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Estimates of Post- Harvest Losses of Rice (*Oryza sativa*) during Storage by Small Holder Rice Farmers in Benue State Nigeria

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ABSTRACT

Estimates of post-harvest losses of rice during storage by smallholder rice farmers was carried out in Benue State Nigeria, with the following objectives, identifying the demographic features of the respondents, estimating post harvest losses using different storage techniques and determining factors influencing post harvest losses during storage. Cluster, purposive and simple random sampling Methods were used in collecting samples, 288 respondents through questionnaires. Data analysis was done using Means, percentages, frequency counts and OLS. Results revealed that, mean age was 41 years, males were 63%, while 56% of those interviewed were married, mean size of family was 8 persons, mean size of farm cultivated was1.6 hectares, mean number of years spent in schooling was 5 years and mean years of farming rice was 10. Local /Traditional storage techniques recorded the highest losses 58.78 %, semi modern storage techniques recorded 39.99% and the modern storage techniques recorded 1.23%.The result of OLS revealed that, R^2 was 0.45%. Five factors were significant, and their coefficients conformed to econometric criteria. Types of rice storage techniques used, education and experience were significantly negative at 1% , meaning, decrease in these factors leads to increase in the dependent factor by the size of their coefficients -0.79, -0.40 and -0.27. While the quantity of rice stored and duration of storage were significant at 1% and positive implying, increase in these factors leads to increase in the value of the dependent factor by the magnitude of their coefficients 0.21 and 0.49. The following recommendations have been made; rice farmers should be given training and also provided with amenities that will aid in managing post-harvest losses of rice on their farms in the study area.

Keywords: *Storage, postharvest losses, Smallholders Rice farmers, Estimates*

Introduction

Storage is a vital component in the food supply chain; it takes care of agricultural products fluctuations throughout the year due to its seasonality, according to (19) the maximum percentage of post harvest losses occurs through the storage of crops due to a lack of in appropriate or inadequate storage infrastructure. Losses through storage can be classified into two categories: direct losses, owing to physical or quantitative loss of commodities; and indirect losses, owing to loss in quality and nutrition. Nigeria farmers do face many challenges in the process of producing staple crops; they are also faced with management constraints after harvest. One of the constraints include not been able to store farm produce effectively, leading most farmers not to take advantage of price hikes that occur during the production cycle. Nigeria, almost food self-sufficient in the 1960s, has become a food-deficit country relying on large quantities of imported foods, (12) states that in 2020 about 14.6 percent of the population were undernourished while poverty and unemployment levels in 2021 were also high estimated at 42.8 percent and 33.3 percent (18). Different farming localities or communities in Nigeria have diverse storage methods subject to the type of crops produced (1). Farmers achieve diverse degrees of achievement while applying the essential philosophy concerned with the secured food storage (4). The customary/local grains and cereals storage structures used in various locations are made of different locally accessible materials in Nigeria. Typically, the type of locally available materials shows the type of storage structures. For example, paddy straw are used in making most of the storage structures, and also used are, divided or whole bamboo poles, planks, reeds, glad rags, mud bricks etc. Most of the structures are constructed at the beginning of harvesting season although; time of harvesting differs to some extent all through the agro-climatic zones. The grains are stored in processed or unprocessed forms. The different types of farm storage structures found in the three different climatic zones of Nigeria have been studied (9). Some structures are used for short term storage (mostly intended for the drying of crops), while others are for long-term storage. Temporary storage methods are grouped into aerial storage and storage on the ground, or on drying floors and open timber platforms. Long-term storage methods include: storage baskets made of plant materials; calabashes, gourds, earthenware pots; jars; solid wall bins (mud rhombus), underground storage, poly grain bags, improved pics bags and store rooms in houses (11). Storage methods used in the study area comprise of storage bags, baskets, drums, improved rhombus, raised platforms, storehouses, warehouses, silos, enhanced pics bags, airtight containers. The storage methods have been grouped under, local/traditional storage methods at both farm and household stage to include local cribs and rhombus, platforms, open field, roof and fire places.

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Improved or semi modern grain storage techniques at the farm and household stages include improved rhombus and brick bins, ventilated cribs. While the modern centralized storage methods at commercial stage includes silos, warehouses and improved pics bags (16). In many African countries including Nigeria, food losses are caused by a number of factors, these include, lack of resources, meagre on-farm processing facilities, use of obsolete technology, poor production practices/scheduling, poor transportation services, inadequate or inappropriate storage facilities, consumer preferences/attitudes, untimely harvesting, inadequate credit facilities, deficiency or inaccessibility to good quality packaging materials, poor technology and inadequate market systems (10). If the issue of inappropriate or inadequate post harvest storage is not checked or taken seriously the problem of post harvest losses will be worsen as evident in the magnitude of this menace,

Material and Methods

Study Area

This research was conducted in Benue State Nigeria; and was selected based on the intensity of rice farming activities. The geographic coordinates of the study area are longitude 7° 47' and 10° 0' East; Latitude 6° 25' and 8° 8' north. The State has a population of about 5,663,355 (14). The land area of 32,518 sq km, and it is located in the north central region of Nigeria, about 80 to 90% of this population are predominantly farmers.

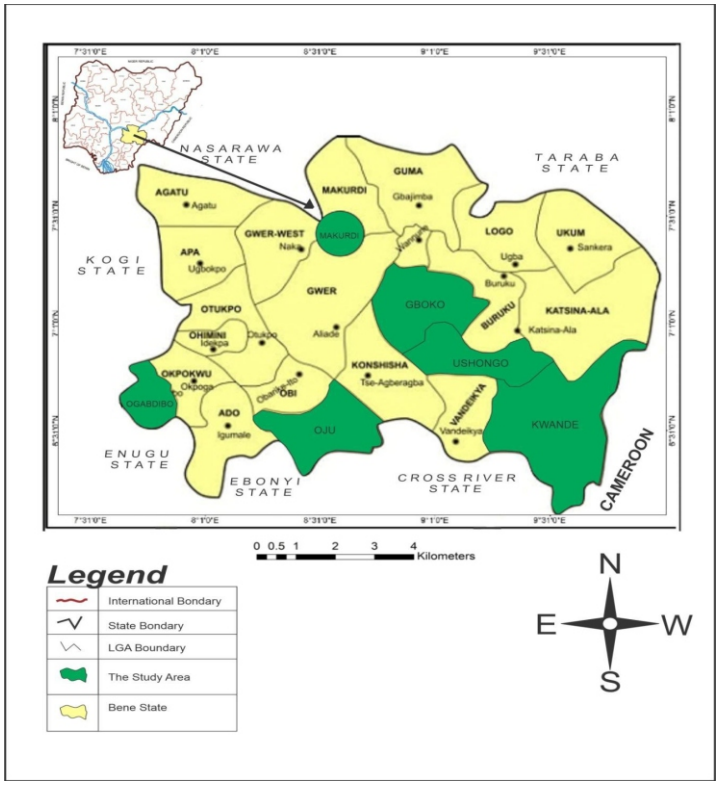

Figure 1: Map of the Study Area (Benue State) showing the Local Governments sampled

Sample size/ Sampling Technique

This study employed Cluster sampling method, purposive and simple random sampling methods for the collection of samples.

The study area was divided into three clusters according to the state Agricultural Development Programmes zones (ADP zones) Purposive sampling was use to select two local Government areas in each of the clusters, the study also employed the use of purposive sampling to select one rice producing community within each of the local government areas which gave a total of six rice producing communities in the study area. The study used Taro Yamane's formula of proportionate sampling using simple random sampling method to select 294 respondents using questionnaires, although only 288 questionnaires were returned for analysis. The local Government Areas include: Oju and Ogbadibo in the ADP central cluster, while Ushongo and Kwande were selected in the ADP eastern cluster, Makurdi and Gboko Local Government Areas were selected in the ADP Northern cluster.

Sample Size

Sample size for this study was determined based on the 117,428. Rice farmers registered with the Agricultural and Rural Development Authority (BNARDA) of Benue State using Taro Yamane's proportionate formula:

$$n = \frac{N}{[1+(Ne^2)]} \text{ --------(1)}$$

Where:
n = required sample size
N = population sample
e = error limit at 5% (standard error of 0.05)
1 = constant value.

Table1: Distribution of selected respondents from the selected study communities

S/No.	BNARDA Clusters	LGAs Selected	Communities Selected	Sampling Frame	Sample Size%
i	Central Cluster	Ogbadibo Oju	Orokam Oju	14,968 42,728	38 107
ii	Eastern Cluster	Ushongo Kwande	Sati Ikyor Jato-Aka	8,544 12,272	21 31
iii	Northern Cluster	Makurdi Gboko	Abua Mbatiav	6,388 32,528	16 81
	Total			117,428	294

Source: BNARDA contact farmers, 2019

Methods of Data Collection

Primary data was sourced through questionnaires distributed to the respondents. The questionnaires provided information on the socio-economic features of rice farmers, estimates of post-harvest losses through storage, factors affecting post harvest losses of rice during storage. Questionnaires were administered to both illiterate and literate farmers with the help of some trained research assistants.

Methods of Data Analysis

Simple statistics such as means, frequency counts and percentages were used for the socio-economic characteristics and estimates of storage losses recorded using different storage methods.

The mean is expressed as:

$$\bar{x} = \frac{\Sigma f x}{n} (1)$$

Were

$\bar{x}$ = Mean

f=frequency

x=observations

fx=frequency of observations

S_i=losses during storage activity on the farm

i= 1,2 .n

$\Sigma f x$ = sum of individual observations

n = sample size

Ordinary least squares regression (OLS) model.

Analysis factors affecting post-harvest losses of rice while in storage was done using ordinary least square regression method expressed as:

$Y=b_o+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_{6+}\mu$ (3)

Where:

Y = Storage losses (kg)

X_1= Storage technology (1=Traditional 2= semi-modern 3=Modern Storage Techniques)

X_2= Quantity of Storage (kg)/ton

X_3= Storage Experience (Years)

X_4= Education (Years)

X_5= Duration of Storage (years)

X_6= Use of Chemicals (kg)/ton

$\beta_1 - \beta_{6=}$parameter estimates

μ = Random error

Results and Discussion

Result of the Demographic features of age of the respondents in table 2 revealed that, majority of those interviewed fell within the age range of 31-44years as represented by 49.0% of smallholder rice farmers, while 21.0% of these interviewed fell within age group of 17-30 years and 20.0 % of those interviewed fell in the age group of 45-58, 19.0% of rice farmers were in the age group of 59-72, only 3.5% of these that were interviewed fell in the age group of 73-86 and more. This shows that, the bulk of those interviewed were young adults who were full of energy to contribute meaningfully in rice post harvest handling activities in the study area, the mean age of those interviewed was (40.6). This is the full of life and main era at which farmers considerably add individual manual labour to farm labour. The result further revealed that, males were the majority in the study area as represented by 63.0% of these interviewed, while only 37.0% were females. This implies that, male farmers were prevalent in the study area. In developing countries, males are more involved in agricultural production due to how strenuous and laborious the customary agricultural methods and land possession or legacy arrangement. The later transfer landed properties to males and put family circle belongings under the rights of the family unit head which must be a male. This finding is in line with (2) tomato cultivation in Offinso district of Ghana was mostly by males (77%). This study revealed further that, most of these interviewed fell within the married category as was represented by (56%), while 15.0% of those interviewed were single, 20.0% divorced and only 8.0% were widows/widowers. This implies that, in traditional farming settlements or communities, marriage is a positive feature as it also serves as a source of farm labour. The mean family size of the respondents was 8 persons 43.0% of these interviewed had family size of between 1-6 persons, while 17.0% of the respondents had between 7-12 family size and 26.0% had between 13-18 persons and only 15.0% had family size of 19-24 persons. This implies that, typical farming communities in rural Nigeria have large family size and the system is such that, a family comprised some members of the extended family. The result further showed that, 34.0% of the respondents did not attend formal education while 36.0% spent between 1-6 years in school, 30.0% of the respondents spent between 7-12 years in school and only 0.7% spent between 13-24 years and above number of years in school, while mean number of years of schooling was five years depicting that the respondents had at least attended primary school. Mean number of years of farming was about ten years meaning that most of these interviewed ventured into rice farming not too long. The result revealed that, most of those interviewed had number of years of farming between 7-12 years as represented by 50.0%, while 30.0% of these interviewed had farm experience of 1-6 years and 15.0% of these interviewed had been farming rice for 13-18 years, while only 2.0% had number of years of 25-30 and above. Majority of these interviewed had farm size of 0.1-1.6 hectares of rice farm as represented by 58.0% of the respondents, while 36.1% of the respondents cultivated rice farm of 1.7-3.2 hectares. The result also revealed that, 2.1% of the respondents cultivated farm size of 3.3-4.8 and 4.9 -6.4 hectares respectively while only 1.7% of the respondents cultivated rice farm of 6.5-8.0 and above hectares of rice farm. Mean farm size was 1.6 hectares meaning that rice farming in the study area was done mostly by small-scale farmers.

Table 2. Socio economic characteristics of the Respondents

Variable	Frequency	Percentage	mean
Age			
17 – 30	61	21.18	
31 – 44	142	49.31	
45 – 58	56	19.45	40.6
59 – 72	19	6.60	
73 – 86	10	3.48	
		100	
Total	288		
Sex		63.0	
Male	182	37.0	
Female	106	100	
Total	288		
Marital Status		55.9	
Married	161	15.6	
Single	45	20.8	
Divorce	60	7.6	
Widow/Widower	22	100	
Total	288		
House hold size		42.7	
1-6 Persons	123	17.0	
7-12	49	25.7	

13-18	74	14.6	
19-24	42	100	
Total	288		8.0
Farm Size(Ha)		58.0	
0.1-1.6	167	36.1	
1.7.3.2	104	2.1	
3.3-4.8	6	2.1	1.6
4.9-6.4	6	1.7	
6.5-8.0	5	100	
Total	288		
Years of formal Education		34.0	
No formal education	98	36.0	5.0
1-6	103	30.0	
7-12	85	0.7	
13-18	2	100	
Total	288		9.6
Farm experience in years		30.0	
1-6 years	86	50.0	
7-12	138	15.3	
13-18	44	5.2	
19-24	15	1.7	
25-30	5	100	
Total	288		

Field surveys, 2019

Estimates of Storage losses incurred according to different storage techniques used by respondents

Table 3 shows the result of the estimates of storage losses incurred by smallholder rice farmers; the result explains that, local and traditional storage techniques recorded the highest losses of 58.78% of the total mean losses, while semi-modern storage techniques recorded the second highest losses of rice during storage representing 39.99%. Modern storage techniques recorded the least losses during storage with 1.23% of rice loss. Seasonality of agricultural production makes storage very important in that, the production of farm produce is seasonal, but the demands for agricultural produce are not seasonal it is usually throughout the year. Therefore, there is need to store during the harvesting period when there is glut for later days when farm produce are in short supply or scarcity, and then released into the market. It is generally believed that storing grains for long term is profitable (17). Storage processes contributes significantly in the food available throughout the year. Previous research studies have proved that during storage, greatest post harvest losses take place (*3, 8*, 5, and 11). During harvest, the grains are stored for a short or long period as food reserves and as seeds for the next season. In Nigeria, different storage techniques have been classified by (13,16 and 9) as local/traditional examples of this methods include, cribs, thatched houses, mud rhombus, in -huts, earthen pots, gourds, calabashes etc, semi modern storage techniques includes, room in house, built store houses, cemented drying floors, underground storage and storage bags, While modern storage techniques includes, ware houses, still metallic containers, air tight containers Purdue pics bags and use of chemicals e.g., phostoxins etc.

Table 3: Estimates of Storage losses incurred according to different storage techniques used by respondents

Variable	Storage Method	Actual Storage loss(kg)	Mean Loss(kg)	Percentage (%)
Traditional/Local Techniques	In-hut Thatched houses	2898.72	16.20	58.78
Semi-Modern Techniques	Room-in house Stores	1972.80	11.02	39.99
Modern Techniques	Pics bags Airtight containers	60.48	0.34	1.23
Total		4932	27.56	100

Source; Field survey, 2019

Result of Factors influencing post harvest storage losses by the respondents

The result of factors influencing post harvest storage losses by smallholder rice farmers was analyzed using ordinary least square regression (OLS) estimates in Benue State, this was evaluated using different functional namely:, linear, semi-log, Cobb-Douglas and exponential functional forms of the model, Cobb-Douglas functional form was best fitted and was selected as the lead equation. Results of factors influencing post-harvest losses of rice during storage by rice farmers in Benue State are presented on table 4. The model was examined using statistical, economic, and econometric criteria. The equation was significant at 1% level with a coefficient of determination of 0.46 and adjusted (R^2) was 0.45. The value of the R^2 implies that about 45% of the variation in the post harvest losses of rice during storage is explained by the six variables included in the model altogether. The result revealed that, five variables were significant, and their coefficients conformed to economic and econometric principles. The types of rice storage techniques used, years of schooling and years of farming were significant at 1% and negative implying that, negative change in these variables leads to positive change in the value of the dependent variable at the magnitude of their coefficients which is -0.79, -0.40 and -0.27.

While variables of the quantity of rice stored and duration of the storage were significant at 1% and positive implying that, positive change in the value of these variables leads to positive change in the value of the dependent variable which is post harvest losses of rice during storage by the magnitude of their coefficients which is 0.21 and 0.49. These variables and the dependent variable storage losses have a direct relationship as these variables increase, the value of the dependent variable also increases. The variable of chemicals (insecticides and pesticides) was statistically not significant but negative. The result of this study corroborates previous results of (7) which posited that post-harvest losses influence rice farmers' income and profit of those interviewed. (6) Reported that post-harvest losses cause a decline in rice farmers' output and income and profits respectively. (15) Made known that an important and positive association exist between income and post-harvest losses in the cause of rice farming activities.

Table 4. Factors Affecting Post harvest losses of rice during storage

Log of Storage losses	Coefficient	T-Ratio
Log Storage technique used	-0.7879066	-5.52 ***
Log quantity stored	0.2078227	3.19 ***
Log education	0.2078227	-5.33 ***
Log storage experience	-0.2655551	-4.04 ***
Log Duration of Storage	0.4870328	8.49 ***
Log use of chemicals	0.1175907	0.85
cons	2.572729	5.14 ***

Number of obs= 288, F(6, 281)=40.36,Prob>F=0.0000,R-squared=0.4629,Adj squared=0.4514 *** significant at 1%
Source: Field Survey, 2019

Conclusion and Recommendation

This study concludes that, rice farming activity is dominated by male farmers in Benue state, and most of the farmers are married and had large household sizes and attended formal education and were in there lively and most important ages at which farmers significantly partake individual effort to agricultural activities. The result also concluded that farmers were less experienced and cultivated small farm size. Local /Traditional storage techniques e.g use of thatched houses recorded the highest losses followed by the semi-modern storage techniques of in-house stores while the modern storage techniques of pics bags and air-tight containers recorded the least losses. The result of the study further concludes that, factors influencing post-harvest losses of rice during storage by rice farmers, were types of rice storage techniques used, education, farm experience, decrease in these variables leads to increase in rice storage losses at the magnitude of their coefficients, while variables of quantity of rice stored and duration of the storage also influenced post harvest losses of rice during storage positively, positive changes in the value of these variables leads to positive changes in the value of the dependent variable which is post harvest losses of rice during storage, these variables and post harvest losses of rice during storage have a direct relationship as these variables increases, post harvest losses of rice during storage also increases. The following recommendations have been made that, government and nongovernmental organizations should work on improving some of the socio economic characteristics affecting post harvest losses of rice during storage and modern storage techniques be made within the reach of smallholder rice farmers as this will reduce post-harvest losses of rice during storage which estimates has shown to be significantly high.

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