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Improve storage of yam tubers as a solution to household food insecurity in Oyo and Benue States, Nigeria

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Abstract

Effective crop storage plays an integral part in ensuring domestic food supply at household level, smoothing availability into the off season. This study investigated the time value addition of yam storage and its implication on household food security in Benue and Oyo States, Nigeria. The Yam Improvement for Income and Food Security in West Africa (YIIFSWA) project data was used. A total of 180 yam farmers from Benue and Oyo States, Nigeria were used for this study. Data were analyzed using descriptive statistics and the Logistic model. The Logistic regression results revealed that the number of months of storage of yam tubers and whether the household stored food or not were significant and positively related food security. Other factors that negatively affect household food security are losses due to sprouting and household size. The study recommends that the government should introduce and provide improved yam storage methods to farmers growing yams so as to increase the shelf life of yam, smoothing consumption and make available seed yam for the next planting season.

Keywords- Yam, Time value addition, storage efficiency, household food security, logit model

Introduction

Yam remains an important food security crop and is integral to the socio-cultural life in West Africa (IITA, 2012). It is estimated that about 48 million tonnes are produced annually in the sub-region with major producing countries being Bénin, Côte d'Ivoire, Ghana, Nigeria, and Togo as they account for 93% of total global production (FAO, 2013). Nigeria alone accounts for 68% of global production. As reported by Akanji *et al.*, 2003, major producers of yam in the country include Adamawa, Benue, Cross River, Delta, Edo, Ekiti, Imo, Kaduna, Kwara, Ogun, Ondo, Osun, Oyo, and Plateau. Yam is therefore an important food security crop, as the mainstay for at least 60 million people, generating income on which 31.8% of the population depends, at domestic retail price of US$0.49/kg for the 36 million tons produced in Nigeria (IITA 2012).

Almost 805 million people in the world have faced a daily challenge of accessing food in sufficient quantities for their dietary needs and most of them (791 million) reside in developing countries (WFP, 2014). Nearly one in every four persons in Africa is living with some degree of food insecurity, with Sub-Saharan Africa having the largest concentration (FAO 2014). According to Akinyele, (2009) and Adepoju *et al*., (2015), a high proportion of households in rural Nigeria are food insecure and Nigeria's progress in reducing hunger and food insecurity remains very slow (IFPRI, 2009).. One of the important sources of food insecurity in Africa has been attributed to

pre and post-harvest food losses, which AMCOST, (2006) estimated to be about 10% higher than the global average of 130 million. There are claims that post-harvest losses in yam is as much as 20% due to pest attack in storage, but it has been difficult to actually quantify these losses (Sauphanor and Ratnadass 1985 cited by FAO 1998). Rot is also a major factor limiting the time value of yams and losses due to it can be very high. These losses significantly affect farmers' and traders' income, food security and quality of seed yams stored for planting. (Okigbo and Ikediugwu, 2002; Aidoo, 2007).

Storage facilities can contribute to food security in multiple ways. They can reduce post-harvest losses, thereby increasing the amount of food available for consumption by farmers and poor rural and urban consumers. This can benefit consumers as produce may not be too highly priced and it can create employment and thus income and better food security (Kiaya 2014). Effective crop storage therefore plays an integral part in ensuring domestic food supply at household level by smoothening seasonal food production.

This study examined the time value addition to yam through storage as a solution to household food insecurity in Oyo and Benue States, Nigeria. Specific objectives were to:

a. identify the various methods of yam storage.
b. investigate yam storage efficiency
c. estimate the household food security status.
d. determine the effect of yam storage on household food security.

Methodology

Study Area

Oyo state, Nigeria is an inland state in the derived savannah agro-ecological zone of the country, with its capital in Ibadan, located in the South West region of Nigeria. It's coordinates lies between 8°00'N and 4°00'E.The climate is equatorial, notably with dry and wet seasons with relatively high humidity. The average daily temperature ranges between 25 degree Celsius (77°F) and 35 degree Celsius (95°F) almost throughout the year. Benue State, Nigeria is one of the six states constituting the North Central region of Nigeria. The State is situated within the middle belt of Nigeria. It's coordinates lies between 7°20'N and 8°45'E The average daily temperature ranges between 21 degree Celsius (70°F) and 37 degree Celsius (99°F) almost throughout the year.

Type and Source of Data

The Yam Improvement for Income and Food Security in West Africa (YIIFSWA) project data collected was used for this study. The YIIFSWA (Yam Improvement for Income and Food Security in West Africa) project is an R4D project of IITA. The project is funded by the Bill & Melinda Gates Foundation and executed in Nigeria and Ghana by IITA in partnership with a consortium of national and international R4D agencies and in collaboration with service provider organizations, the private sector, farmers, and yam traders.

Analytical techniques

Descriptive statistics was used to describe the socio-economic characteristics of yam households and identify the various yam storage systems used by yam farmers. Yam storage efficiency was measured using storage length and losses during storage (including quality deterioration).

Food security status of yam farming households by FGT- Measure

The food security status of yam farming households was estimated by adapting the class of decomposable poverty measures by Foster, Greer and Thorbecke (FGT). They are widely used because they are consistent and additively decomposable (Foster *et al*., 1984). It is a generalized measure of food security status that measures the outfall from the food insecurity line and it is usually weighted by a food insecurity aversion parameter (α).

The formula for FGT is given by:

$$FGT\alpha = \frac{1}{N}\sum_{i=1}^{H}\left(\frac{z-yi}{z}\right)\alpha \qquad (1)$$

z: an agreed upon food insecurity line (using Moderate food insecure: two-third of mean per capita food consumption expenditure of respondents); N: total number of respondents in the study; H: number of food insecure (those with per capita food expenditure at or below z); yi: individual household per capita food expenditure; α: sensitivity parameter and could be set at 0, 1 and 2.

Logit Regression

The logit regression was used to examine the effect of the yam storage methods on household food security. The logistic model formula is as follows:

$$P = Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_n X_n \ldots\ldots (1)$$

The variable Z is the dependent variable which takes the value of 1, if household is food secure and 0 if food insecure.

$$Y_i = x_i\beta + \mu_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:y_i: denotes the dichotomous qualitative variable; x_i: denotes the vector of predictor variables; β: denotes vector of parameters; μ_i: denotes the residuals (errors)

The predictor variables are: X_1 = Age of respondent (years); X_2 = Household size (number); X_3 = yam farming experience (years); X_4= percentage loss in storage due to sprouting (%); X_5 = percentage loss in storage due to rotting (%); X_6 = Number of months of yam storage; X_7 = Storage status (1= household stores yam and 0 otherwise).

Results and Discussion

Socio-economic characteristics

The socio-economic characteristics of yam farmers in Benue and Oyo States, Nigeria are presented in Table 1. As typical in African farm households, males constitute over 95% of the household heads across the states considered. This might be because of the intensive labour requirements associated with yam production such as heap making, staking etc. Majority of the farmers are between the ages of 41-60 years, constituting about fifty one percent among sampled households with more proportion of yam farmers in this category in Oyo State (66.7%). The mean age of yam farmers was 48.29±13.58 years. It is evident that most farmers are in their active working age and this enables them to cope with the rigours in yam production. Majority of these yam farmers are married with an average of 8.4 years of education. The years of education is higher in Benue state (10.58±4.32 years) than Oyo state (4.02±4.942 years). More than half of the yam farmers in Oyo state have no formal education (51.7%) and 49.2% have secondary education in Benue state. This reveals the poor literacy level of yam farmers in both states. There is need for increased literacy among household heads and also access to education beyond secondary level. About 72.8% of respondents have at least seven household members across both states. The mean household size was higher for Benue state (10.66 ±7.403) than in Oyo state (7.52±3.311).This implies that the large households in both states can serve as a good source of family labour supply. The average number of years of yam farming was about 25.19±13.01 years in Benue state and 24.28±9.83 years in Oyo state. Majority of yam farmers do not belong to farmer's association (55.6%) across sampled states with exactly half of yam farmers in Oyo states who do not belong to farmer's association.

Table1: Socio-economic characteristics of Yam farmers

Characteristic	Pooled (N=180)	Benue (N=120)	Oyo (N= 60)
Gender			
Male	174 (96.7)	114 (95.0)	60 (100.0)
Female	6 (3.3)	6 (5.0)	-
Age (years)			
<=20	2(1.1)	1 (0.8)	1 (1.7)
21-40	56 (31.1)	42 (35.0)	14 (23.3)
41-60	92 (51.1)	52 (43.3)	40 (66.7)
61-80	28 (15.6)	23 (19.2)	5 (8.3)
81 and above	2 (1.1)	2 (1.7)	-
Mean±SD	48.29±13.58	48.18±14.971	48.52±10.359
Marital status			
Single	7 (3.9)	3 (2.5)	4 (6.7)
Married	172 (95.5)	116 (96.7)	56 (93.3)
Widowed	1 (0.6)	1 (0.8)	-
Years of Education			
No education	36 (20.0)	5 (4.2)	31 (51.7)
1-6	38 (21.1)	21 (17.5)	17 (28.3)
7-12	66 (36.7)	59 (49.2)	7 (11.7)
13-18	39 (21.7)	34 (28.3)	5 (8.3)
19-24	1 (0.6)	1 (0.8)	-
Mean±SD	8.39±5.48	10.58±4.319	4.02±4.942
Household size			
1-3	8 (4.4)	3 (2.5)	5 (8.3)
4-6	41 (22.8)	22 (18.3)	19 (31.7)
7-9	57 (31.7))	36 (30.0)	21 (35.0)
>=10	74 41.1)	59 (49.2)	15 (25.0)
Mean±SD	9.6±6.5	10.66 ±7.403	7.52±3.311
Farming experience (years)			
1-10	24 (13.3)	19 (15.8)	5 (8.3)
11-20	56 (31.1)	37 (30.8)	19 (31.7)
21-30	56 (31.1)	29 (24.2)	27 (45.0)
31-40	30 (16.7)	23 (19.2)	7 (11.7)
41-50	7 (3.9)	5 (4.2)	2 (3.3)
51 and above	7 (3.9)	7 (5.8)	-
Mean ± SD	24.89±12.02	25.19±13.012	24.28±9.827
Membership of farmer's association			
Yes	80 (44.4)	50 (41.7)	30 (50.0)
No	100 (55.6)	70 (58.3)	30 (50.0)

*Figures in parenthesis are percentages

Methods of yam storage

Table 2 presents the profile of the different yam storage methods employed in the study area. The traditional room storage is the predominant yam storage method used in both states although the percentage was higher in Benue state (74.2%) than in Oyo state (28.3%). This is followed by "yam barns in compound" method constituting about 26.7% in Oyo state and 20% in Benue state. "Raised sheds in the fields" method of yam storage was quite in use in Oyo state (11.7%) as compared to 5.6% in Benue state. Other storage methods include "storage under trees", "yams left in the soil after maturity" and "stored on raised huts" methods. It is imperative to say that the traditional room storage is mostly used in Benue state while yam farmers in Oyo state use both the traditional room storage method and "yam barns in the compound" method.

Table 2: Distribution of Yam Storage Methods

Storage methods	Pooled (N= 180)	Benue (N= 120)	Oyo (N= 60)
No storage	14 (7.8)	1 (0.8)	13 (21.7)
Traditional room storage	106 (58.9)	89 (74.2)	17 (28.3)
Under trees	8 (4.4)	4 (3.3)	4 (6.7)
Raised sheds in the fields	10 (5.6)	3 (2.5)	7 (11.7)
Yam barns in the compound	36 (20.0)	20 (16.7)	16 (26.7)
Raised hurts	2 (1.1)	2 (1.7)	-
Left in the soil after maturity	4 (2.2)	1 (0.8)	(5.0)

*Figures in parenthesis are percentages

Yam storage efficiency

The efficiency of yam storage was determined by two factors, namely storage duration and incurred losses (losses due to sprouting and rotting). This is presented in table 3 and 4. The storage duration for all storage methods ranged from 2 months to 8 months, the average storage duration was higher in Benue State than in Oyo State. This was approximately 5 months in Benue State and 3.7 months in Oyo State. This means that all the storage methods used by the households are inefficient indicating that the yams are consumed prior to the time the new season's yam is ready for harvesting. Also, the percentage loss at 8 months of storage due to rotting was 14.4% in the study areas with higher losses reported in Oyo State (17.79%) than Benue State (13.03%). Percentage losses at the end of storage due to sprouting was however higher in Benue State (41.3%) than Oyo State (27.8%). These losses are however as high as 37.4% of total stored quantity in the study areas. This is not far-fetched since none of the farmers use improved storage methods, as shown in table 3.

Table 4 presents the disaggregation by different storage methods employed by the farmers. All the storage methods used by yam farmers were inefficient. Majority of the farmers used the traditional room storage despite losses due to sprouting at the end of storage being as high as 37.3% and losses due to rotting put at 12.7%, it still had the highest average storage length of about 5 months. Farmers who used barns stored yam for an average of 4 months but with huge losses to rotting (17.72%) and sprouting (42.25%). The maximum storage length for the traditional room storage and yam barns was 8 months. Other methods had lower maximum months of yam storage with huge percentage losses as high as 45% losses due to sprouting for farmers who used raised huts. This implies that farmers would likely purchase additional yams for planting in the next season and for household consumption before the next harvest/season, highlighting the inadequacy in production and /or storage systems.

Table 3: Yam Storage Efficiency

Factors	**Pooled (N= 166)**	**Benue (N= 119)**	**Oyo (N= 47)**
Average Storage length (Months)	4.62	4.99	3.67
Minimum Storage length (Months)	2	2	2
Maximum Storage length (Months)	8	8	8
Average percentage loss due to rotting during storage (%)	14.40	13.03	17.79
Average percentage loss due to sprouting during storage (%)	37.35	41.25	27.81

Table 4: Storage Efficiency of different Yam Storage Methods

Storage type	Average Storage duration (Months)	Minimum Storage duration (Months)	Maximum Storage duration (Months)	Average percentage loss due to rotting (%)	Average percentage loss due to sprouting (%)
Traditional room storage	5.07	2	8	12.67	37.32
Under trees	3.5	2	6	14.5	24.12
Raised sheds in the fields	3.70	2	5	17.7	33.80
Yam barns in the compound	4.06	2	8	17.72	42.25
Raised huts	2.50	2	3	8	45.00
Left in the soil after maturity	3.25	3	4	24.00	26.75

Food Security Status of Yam Farming Households

The mean per capita household food consumption expenditure per month amounted to ₦2,613.03. Any household whose average monthly expenditure is equal to or more than Z is said to be food secure while any household with average monthly food consumption expenditure lower than Z is said to be food insecure. The food insecurity incidence of 37.2% implies that slightly more than one-third of the yam farmers in the study areas are food insecure (as shown in Table 5). This incidence is higher for yam farmers in Benue State than in Oyo State where about 44% of the yam farmers are food insecure compared to the 23.3% in Oyo State (table 5).

Table 5: Household Food Security Status for both states

Food Security Status	Pooled (N= 180)	Benue (N= 120)	Oyo (N= 60)
Food Secure	113 (62.8)	67 (55.8)	46 (76.7)
Food Insecure	67 (37.2)	53 (44.2)	14 (23.3)

*Figures in parenthesis are percentages

Effect of Yam Storage on Household Food Security Status

The effect of storage on household food security status among yam farming households is presented in Table 6. This was investigated by fitting a logit model and observing its marginal effect estimates. The diagnostics reveal that the Chi-square distribution which was used to test for the overall model adequacy was significant at 1% (P>chi2= 0.0017). The log-likelihood ratio was -100.35491. The number of months of yam storage, whether the household store food or not, losses due to sprouting and household size significantly influenced the household food security. The number of months of yam storage was significant at 1% and positively related with the probability of household food security. This means that the likelihood of yam farming households being food secure increases as the number months of yam storage increases. The marginal effect estimates reveal that this probability increases by 6.5%. This implies the storage duration increases by 6.5%. In a similar vein, yam households who store yam tubers was significant at 1% and positively related with the probability of yam households being food secure. This implies that households store yam regardless of the storage method employed by these farmers. The marginal effect estimates reveal that this probability increases by 37.9%. It therefore shows that improving the time value of yam through storage improves food security at the household level by 37.9%. Furthermore, the probability of yam farming households being food secure decreases as the percentage loss due to sprouting increases. This was significant at 10%. This means that the likelihood of household food security decreases as losses due to yam sprouting in storage increases. The marginal effect estimates reveal that this probability decreases by 0.026%. It is suggested that improved storage methods be made available to yam farmers and its adoption encouraged. Household size was significant at 5% and negatively related with yam household food security status. This means that the probability of households being food secure decreases with increase in the number of household members. This implies that households with lesser number of members are likely to be more food secure than large numbers. The marginal effect estimate reveals that this probability decreases by 1.71%. This is because household size exerts pressure on consumption than on production.

Table 6: Effect of Storage on Household Food Security among Yam Farming Households

Variables	Coefficient	Z	Marginal effect	Z
Percentage loss due to sprouting	-0.0112* (0.0067)	-1.68	-0.00026* (0.0015)	-1.67
Percentage loss due to rotting	-0.0053 (0.0139)	0.38	-0.0012 (0.0032)	0.38
Number of months of yam storage	0.2866*** (0.1002)	2.86	0.0655*** (0.0229)	2.86
Storage status	1.6013*** (0.6440)	2.49	0.3799*** (0.1349)	2.82
Yam farming experience	-0.02056 (0.0177)	-1.16	-0.0047 (0.0040)	-1.17
Household size	-0.0747** (0.0339)	-2.20	-0.0171** (0.0078)	-2.18
Age of Household head	0.0073 (0.0145)	0.51	0.00168 (0.0033)	0.51
Constant	0.0076 (0.9134)	0.01		
LR chi2(7) = 22.99				
Log likelihood = -100.35491				
Prob> chi2 = 0.0017				

*** Significant at 1%, ** significant at 5%, * significant at 10%
Note: Figures in parenthesis are standard errors.

Conclusion and Recommendation

The study examined the time value addition to yam tubers (storage) and its implication on household food security in Benue and Oyo States, Nigeria. Findings reveal that the traditional room storage method is still predominant in the study areas. The storage methods used were inefficient as the average storage length was as low as 5 months and losses incurred due to rotting and sprouting was quite high. Slightly more than one-third of yam farmers (37.2%) were food insecure with the incidence higher amongst yam farmers in Benue State than in Oyo State. Comparison of the number of months of storage of yam tubers and whether the household stores yam or not were significantly different, but were positively related to household food security. Other factors that negatively affected household food security were are losses due to sprouting and household size. The study of introduction and provision of improved yam storage methods to yam farmers is therefore very important, so as to increase the shelf life of yam tubers, smoothen availability for consumption, reduce losses and make available seed yam tubers for the next planting season, all towards improve household food security status of yam farmers in the states.

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