Storage Losses Intensity of Paddy Rice in Benue State, Nigeria: Estimate, Determinants, and Policy Implications

Z.T. Nyiatagher[1], A. M. Okeke[2], S.O. Ekele[3]
[1, 2, 3] Department of Agribusiness, Joseph Sarwuan Tarka University,
Makurdi, Benue State, Nigeria
Email: anayomichaelokeke@gmail.com
DOI: 10.56201/ijaes.v10.no7.2024.pg10.17

Abstract

The study investigated the intensity of storage losses of paddy rice in Benue State, Nigeria. Data were collected from 246 rice farmers selected from 12 communities and six Local Government Areas using multistage sampling technique. The collected data were analysed using descriptive statistics and multiple regression model. The result on the intensity of storage losses of paddy rice showed that on average, 11.34% of paddy rice produced in the study area were lost during storage. The multiple regression analysis showed that age (β = -0.71), level of education (β=0.61), farming experience (β=0.63), annual income (β=0.51), and involvement in off-farm business (β=0.31) influenced intensity of post-harvest storage losses of paddy rice in the study area. The study recommended that policies and programmes aimed at minimizing storage losses of paddy rice should take into consideration the socio-economic characteristics of the rice farmers especially their age, educational level, farming experience, annual income, and off-farm activities involvement, in their design and implementation; and the State ministry of agriculture should annually organize workshops targeted at training of rice farmers on post-harvest handling and storage of paddy rice with the objectives of acquiring skills in timing of harvest, grain drying, moisture management, and safe storage.

Key Words: *Intensity, Storage, Losses, Paddy Rice, Benue State, Nigeria*

INTRODUCTION

Rice (*Oryza sativa*) as a core staple food among Nigerians has been subjected to a combination of measures by successive administrations in an effort to boost local production and reduce the country's large dependence on imports. These efforts are yet to yield the targeted objectives as report by Ibirogba (2022) showed that as at the year 2022, the country's consumption of rice was 6.95million metric tonnes and production was 5.00million metric tonnes leaving a deficit of approximately 2.00 million metric tonnes. This deficit is reported to continue and projected to attain 4.5million metric tonnes by the year 2029 (Olowa, 2020). This situation has continued to encourage importation which as at 2022, 2.1million metric tonnes of rice was imported into the country, as well as smuggling owing to the porous borders with neigbouring countries (Ibirogba, 2022).

Empirical studies (Ayanda *et al*., 2013; Osanyinlusi and Adenegan, 2016; and Ahmed *et al*., 2017) had attributed this dismal performance of the rice sector in Nigeria to several factors such as high cost of inputs, diversion of subsidized farm inputs, soil degradation, annual bush burning, land issues, lack of capital, neglect of the agricultural sector, inadequate extension agents, market failures, insufficient technical-know-how in the area of fertilizer application and improved seeds among others. Important but yet understudied factor responsible for this poor performance of the Nigerian rice sector is post-harvest storage losses of the harvested paddy rice.

According to Danbaba *et al*. (2019), 10-30% of paddy rice produced in Nigeria does not reach the final consumers due to inefficient postharvest management practices. In a study conducted in Sokoto State, Nigeria, Sani *et al*. (2022) revealed that 8.44% of rice produced in the State was lost between the time of harvesting and storage and was estimated to be 575kg/ha. In a similar report, Oparinde *et al*. (2016) observed 10% intensity of post-harvest storage losses among rice farmers in Ekiti State, Nigeria.

In order to formulate policies that will minimize storage losses experienced by rice farmers, information on the intensity of this storage losses as well as their determinants is pertinent. Also information on intensity of storage losses of paddy rice and the socio-economic characteristics of rice farmers that influence it is scanty. It is against this background that this study was designed to assess the intensity of storage losses for paddy rice in Benue State, Nigeria. Specifically, the study sought to: estimate the intensity of storage losses of paddy rice; and identify and analyse the determinants of storage losses intensity of paddy rice. The null hypothesis tested was that the socio-economic characteristics of rice farmers do not significantly influence the intensity of post-harvest storage losses of paddy rice produced in the study area.

MATERIAL AND METHODS

The Study Area

The study was conducted in Benue State which lies within the lower river Benue trough in the middle belt region of Nigeria. It geographical coordinates are Longitude $7°47^/$ and $10°0^/$ East. Latitude $6°25^/$ and $8°8^/$ North and occupies a land mass of 34,059 km2. The State is one of the North Central States in Nigeria with a population of about 4, 253,641 in 2006 census. The projected population of the State in 2022 was 6,141,300 (Brinkhoff, 2022).

The State derives its name from the Benue River which is the second largest river in Nigeria. The State borders Nasarawa State to the North; Taraba State to the East; Kogi State to the West; Enugu State to the South-West; Ebonyi and Cross-Rivers State to the South and has an international border with Cameroon. Farmers who engaged in arable crop production like rice, yam, cassava, sweet potato, maize, vegetables, soybeans as well as livestock like poultry, goat, sheep, piggery, cattle and fish abound in the State.

Population of the Study

The population of the study consisted of the 210,839 registered rice farmers in Logo, Kwande, Guma, Makurdi, Agatu, and Apa Local Government Areas of Benue State obtained from Benue

State Agricultural and Rural Development (BNARDA) in 2021. These LGAs were chosen because of their vast production of rice.

Sampling Technique and Data Collection

Multi-stage sampling technique was employed to select a sample of 246 rice farmers. The data for the study were collected using structured questionnaire.

Analytical Techniques

The data collected were subjected to descriptive and econometric analyses. Descriptive statistics such as mean, percentage, and frequency table were used to examine the intensity of storage losses of paddy rice while multiple regression model was used to identify and analyse the determinants of storage losses intensity of paddy rice.

The four functional forms: linear, exponential, semi-log, and double-log were tried. The double-log was selected as the lead equation based on the magnitude of R^2, the *a priori* expectation, and number of significant coefficients of the independent variables.

The four functional forms were specified as follows:

Linear:

$$Y = a_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} + \varepsilon_i \dots\dots (1)$$

Exponential:

$$lnY = a_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} + \varepsilon_i \dots\dots (2)$$

Semi-log:

$$Y = a_0 + b_1X_1 + b_2lnX_2 + b_3X_3 + b_4lnX_4 + b_5lnX_5 + b_6lnX_6 + b_7lnX_7 + b_8X_8 + b_9X_9 + b_{10}lnX_{10} + b_{11}X_{11} + \varepsilon_i \dots\dots (3)$$

Double-log:

$$lnY = a_0 + b_1X_1 + b_2lnX_2 + b_3X_3 + b_4lnX_4 + b_5lnX_5 + b_6lnX_6 + b_7lnX_7 + b_8X_8 + b_9X_9 + b_{10}lnX_{10} + b_{11}X_{11} + \varepsilon_i \dots\dots (4)$$

Where:

ln = Natural logarithm

Y = Intensity of storage losses (percentage)

a_0 = Constant

b_1-b_{11} = Regression coefficients

X_1 = Sex (male=1, female=0)

X_2 = Age (years)

X_3 = Marital Status (single=1, married=0)

X_4 = Farm size (Ha)

X_5 = Level of education (years)

X_6 = Household size (number of persons)

X_7 = Farming Experience (years)

X_8 = Cooperative Membership (member=1, Non-member=0)

X_9 = Extension Contact (had contact=1, had no contact=0)

X_{10} = Annual Income (Naira)

X_{11} = Off-farm business (involved =1, not involve = 0)

ε_i= Error term

The *a priori* expectation was that the coefficient of sex, farm size, marital status, household size, and off-farm business involvement would be positive while those of age, level of education, farming experience, membership of cooperative, extension contact, and annual income would be negative.

RESULTS AND DISCUSSION

Intensity of Post-Harvest Storage Losses of Paddy Rice

The distribution of rice farmers by intensity of post-harvest storage losses of paddy rice is presented in Table 1

Analysis of Table1 shows that majority (61.0%) of the rice farmers in the study area recorded less than or equal to 10% post-harvest storage losses. The mean storage losses experienced by the farmers was 11.34%. This finding is in consonance with Oparinde *et al*. (2016) who observed 10% post-harvest storage losses among rice farmers in Ekiti State, Nigeria.

Table1: Distribution of rice farmers by intensity of post-harvest storage losses (n=246)

Variable	Frequency	Percentage	Mean
Storage losses intensity (%)			11.34
≤10.00	150	61.0	
10.01-21.00	70	28.5	
21.01-32.00	15	6.1	
≥32.01	11	4.5	

Source: Field survey data, 2022

Socio-economic Determinants of Post-Harvest Storage Losses Intensity

The socio-economic determinants of post-harvest storage losses intensity of paddy rice are presented in Table 2. The result in Table 2 shows that 53.52% of the variation in the level of post-harvest storage losses intensity was explained by the independent variable included in the model as shown by the R^2. The F-value (21.83) as shown in Table 2 was significant at 1% level. Thus, the null hypothesis that socio-economic factors do not significantly influence intensity of post-harvest storage losses of paddy rice in the study area was rejected.

Table 2: Socio-economic determinants of intensity of post-harvest storage losses (n = 246)

Variables	Linear	Exponential	Semi-log	Double-log†
Sex	-4.84^{NS}	0.059^{NS}	-22.57^{NS}	0.029^{NS}
	(62.14)	(0.11)	(66.46)	(0.11)
Age	-10.24**	-0.0087^{NS}	-616.52**	-0.71*
	(5.13)	(0.0091)	(239.02)	(0.37)
Marital status	10.65^{NS}	-0.088^{NS}	59.57^{NS}	0.12^{NS}
	(85.89)	(0.16)	(93.52)	(0.15)
Farm size	38.33***	0.038**	232.87***	0.16^{NS}
	(9.30)	(0.016)	(78.72)	(0.12)
Level of education	11.23^{NS}	0.042***	168.33*	0.61***
	(7.97)	(0.014)	(99.90)	(0.15)
Household size	29.09***	0.049***	139.71^{NS}	0.21^{NS}
	(8.99)	(0.015)	(89.91)	(0.14)
Farming experience	9.48*	0.030***	220.02**	0.63***
	(5.43)	(0.0097)	(107.34)	(0.16)
Membership of cooperative	-4.67^{NS}	-0.11^{NS}	-14.80^{NS}	-0.13^{NS}
	(63.61)	(0.12)	(65.88)	(0.10)
Extension contact	-44.08^{NS}	0.013^{NS}	-24.15^{NS}	0.025^{NS}
	(67.41)	(0.12)	(72.96)	(0.11)
Annual income	3.29×10^{-5NS}	$1.33 \times 10^{-7***}$	98.72^{NS}	0.51***
	(2.90×10^{-5})	(4.89×10^{-8})	(66.68)	(0.10)
Off-farm business involvement	-61.38^{NS}	0.21^{NS}	-11.21^{NS}	0.31**
	(80.72)	(0.14)	(89.40)	(0.14)
Constant	-39.54^{NS}	3.55***	-419.49^{NS}	-3.22***
	(196.06)	(0.34)	(978.98)	(1.49)
R^2	0.2813	0.4795	0.2199	0.5609
Adjusted R^2	0.2475	0.4516	0.1801	0.5352
F-value	8.32***	17.17***	5.53***	21.83***

Source: Field Survey data, 2022. Values in bracket are standard error, ***= sig @ 1%, ** =sig @ 5%, * = sig @ 10%, NS = not significant; †= lead equation.

The coefficient of age was significant at 10% and negatively related to intensity of post-harvest storage losses. The negative sign of the coefficient implies that as age of the farmer increases by 1%, intensity of post-harvest storage losses decreases by 0.71%. Aged farmers are likely to have more years of experience in handling farm produce and hence will have good handling skills for

stored produce. This finding is in tandem with Kulwijila (2021) who posited that farmers with more years of experience are good in handling practices for stored produce and hence incur less post-harvest losses.

Level of education, farming experience, and annual income had positive coefficients and significant at 1%. Involvement in off-farm business also had positive coefficient but significant at 5%. The positive sign of their coefficients implies that as the level of education, years of farming experience, annual income of the farmers' increase by 1%, the intensity of postharvest storage losses incurred increases by 0.61%, 0.63%, and 0.51% respectively. Also, the positive coefficient of involvement in off-farm business implies that if a rice farmer engages in off-farm business, the farmer's intensity of storage losses increases by 0.31%.

Well-educated and experienced farmers including those with higher annual income and are involved in off-farm economic activities will experience minimal post-harvest storage losses as their attributes favour adoption of modern post-harvest technologies that prevent losses of rice along the post-harvest chain. However, farmers with these favourable adoption attributes that their intensity of storage losses increase are those without access to the necessary inputs and aids that minimizes post-harvest storage losses. According to Okadonye *et al*. (2021), if farmers are provided with adequate equipment and necessary infrastructures, they tend to experience minimal post-harvest losses. Also, Bala *et al*. (2016) revealed that lack of credit to acquire post-harvest technologies contribute to post-harvest losses of rice among farmers in Bangladesh.

CONCLUSIONS

On average, 11.34% of stored paddy rice was lost owing to storage structure in the study area. Evidence from the study also shows that the socio-economic characteristics of rice farmers in the study area influence the intensity of storage losses of paddy rice produced. The variable age decreases storage losses by 0.71%, while educational level, farming experience, annual income, and involvement in off-farm business increase it by 0.61%, 0.63%, 0.51%, and 0.31% respectively.

Based on the findings of the study, the following were recommended:

- Policies and programmes aimed at minimizing storage losses of paddy rice should take into consideration the socio-economic characteristics of the rice farmers especially their age, educational level, farming experience, annual income, and off-farm activities involvement, in their design and implementation; and
- The State ministry of agriculture should annually organize workshops targeted at training of rice farmers on post-harvest handling and storage of paddy rice with the objectives of acquiring skills in timing of harvest, grain drying, moisture management, and safe storage.

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