinyawa and Alaba, 2013). Yams for planting are usually stored fresh with those meant for consumption either kept fresh or processed into chips or flour and stored dry. An attempt of reducing post-harvest losses and long storage, the yam barn presents the best results in comparison to other storage systems in West Africa. Improved technologies tend to provide protection and increase the useful shelf life of the produce in the structures. Without totally changing the type of storage, some precautionary measures can be added to the construction aid an improvement barn condition (Knoth, 1993). Effective yam storage requires the selection of healthy, sound tubers, carrying out effective curing procedure and if possible the application of fungicide, regular inspection or monitoring may also be carried out to detect the presence of destructive rodents as well as eliminate direct sun rays and excessive rainfall (Umogbai, 2013).

Tubers of yam are most effectively stored in environments that are cool but dry and well ventilated, Temperatures ranging from 12^o C to 16^o C are recommended for effective storage of fresh tubers of yam in ambient and/or refrigerated environments. Temperatures of 15^o C or 16^o C with relative humidity of 70% to 80% are as well recommended for cured yams (Cooke *et al.,* 1988; Opara, 1999). Most edible yams species reach maturity in 8 to 11 months after planting. As a seasonal crop, harvested yam tubers are stored to meet the demand during the off-season period. Ventilation prevents the condensation of moisture on the surface of tubers and helps in the removal of heat as a result of respiration. Low temperatures are necessary for the reduction of storage losses resulting from respiration, sprouting and rotting. Additionally, regular inspection is very vital in combating sprouting and tuber rots as well as monitoring of the incidence of pests such as rodents among others. Storage conditions for yam should be such that they will considerably slow down the process of sprouting as this will significantly increase the respiration rate within the produce leading to the shrinking and deterioration of the yams, the shelf or storage can be considerably improved under such environment (Opara, 1999).

Microorganisms thrive in conditions where they can survive and therefore such conditions must not be established as much as possible. Moisture, temperature, relative humidity and soil type are the major factors which influence the development and growth of these microorganisms (Kay, 1973). Effective yam storage requires the control of moisture within the storage environment to a suitable level so it does not trigger other factors. Additionally, the soil type may be considered in instances of underground storage. Considerable variations exist in storing different varieties of yam. *D. alata* is extremely difficult to keep for long than *D. rotundata*. Under high storage temperatures (16°C and above) and relative humidity (85% and above) sprouting and decay occur in water yams (*D. alata*) as compared to *D. rotundata* (white yam). However, at high temperatures and lower humidity the case is the same since water yam has high moisture or water content compared to the *D. rotundata*. Water yam will therefore require lower temperatures and humidity to be stored effectively. For instance, burying water yam inside the ground and covering properly with earth can help it last for few weeks until is ready for use (Maduewese and Onyike, 1981).

There are numbers of post-harvest problems and implication connected with yams, which affects the economy of the peasant farmers. These problems have up to date received much less attention than their magnitude appears to warrant. Damages due to post-harvest rot significantly affect 'farmers' and 'sellers' income, food security and seed yams stored for planting. The quality of yam tubers is affected by rots, which makes them unappealing to consumers (Zaknayiba and Tanko, 2013). In other words, yams damages due to rots as a result of poor storage will affect its availability, food security and revenue of farmers and traders (Akangbe, 2012). However, according to Burton (1970), the damages on yam experienced by the peasant farmers in the post-harvest period have a great economic implication in the aspect of improving their production from small scale farming system to large scale. Burton, (1970) holds the view that; the damages done on yams during post-harvest reduce both quality and quantity of yam, which affect its seeds and even the marketed surplus. The affected seed yams restrict the peasant farmers from expanding their farms in the coming years due to inadequate seed yams.

On the other hand, they ones that will be taken to the markets will attract low price; which affects the farmers income that is supposed to be used in modernizing and expanding their production.

Also, the intention of many peasant farmers was not only to expand their farms, but to also diversify his business. The losses during post-harvest has always made them handicap to plough back (Akangbe, 2012). The storage of yam tubers has been confronted with major problems over the years. Physiological and pathological factors contribute to yam losses in storage (Ravi and Aked, 1996; Kader, 2005; Imeh *et al*., 2012). According to Marcotte *et al*. (2005), Osunde, (2008) and Imeh *et al*. (2012), physiological activities in yam that lead to post-harvest losses are transpiration and respiration which in turn contribute to weight loss and sprouting.

Pathogenic causes of postharvest yam deterioration include mould and bacterial infections (Green and Simons, 1994; Dumont, 1995). Physiological activities taking place in yam tubers in storage may bring about some changes in their internal composition, resulting in loss of nutritional qualities (Serge and Agbor-Egbe, 1996; Afoakwa and Sefa-Dedeh, 2001; Osunde, 2008), can cause 10% losses within 3 months and up to 25% losses in 5 months (Robertson and Lupien, 2008). According to Ezeh (1995), significant causes of postharvest losses, are weight loss, insect attack, microbial infection and sprouting. Sprout development is a major cause of storage losses (osunde, 2008).

However, the peasant farmers in wukari local government area are not exceptional of the challenges of post-harvest storage of yam.

Therefore, it is on this premise that, this research seeks to look into determinants of yam tuber post-harvest losses among yam farmers in Wukari, Taraba State, Nigeria and specifically to identify the socioeconomic characteristics of the respondents and determine the factors affecting yam storage in the study area.

METHODOLOGY

Study area

The study was conducted in Wukari local government area of Taraba State. Wukari local government was the headquarters of the historically famous Kwararafa Confederacy. Wukari is a multi-ethnic area, predominated by the Jukun people who are also call Wapan, with the composition of other major ethnic groups as Ichen, Kpanzon, Chamba, and Kutebs. Other ethnic groups that settled within the town and its environs are the Tiv, Hausa, Fulani, Yoruba, Igbo and others. The Wukari people are predominantly farmers, hunters and partly fishermen, while some are civil servants (Anyeze, 1983). Geographically, Wukari local government is situated in the southern part of Taraba state. Ibi local government area borders it to the north, east by Gassol local government area, from the south by Donga local government area of Taraba State, and to the west by Ukum local government area of Benue State. The local government area has a total area of 4,308 km^2 (1,663 Square mile), located between latitude 7°51′ N 9°47′ E and longitude 10° E and 12°E. According to 2006 National population Census figures, Wukari has a population of 241,546 people (Danjuma, 2005), projected to 350,731 people in 2017. Wukari lies on the Guinea Savannah zones vegetation, which is marked by mainly forest and tall grass. The plain and fertile land and the consistent annual flood of the rivers and streams within the area make the land conducive for seasonal farming and grazing, and all seasons fishing. These activities informed the distribution of cultural and natural resources of the area, and also make Wukari a very rich agricultural land. The land is suitable for the cultivation of both arable and perennial crops such as yam, cassava, rice, sorghum, maize, millet, groundnut, cowpea, beans, banana, coconut, fruit trees, and vegetables, as well as animals such as cattle, sheep, goats and pig among others. It is also blessed with large volume of mineral deposits such as salt lead, zinc, limestone and others all untapped (Danjuma, 2005).

Sampling procedure

Purposive multistage random sampling technique was adopted in sampling of the respondents. In the first stage, five wards that were predominantly rural farming communities (Chunku, Akwana, Rafin-Kada, Kente and Tsukundi) was purposively selected from the ten wards in the local government area and in the second stage two villages were randomly selected and lastly, 12 respondents were randomly selected in each village to make a total of 120 respondents. However, 155 questionnaires were retrieved and used for the analysis for this study.

Data collection

This research focuses only on primary data that was generated by using structured questionnaires developed by the researchers was administered to the respondents in the study area. In this regard, the data was generated elicits answers on the objectives of this study.

Model specification

Both simple descriptive statistics and multiple regression analysis were used in analyzing data for the study.

Multiple regression

The multiple regression analysis was used to determine the factors influencing yam post-harvest storage in the study area. Hence different functions were fitted. The best regression fit was determined by combinations of criteria of the higher adjusted coefficient of multiple determine (R^2), the level of significance of the overall equation (F – statistics), the level of significance of each coefficient (T-Statistics) and the correct signs of the coefficient relative to *a priori* expectations. The multiple regression was represented explicitly as follows:

$Y=F(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, u_i)$

Where

Y = Kilograms of yam tubers sold
X_1 = Age in years
X_2 = Marital status (0=Single, 1=Married)
X_3 = Years of farming experience
X_4 = Number of years attained in formal education
X_5 = Household size in number
X_6 = Number of yam tuber stored initially
X_7 = Method of yam tubers grading
X_8 = Duration of yam tuber storage in Weeks
X_9 = Method of Yam tuber storage (Modern=1 and Traditional =2)
u_i = Error term.

The following functional forms were tested;

$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4 X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + U_i$ (Linear)

$Y = b_0 + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 + b_4\log X_4 + b_5\log X_5 + b_6\log X_6 + b_7\log X_7 + b_8\log X_8 + b_9\log X_9 + U_i$ (Semi log)

$\log Y = b_0 + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 + b_4\log X_4 + b_5\log X_5 + b_6\log X_6 + b_7\log X_7 + b_8\log X_8 + b_9\log X_9 + U_i$ (Double log).
$\log Y = b_0 + b_1x_1 + b_2X_2 + b_3X_3 + b_4X_{4+} + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + U_i$ (exponential).

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

Table 1 showed that Majority (94%) of the respondents were less than 60 years of age, and only 6% of the respondents were above 60 years. This indicates that most of the respondents were in their active age to engage in yam storage that requires physical strength and time to be achieved. 66% of the respondents were male, while 34% respondents were female. The majority of the male respondents implied that they are usually head of households in African context, having a lot of responsibilities that makes them to engage in such activities as farming and storage that will earn them income to meet the basic demand of their respective family members. Majority (91%) of the respondents were household heads, while only 9% respondents were not household heads. Most of the respondents were household head because they are the ones saddled with the responsibility of providing food in their respective homes. 67% of the respondents were less than 5 in number, while 33% of the respondents' household size is from 5 above in number. This indicated that most of the respondents fall within the household size of less than 5 in number because most of them have only one wife. Majority (65%) of the respondents attended the basic education of primary and secondary, while 35% of them had education beyond secondary education. This depicts that majority of the respondents did not further their education to the post-secondary education which is likely because of lack of resources to cater for their education which they involve themselves in such activities of yam storage to boost their income.

Factors influencing yam tubers post-harvest losses

Four functional forms of multiple regression; Linear, Semi-log, Exponential and Cob-Douglas were tested. Out of the four forms, Cob-Douglas functional form model was chosen and considered as the best fit for this study as presented on (Table 2). The R-Squared (R^2) value was 0.85 indicating that the explanatory variable explained 85% of changes in the dependent variable. The F-ratio was high (135) and significant at 1% depicting goodness of fit of the model used. Household size, education level, years of experience, number of yam tubers stored and methods of yam tubers storage were positive and significant at 1% level, while duration of yam tubers storage was negative and significant at 1% level. However, age, sex and method of yam tuber grading were insignificant at conventional level. The household size was positive and significant at 1% with coefficient of 0.11. This indicates that for any additional member in the household there will be an increase of yam tubers output by 0.11 kg after storage. This implies that the more the household size the more the hands to inspect the yam tubers and also participation in removing sprouted stems from the yam tuber and sanitizing the storage environment, as sprouting reduces quality and quantity of the yam tuber and unclean environment will attract pest and diseases. The educational level was positive and significant at 1% with coefficient of 0.11. This shows that an additional year in formal education by respondent will increase output by 0.11 kg of yam tubers after storage. This depicts that their level of education improves their basic knowledge of yam storage and how to avoid damages and subsequently reduction in yam tubers value. The years of experience in yam tubers storage was positive and significant at 1% with coefficient of 0.26. This indicates that for any additional year of experience by a respondent will increase yam tubers output by 0.26 kg of yam tubers after storage. This implies that, the more the experience in yam tubers storage the more the chance to remedy mistakes done in previous experience through continuous practices, which increases efficiency and effectiveness in yam tubers storage. The numbers of yam tuber stored initially was positive and significant at 1% with coefficient of 0.36. This shows that, for additional yam tuber stored, it will increase 0.36 kg of yam tubers after storage. This portrays that the more yam tubers a respondent store, the more output was realized after storage. The duration of yam tubers storage was negative and significant at 1% with coefficient of (-0.21). This suggests that, for any additional week of yam tuber in storage facility will reduce yam output by 0.21 kg. This show that any extension of time period of yam tuber in the store will reduce the value after storage as yam tuber is contain 70% which reduces both quality and quantity of yam tuber after storage. In addition the longer the storage period, the more susceptible is the yam tuber to sprouting and pests/diseases. The effectiveness of the method of yam tuber storage was positively significant at 1% with coefficient of 0.20. The result shows that for a shift of respondent from traditional method to modern method there will be increase yam tuber by 0.20 kg. This implies that modern storage system which is technologically inclined is capable of preserving yam tubers in store than the traditional method using crude tools and equipments.

Conclusion and recommendations

It is concluded that socio-economic factors such as household size, education level, years of experience, number of tubers stored, duration of yam tubers storage and method of yam tuber storage are major factors that influence value of yam storage in the study area. In order to enhance better yam storage strategies among farmers in Wukari Local Government, Taraba state, Nigeria and other like communities, the following recommendations were made:

Table 1. Socio-economic characteristics of respondents.

Item	Frequency	Percentage	Mean
Age (Years)			
< 30	40	34.78	
30 – 45	32	27.83	
46 – 60	36	31.30	
> 60	7	6.09	
Total	115	100	31.2
Sex			
Male	76	66.09	
Female	39	33.91	
Total	115	100	
Household head status			
Not Household Head	10	8.70	
Household Head	105	91.30	
Total	115	100	
Household Size (Members)			
< 5	77	66.95	
5 – 10	31	26.96	
> 10	7	6.09	
Total	115	100	3.6
Education			
Primary	30	26.09	
Secondary	45	39.13	
Post-Secondary	40	34.78	
Total	115	100	

Source: Field Survey, 2018

Table 2. Result of multiple regression analysis of factors affecting yam tuber storage in study area.

Variable	Coefficient	t – Value
Constant	9.02	
Age (X_1)	-0.03	-0.89
Sex (X_2)	0.02	0.57
Household size (X_3)	0.11	3.09***
Level of education (X_4)	0.11	3.32***
Years of experience (X_5)	0.26	7.17***
Number of yam tubers stored (X_6)	0.36	8.10***
Method of yam tubers grading (X_7)	-0.04	-1.33
Duration of yam tubers storage (X_8)	-0.21	-6.36***
Method of yam tubers storage (X_9)	0.20	5.40***
R^2		0.85(85%)
F-Ratio		135***

***1% Level Significance
Source: Field Survey, 2018

(i) There should be capacity building for all extension functionaries so as to make them highly responsive to the task of disseminating technical information on improved variety, improved storage practices and new storage facilities.
(ii) Research institutes should be encouraged to engage into researches that will make a way in which the natural phenomena causing deterioration in yam tubers could be prevented and controlled.
(iii) Modern storage facilities should be made available for the farmers in order to reduce level of loss in yam tubers storage.

Authors' declaration

We declared that this study is an original research that was carried out by our research team and we agreed to publish it in the journal.

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