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Research Article

Effect of Agricultural Extension Services in Minimizing Post-Harvest Losses of Yam Produce in Benue State, Nigeria

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Abstract
The study assessed the effect of agricultural extension services in minimizing post-harvest losses of yam in Benue State. Multistage sampling procedure was used to select 240 yam producers. Data were collected using structured questionnaire. *Descriptive statistics such as frequency, mean and standard deviation, post-harvest management coefficient (PMC) and binary logistic regression (BLR) were used to analyse the data. Results on producers' capabilities to manage PHLs revealed that 58.5% of the total yam produce (PMC = 0.585) was preserved while a sizeable proportion (41.5%) of losses were incurred after harvest. The availability of agricultural extension services showed that, the provision of agricultural information ($\bar{x}$ = 1.54), access to agricultural markets ($\bar{x}$ = 1.50) and facilitation of the formation of producers' self-help groups ($\bar{x}$ = 1.50) were the prime extension services rendered in the study area. Empirical result on the effect of agricultural extension services on PHLs management revealed that the number of agricultural extension services ($P \leq 0.01$) and access to agricultural credit ($P \leq 0.01$) exerted positive and significant influence on PHLs management. Also, the level of producers' education ($P \leq 0.1$) enhanced significantly and consistently, their capabilities to minimize PHLs. Conversely, the number of agricultural information sources ($P \leq 0.1$) exerted negative and significant influence on yam producers' capabilities to manage post-harvest losses. The study concludes that agricultural extension services are potent in the management of post-harvest losses. The study thus recommends the provision of agricultural extension service by service agencies, given that the capacities of yam producers' in minimizing post-harvest losses could be enhanced significantly and consistently with increase in the numbers of agricultural extension services at their disposal, and the enhancement of access to agricultural extension services by yam producers, individually and cooperatively, to curtail the incidences incidence of post-harvest losses on yam.*

Keywords: *Agriculture, Extension services, Post-harvest losses, Yam, Benue State*

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Introduction

The global challenge in recent decades is how to ensure long-term sustainable food security for the teeming populations of the world. According to International Fund for Agricultural Development {IFAD}, World Food Program {WFP} and Food and Agriculture Organisation of the United Nations {FAO}, (2012), the number of food insecure remains unacceptably high and to meet the growing food need of the estimated 9 billion people by 2050 will require 70% growth in food production. However, massive quantities of food are constantly lost yearly due to spoilage and infestations on the journey to consumers (Stuart, 2009; FAO, 2011). In some African, Caribbean and the Pacific countries, where tropical weather and poorly developed infrastructure contribute to the problem, food wastage can be as high as 40-50% (SPORE, 2011).

Post-harvest loss entails all measurable decrease or change in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption (Parfitt *et al.*,

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2010). Post-harvest food losses are actually one of the important sources of food insecurity in Africa (Okoedo-Okojie and Onemolease, 2009**).** According to Ansah and Tetteh (2016), the possibility of feeding the teeming population is shrouded in uncertainty unless serious attention is given to postharvest losses. Evidently, one of the most important pathways to increasing food availability and strengthening food security is by reducing post-harvest losses and wastes (Tanye, 2016; ACF, 2014; Bourne, 2014). According to Goldsmith *et al*. (2015), preventing food loss and increasing production remains the two realistic alternatives by which the world can meet its ever-rising food demand. This debate has spurred the renewed focus on investment in agriculture that is stimulated by increasing interest in effective intervention for post-harvest losses (PHLs) reduction in order to improve food security and livelihoods in developing countries (ACF, 2014).
The importance of yam in the food security equation of Benue State and Nigeria at large cannot be overemphasised. It is one of the most important tropical tuber crops second to cassava. Nigeria is reckoned with as the largest producer of yams in the world, followed by Ghana, Cote D'Ivoire, Benin, Togo, and Cameroon (FAO, 2013) and yams are the fifth most widely harvested crop in Nigeria (National Bureau of Statistics, NBS, 2012). Available statistics attest that Benue State takes the centre stage in yam production in Nigeria (Verter and Becvarova, 2014). However, substantial amount of yam produced in the State is wasted and only 43% of households harvesting yams sell any share of their production (NBS, 2016). This is because most of the yam producers failed to meet the phytosanitary regulations of the yam consuming communities as a result of post-harvest losses and damages of their produce. In addition, the proportion of losses incurred in the post-harvest operations of yam, due to pest, rodents and deterioration raise critical questions about the mandate of this important crop in exerting positive influence on the livelihood of the citizen (Veter and Bečvařova, 2014; Adisa *et al.*, 2015).A number of reasons have been advanced for the abysmal performance such as infrastructural deficits, undeveloped yam value chain, paucity of fund, pest infestation, environmental and institutional constraints (Shambe, 2017; Mahmud and Idris, 2017). However, a more convincing argument hinges on the issues of technical support to agriculture and extension services (Agbo *et al.,* 2016). Thus, achieving the full potentials in yam production and PHL management, there is need to improve the producers' technical, organizational and management skills and practices through information and service delivery.

The concept of Agricultural Extension Services (AES) is increasingly recognised as indispensable vehicle of rural development (Živković *et al*., 2009). According to Global Forum for Rural Advisory Services, GFRAS (2016) and Christoplos (2010), agricultural extension services refer to all the different activities that provide the information and services needed and demanded by farmers and other actors in rural setting to assist them in developing their own technical, organizational, and management skills and practices to improve their livelihoods and well-being. According to Živković *et al.* (2009), extension service in agriculture is indispensable and it offers more than just expert assistance in improvement of production and processing, but it enables flow of information and transfer of knowledge and scientific findings to practice. In fact, it is regarded as an important agrarian-political instrument that stimulates the development of agricultural production. However, access to agricultural extension services in West African yam producing belt is weak Mignouna *et al.* (2014). Studies on PHLs of Yam in Nigeria, however laid more emphasis on the causes and storability measures (Mahmud and Idris, 2017; Shambe, 2017; Agbo *et al*., 2016; Akangbe *et al.,* 2012) rather than extension and service needs. This study therefore was conceived to examine the effect of agricultural extension services in the minimizing post-harvest losses (PHLs**)** of yam produce in Benue State, Nigeria for improved yam productivity and post-havers management**.**

Materials and Methods

The study was conducted in Benue State (The Food Basket of the Nation) in North-Central Nigeria. The state has land mass of 33,955 Km^2 with estimated population of 5,741,800 people (National Bureau of Statistics {NBS}, (2016) and

413, 156 farm-families (Benue State Agricultural and Rural Development Authority {BNARDA} (2015). Benue State is located in the Southern Guinea Savannah, a transition belt between the grassland savannah in the North and the rainforest in the South. The State lies between Longitude 7° 47' and 10° 0' E, and Latitude 6° 25' and 8° 8' N of the Greenwich Meridian. Its hares its boundary to the North by Nasarawa State, Kogi State to the West, Taraba State and the Republic of Cameroun to the East, and to the South by Cross-River and Enugu States. The well-drained environs and ambient temperature of the State support commercial production of yam (*Discorea Spp*.), cassava (*Manihot Spp*.), rice (*Oryza sativa*), soybeans, and fruit trees.

Multi-stage sampling procedure was used to select 240 respondents from the three Agricultural zones (A, B and C) of the State. The first stage involved a purposive selection of one (1) Local Government Area (LGA) from each zone based on the volume of yam production (Ukum, Gboko and Okpokwu from zones A, B and C, respectively). The second stage involved a proportionate (30%) sampling of yam producing communities in each LGA and 13 communities were selected. Furthermore, a proportionate (5%) sampling procedure was used to select 240 yam producers from a database of 4,793 producers (Table 1). Quantitative and qualitative data were collected using interview schedule with open and closed ended question. Data analysis was done using descriptive statistics such as frequency count, mean and standard deviation, Post-harvest Management Coefficient (PMC)and Binary Logistic Regression (BLR) analysis to achieve the research objectives.

Post-harvest management coefficient (PMC): PMC refers to the ratio of the quantity of usable yam tubers after harvest to the total quantity of yam produce stored after harvest. The use of this ratio to a large extent reduces the variability in farm size, and standardisation of yam tubers.

$$PMC = \frac{Qty\ of\ yam\ sold/consumed/stored\ after\ harvest - Qty\ lost\ after\ harvest}{Qty\ sold/stored/consumed\ after\ harvest} \ldots (1)$$

This coefficient has values closed between 0 and 1 (i.e., $0 \leq PMC \leq 1$). PMC measures the extent or degree of effectiveness of a farmer in managing postharvest losses (Ansah and Tetteh, 2016); the larger the coefficient, the greater the farmer's ability to manage losses after harvest and *vice-versa*.

Binary logistic regression: The choice of a probability model here is stemmed from the fact that the coefficient of post-harvest management lies between 0 and 1. Other researchers such as Ansah and Tetteh (2016) used Fractional Regression Model in similar fashion. However, since it is not feasible for the PMC to lie outside the range of 0 and 1, any value that is less than 0.5 is assumed a unit value of 0 and any value above or equal to 0.5 as 1.

$$P_i\left(PMC = \frac{1}{X_i}\right) = f(Z_i) = \frac{1}{1+e^{-(\alpha+\beta_i X_i+\varepsilon_i)}} \ldots (2)$$

Where,
e = the base of natural logarithm
X_i = a vector of explanatory variable (AES)
α and β_i = the regression parameters to be estimated, and
ε_i = Random error terms
Thus;

$$PMC = \beta_0 \sum_{i}^{N} \beta_j X_{ij} + \varepsilon_i \ldots\ldots\ldots\ldots (3)$$

Where,
PMC = Post-harvest Management Coefficient, a measure of post-harvest losses (a dichotomous dependent variable with values of 0 and 1)
β_0 = constant term
β_j = the regression coefficients to be estimated $(\beta_1 - \beta_7)$
X_{ij} = independent variables for the j^{th} farmer $(X_1 - 7)$ {X_1 = Number of agricultural extension services at the producers' disposal, X_2= No. of post-harvest management technologies introduced by extension agencies and used by producers (e.g. Suberization and curing, storage, handling and maturity index), X_3 = Sources of agricultural information available to the producers, X_4 = Number of extension service providers offering extension services, X_5 = Source and access to credit/financial facilities, X_6 = Number of extension contact per year, X_7 = Years of formal education}

N = proposed sample size in the range 1 -240
ε_i = error term that may account for the unmeasured variables.

Results and Discussion

Estimation of post-harvest losses of yam in Benue State

The result in Table 2 showed the extent of post-harvest losses management capabilities of yam producers for a period of four years (2015 – 2018). The Post-harvest Management Coefficient (PMC) score indicated a mean PMC score of 0.585 for the period under consideration. This implies that yam producers were able to manage and preserve successfully, about 58.8% of the total yam produce whereas, 41.5% losses were incurred. The distribution of PMC across the years showed similar trend between 2015 and 2017 with PMC range of 0.55 – 0.59. However, there was an improvement in 2018 with a PMC index of 0.62. The probable reason for such improvement could be attributed to enhanced access and proximity to the emerging markets across yam producing areas. The minimum and maximum PMC scores were 0.316 (31.6%) and 0.802 (80.2%), respectively with a standard deviation of 0.068. This implies that yam producers exhibited the capacity to preserve and manage between 31.6 – 80.2% of their annual harvests for the period under study. Likewise, it can be inferred that, yam producers suffered PHLs of 19.8 – 68.4% of their total produce. This result shows similarity with the findings of Gernah *et al.* (2013) who averred that postharvest losses of yam in Benue State could be as high as 20 to 67%.In a similar fashion, Iorzua *et al.* (2020) also reported huge losses of 46.25% and 67.44% of yam seeds and yam tubers, respectively in Nasarawa State. The significance of the PMC score is that it measures the extent or degree of effectiveness of a producer in managing post-harvest losses, thus, the larger the value of the coefficient, the greater the producer's ability to curtail losses and vice versa. Therefore, it can be seen that the percentage losses of 41.5% is substantially high, a margin that is in line with postharvest losses (40% to 50%) in in the Africa sub-region (SPORE, 2011; ACF, 2014).

Availability of agricultural extension services

The result of agricultural extension services with regard to the management of post-harvest losses of yam revealed (Table 3) that 53.75% of yam producers affirmed the availability of agricultural information related to PHLs as the prime extension service ($\bar{x} = 1.54$). Approximately half of the respondents indicated that facilitation of producers' access to agricultural markets ($\bar{x} = 1.50$)and the formation of producers' cooperatives and other self-help groups ($\bar{x} = 1.50$), respectively were the next rated extension services. The recognition of these services agrees with the submissions of Agba *et al*. (2019) and Anaeto *et al*. (2012) that agricultural extension services are essential for improved agricultural productivity. The moderately rated extension services were observed in the linkages of producers to extension agencies ($\bar{x} = 1.40$), transfer of improved post-harvest management techniques to yam producers($\bar{x} = 1.34$), access to information on agricultural insurance schemes ($\bar{x} = 1.38$). However, access to access to financial facilities and PHL management inputs ($\bar{x} = 1.32$) were rated as the least available agricultural extension services. The limited availability of these services is validated by the position of African Development Bank Group, AFDB (2015) that agricultural extension service providers in developing countries have limited capacities to meet the daunting challenges of farmers in accessing extension services.

Effect of agricultural extension services on post-harvest losses management of yam

The result of the effect of extension services on post-harvest losses management as summarised in Table 4 showed that the number of agricultural extension services exerted positive and significant effect on the capability and effectiveness of the producers' in minimizing post-harvest losses of yam ($p \leq 0.01$). The result implies that an increase in the number of agricultural extension service will increase significantly and exponentially (Exp (β) = 2.970), the capabilities of the producers to minimise post-harvest losses. This result is in line with findings of McNamara and Tata (2015). Similarly**,** access to agricultural credit tends to enhance positively and significantly, the capabilities of yam producers to manage PHLs ($p \leq 0.01$). Keeping

other factors constant, a unit increase in the access to agricultural credit will increase the management capacity of yam producers by an exponential factor of {Exp(β)} of 33.740. By extension, it is expected that increase access to timely and sufficient credit facilities can facilitate the producers' access to the needed information and resources to minimise PHLs. This assertion is corroborated by the finding of FAO (2011) that credit is a key factor in boosting agricultural production, and lack of it is one of the key constraints in postharvest management.

Conversely, sources of agricultural extension services exerted negative influence on the producers' capabilities to manage post-harvest losses. The result showed that increase in the number of sources of information decreases significantly ($p \leq 0.1$) the management capability of the producers in minimising PHLs. This implies that the ability to manage PHLs successfully does not depend primarily on multiple information sources, but to a large extent, on the quality of the information that is received. This assertion is supported by the submission of Adio *et al*. (2016) who alluded that majority of the farmers rely on informal sources of information from neighbours, friends and colleagues rather than from the extension workers. Thus, information from such informal sources could be conflicting and also counterproductive.

Conclusion

Post-harvest losses of yam are great sources of disincentives to producers and can endanger the livelihood of the yam producers. Year in year out, substantial volumes of yams are lost along the yam value chain (38 - 45%). The study also affirmed that post-harvest losses of yam within the period under study were unreasonably high (41.5%). Based on the findings of the study, the prime agricultural extension services at the disposal of yam producers were provision of agricultural information services, access to agricultural markets and the formation of agricultural cooperatives. Similarly, the number of agricultural extension services that are producer accessed, sources of agricultural information and the number of credit sources available to the producers were the core determinants of post-harvest losses minimisation in the study area. The study recommends improved provision of agricultural extension service though public and private agencies to improve the managerial capabilities of yam producers in minimizing post-harvest losses. In addition, producers should be encouraged to form cooperative and other self-help bodies so as to enable them build social capital, pool resources together and to obtain loans and credits for better and quick responses to post-harvest losses challenges.

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Table 1: Sample Size Selection Procedure

Zone	LGA	No. of Communities	Communities (30%)	No. of yam farmers	Sample Size (5%)
A	Ukum	13	Atereyange	382	19
			Kundav	419	21
			Mbazun	391	20
			Mbatian	348	17
B	Gboko	17	Igyorov	397	20
			Utabar	329	16
			Mbadim	458	23
			Mbakwen	401	20
			Mbatyu	298	15
C	Okpokwu	12	UgwuOkpoga	312	16
			Ugbokolo	417	21
			Ichama	352	18
			OkpuduOkpoga	289	14
Total	**3**	**42**	**13**	**4,793**	**240**

NB: LGA = Local Government Area

Table 2: Postharvest Management Coefficients

Index	2015	2016	2017	2018	Pooled*
PMC	0.588	0.554	0.576	0.622	0.585
Min.	0.277	0.179	0.120	0.135	0.316
Max.	1.000	0.895	0.997	0.973	0.802
Std. Dev.	0.143	0.138	0.148	0.172	0.086

*Cut off index of 0.50 and above indicates increasing level of effective management
Source: Field Survey, 2019

Table 3: Availability of Post-Harvest Agricultural Extension Services to Producers (n = 240)

Extension Services	Not Available	Available	Mean
Provision of agricultural information to producers	111 (46.25)	129 (53.75)	1.54
Facilitation of producers' access to markets and pricing mechanism	119 (49.58)	121 (50.42)	1.50
Facilitates formation and membership of cooperatives and other self-help groups	120 (50.0)	120 (50.0)	1.50
Producers – Extension Agencies Linkages	143 (56.58)	97 (40.42)	1.40
Transfer of improved post-harvest management technologies to producers	149 (62.08)	91 (37.92)	1.38
Encourage producers to get involved in agricultural insurance scheme	158 (65.83)	82 (34.17)	1.34
Facilitate Producers' access to financial facilities	164 (68.33)	76 (31.67)	1.32
Facilitation of producers' access to PHL management inputs	163 (67.92)	77 (32.08)	1.32

Source: Field Survey, 2019. NB: Values in parenthesis indicate percentages

Table 4: Effect of Agricultural Extension Services on Post-Harvest Loss Management

Variables	β	Std. Error	Wald Statistics	Sig.	Marginal Effect {Exp(β)}
No. of Agric. Ext. Services	1.089	0.249	19.074	0.000	2.970***
No. of PHLs management	0.008	0.843	0.000	0.992	1.009
Information sources	-2.696	1.444	3.486	0.062	0.067*
No. of Ext. Serv. Providers	0.568	0.917	0.384	0.536	1.765
Sources of Agric. Credit	3.519	1.184	8.834	0.003	33.740***
No. of Extension Contacts	-0.805	0.725	1.234	0.267	0.444
Level of Education (dummy)	0.353	0.201	3.089	0.079	1.423*
Constant	-5.987	5.652	1.122	0.289	0.003***
-2 Log likelihood	90.698				
Cox and Snell R^2	0.635				
Negelkerke R^2	0.847				

*Wald Chi-Square =242.013; P-Value = 0.000. *** & * indicate Wald test significance at 1 and 10% respectively.*