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Effect of post-harvest losses on rice farmers' income in Sub-saharan Africa: a case of Niger state, Nigeria

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ABSTRACT

Post-harvest losses have been one of the key encumbrances to farmers' income in sub-Saharan Africa, and in particular, Nigeria. It is thus, against this background, that this study ascertained the effect of post-harvest losses on rice farmers' income, in the study area, amongst other objectives. The study covered 120 farming households, using the multi-stage sampling technique. Data analysis was undertaken using descriptive statistical tools, phased estimation of post-harvest losses and regression analysis. Results from the study showed that majority (71%) of the rice farmers cultivated between 1 and 3 hectares; 66% had farming experience of over 30 years. Ironically, almost all respondents (98%) witnessed post-harvest losses, ranging from 7 to 25%, with threshing losses accounting for the peak of 25%, on per capita basis. Average income per farmer stood at ₦111,733.27/Ha. The ordinary least squares regression estimates showed that threshing losses and household sizes were significant determinants of rice farmers' income at 1% and 5% level probability levels respectively, while the analysis of constraints revealed that lack of harvesting equipment constituted the main challenge to rice post-harvest loss mitigation, as affirmed by 92.50 % of the respondents. The study concluded that threshing losses had adverse effect on rice farmers' income and consequently, recommended renewed awareness campaigns and demonstrations on rice handling and post- harvest loss prevention.

Key words: Post-harvest losses, income, Rice, threshing losses, Niger State, Sub Saharan Africa.

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INTRODUCTION

Rice is a major staple food crop globally consumed by 3.5 billion people (over half of the world's population (West Africa Rice Development Agency, 2005). Global production for 2014 to 2015 is forecast at a record 480.7million, while consumption and residual for same period is put at 482.2 million tonnes, an increase of 1.5% from the preceding year (World-Grain, 2014). Projections by Mejia (2001) indicated that 10 billion people will depend on it as main food by 2025, while demand will reach about 880 million tonnes. In Nigeria however, its domestic production has never been able to meet the demand (Akinwunmi, 2011). According to Erenstein et al. (2003) and FMARD (2011), the demand and supply gap in rice production has been widening, resulting in huge import bill. FMARD (2011) further noted that demand for rice in Nigeria is put at about 5 million metric tons a year out of which about 3.2 million metric tons are produced locally. Akinwunmi (2011) further noted that Nigeria is the second

largest importer of rice, with a huge annual import bill of about ₦1 billion daily. Thus, it was in a bid to enhance rice self-sufficiency in local production in the short term and increase export in the medium term, that the Presidential Initiative and National Special Programme for Food Security were implemented, with targets of 3 million hectare under cultivation, and 15 million tons of paddy rice or 9 million metric tons of milled rice (Federal Ministry of Agriculture and Water Resources, 2008).

In spite of these developments, the country has been unable to attain self-sufficiency in local production, partly due to huge post-harvest losses. By and large, post-harvest losses have been a huge drain to local production, as colossal quantities of food, including rice are lost, year after year. Globally, Gustavsson et al., (2011) noted that about 1.3 billion tons of food are wasted or lost annually, while in the local context, International Fund for Agricultural Development (2012) affirmed that Nigeria's agricultural productivity has been generally low, mostly due to post harvest losses of farm produce (20% for grains and over 40% for fruits and vegetables), attributed to poor post-harvest handling, inadequate agro-processing development among other factors. Sanni (1999) observed a total neglect of the post-harvest system in the country, while, Ukoh-Aviomoh et al. (2005) attributed losses in food quality to chemical changes, microbial attack, unhygienic ways of handling foods, exposure to high temperature and high relative humidity, insects and rodent's attack, poor harvesting, poor storage and processing techniques and poor handling during distribution. Post-harvest losses reduce the overall prosperity of the country and contribute to undernourishment among the large minority of the population that live in fragile eco-systems and or have little access to affordable imported food-stuffs. Hence, the elimination of post-harvest losses of agricultural products is important to boost food security and availability (Mrema and Rolle, 2002). Interventions in post-harvest losses reduction are seen as an important element of the efforts of many agencies to reduce food insecurity, shore up farmers' income and the prosperity of the Nation. Post-harvest losses, due largely to the absence of viable storage and processing facilities, are some of these challenges which have impoverished farmers and dampened their enthusiasm for farming. Ukoh-Aviomoh et al. (2005) reported that these losses lead to heavy loss of income and food supplied to rural families, thereby threatening household food security and that, in the face of threat of household food security, malnutrition easily results. It is thus against this backdrop, that this study assessed the effect of post- harvest losses on rice farmers' incomes in Niger State, Nigeria. The objectives of this study, therefore, were to: describe the socio - economic characteristics of rice farmers in the study area, identify the sources, magnitude and causes of post-harvest losses in rice production, determine incomes of rice farmers and ascertain the effect of post-harvest losses on rice farmers' income in the study area.

Hypothesis

Ho: Post-harvest losses do not influence rice farmers' income in the study area.
Ha: Post-harvest losses influence rice farmers' income in the study area.

LITERATURE REVIEW

Post-harvest losses are the quantitative and qualitative degradation of food production from harvest to consumption. Quality losses include those that affect the nutrient/caloric composition, acceptability, and edibility of a given product. These losses leads to a reduction in value of usable product due to physical and chemical changes in the rice which diminish the grain size, cause poor appearance, bad taste and foul aroma. These losses are generally more common in developed countries (Kader, 2002). Quantity losses on the other hand refer to those that result in the loss of the amount, weight or volume of the final usable product from the potential yield or harvestable paddy. Essiet (2014), identified post-harvest losses as one of the major hindrance to rice self-sufficiency and that it takes the form of reduction in weight and quality during drying and milling and in value of paddy while harvesting. According to the study, these losses mean a reduction in farm income. Mejia (2001) revealed that the concept of post-harvest losses is changing, but that attention is however still very much on the quantitative aspect. It was however noted that post- harvest system consists of series of activities from harvest through consumption and that when food losses are minimized, both food security and income increases. In this light, post-harvest systems of rice was seen as deserving special focus since rice is a major staple crop in the world produced mainly by the developing countries, where the implementation of rice post-harvest system is of essence in order to stem the losses from rice. While the study observed losses from rice to be about 16%,Ren-yong et al. (1990) put these losses at between 8 and 26%. Dante (2005), attributed losses in rice to a combination of

factors affecting the way the crop is grown, harvested, cleaned, handled, dried, stored, milled, and marketed. According to the researcher, these losses are either outright physical losses, or deterioration of quality which reduces its commercial value. The researcher further categorized post-harvest losses into both quantitative and qualitative and explained that they are the result of spillage, inefficient retrieval, inefficient processing, inadequate machinery poor operator skills, biological deterioration, and infestation by storage pests.

METHODOLOGY

Study Area

The research was undertaken in 3 Local Government Areas of Niger State, namely; Agaie, Katcha and Lavun. Niger state is one of the states in the North-central geo-political Zone of Nigeria, with coordinates of Latitude $8^{o}22'$N and $11^{o}30'$N and Longitude $3^{o}30'$N and $7^{o}20'$E. The State covers a total land area of 74,244 sq.km, or about 8% of Nigeria's total land area. This makes the State the largest in the Country. The 2006 population figures put the State population at 3,950,249, largely made up of 3 ethnic groups, namely; Nupe, Gbagyi and Hausa. The State is bifurcated into 25 Local Government Areas (LGAs) under 3 Agricultural Zones. Rice is grown in all the LGAs of the State, either as upland or lowland rice.

Method of Data Collection

Primary and secondary data were employed for this research. Primary data were collected through the use of well-structured questionnaire, covering information on socio-economic variables on the farmers, estimates of post-harvest losses along the rice value chain, cost and return profiles of rice farmers. Secondary information from sources such as journals, previous works and publications were also used.

Sampling Technique

Sampling was based on the rice farming household frame generated by the Federal Ministry of Agriculture and Rural Development under the Agricultural Transformation Agenda. A multi-stage random sampling procedure was used for identifying respondents for this study, involving the random selection of 1 LGA each from each of the 3 Agricultural zones, followed by the random selection of 4 wards and villages per LGA, proceeded by the sampling of 10 rice farming households from each village, thus, yielding 40 households per LGA, culminating in 120 sampled households in the three Local Government Areas covered.

Data Analysis

Data analysis was undertaken using descriptive statistics, which included a measure of tendency such as mean, percentages, frequency distribution and tabulation of data, gross margin analysis, estimation of post-harvest losses at each stage of rice value chain, through farmers recall and ordinary least squares regression model. The model to determine the effect of the post-harvest losses on rice farmers' income was expressed thus:

$$Y=b_o+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+b_8X_8+b_9X_9+ b_{10}X_{10}+b_{11}X_{11}+b_{12}X_{12}+\mu \ldots\ldots\ldots\ldots (1)$$

Y = Income from rice production (Naira) X_1 = Harvest losses (Naira)
X_2 = Threshing losses (Naira) X_3 = Winnowing losses (Naira)
X_4 = Transportation losses (Naira) X_5 = Storage losses (Naira)
X_6 = Parboiling losses (Naira) X_7 = Drying losses (Naira)
X_8 = Milling losses (Naira) X_9 = Household size (No.)
X_{10} = Educational Status of Farmer (Years) X_{11}= Age of Farmer (Years)
μ = Random error

RESULTS AND DISCUSSION

Socio-economic Characteristics of Respondents

Table 1 shows the distribution of rice farmers' socio-economic characteristics. Majority (72.2%) of the respondents was between the age range of 31 and 50 years, implying that most of the farmers in the study areas were in their middle age, economically active and likely to adopt innovations more than those in the higher age bracket. In the study on the support for small rice threshers in Nigeria, Adewumi, et al. (2007) puts the average age of rice farmers at 45 years. Almost all respondents were males (97.50%), a manifestation of the gender inequality in

Table 1. Distribution of respondents according to socio-economic characteristics.

Variable	Frequency	Percentage (%)
Age		
21 - 30	2	1.67
31 - 40	24	20.00
41 - 50	64	53.33
> 50	30	25.00
Sex		
Male	117	97.50
Female	3	2.50
Years Spent in School		
0 - 6	83	69.20
7 - 12	26	21.70
> 12	11	9.10
Farming Experience		
1 - 10	3	2.50
11 - 20	14	11.70
21 - 30	24	20.00
>30	79	65.80
Household Size		
1 - 5	4	3.30
6 - 10	34	28.30
11 - 15	54	45.00
>15	28	23.00
Farm Size		
0.01 - 1.00	31	25.80
1.01 - 2.00	47	39.20
2.01 - 3.00	38	31.70
>3.00	4	3.30

Source: Authors' Field Survey, 2014.

rice farming. This calls for concerted effort in mobilizing and empowering women for effective participation in rice production, with a view to enhancing their economic empowerment. This result aligns with the output of the study by Amos (2006), Adewumi (2008), Ojo et al. (2008) who reported male dominance in food crop production in Nigeria. The ensuing development may not be unconnected to the socio-religious coloration in some parts of the study area where women are restricted to mainly household chores in line with religious tenets, while the male gender supports the economic needs of the household. This is however without prejudice to women participation in complementary farming roles, especially those involving downstream operations such as threshing, winnowing, among others. Majority (69%) of respondents in the study area have only basic education, having spent between 0 and 6 years in school. About 66% have farming experience of 30 years and above, implying that respondents were not only involved in farming activities, but were also well experienced in rice production . This experience, when combined with adequate farm resources is likely to translate to profitable and sustainable agricultural production. About 68% of the respondents had household size of 11 and above, implying that most of the respondents have large family size. This might also mean high supply of farm labour by family members, with the assumption that members of the household worked on the farm, all things being equal. Also, 65% of the respondents cultivated between 0.5 and 2 hectares of land, a pointer to that fact that rice farming in the study area is still at subsistence level. Adewumi et al. (2007) revealed that 80% of the respondents cultivated farm size of between 1 and 10 hectares, with the average farm size put at 3 hectares.

Table 2. Sources of post-harvest losses and magnitude.

Sources of Post-Harvest Losses	Magnitude (Kg)	Percentage (%)	Rank
Threshing	0.25	25.00	1st
Winnowing	0.15	15.00	2nd
Harvesting	0.15	15.00	2nd
Milling	0.11	11.00	4th
Parboiling	0.10	10.00	5th
Transporting	0.09	9.00	6th
Storage	0.08	8.00	7th
Drying	0.07	7.00	8th
Total		100.00	

Source: Authors' Field Survey, 2014.

Table 3. Causes of Post-harvest losses among respondents.

Causes	Frequency*		Percentage (%)		Rank
	Yes	No	Yes	No	
Lack of Harvesting Equipment	111	9	92.50	7.50	1st
Lack of Storage Facilities	98	22	87.70	18.30	2nd
Lack of Processing Facilities	105	15	87.50	12.50	3rd
Poor State of Road	95	25	79.20	20.80	4th
Lack of Post-harvest Technology	95	25	79.20	20.80	4th
Poor Handling	43	77	35.80	64.20	6th

Source: Authors' Field Survey, 2014. * Multiple responses.

Sources and Magnitude of Post-harvest Losses

Estimates on Table 2 details the sources and magnitude of post-harvest losses in the study areas and their rankings. The attribution variables covered ranged from harvesting losses to milling losses. The result showed that post-harvest losses ranged from 0.07 kg per farmer at the drying stage (7%) to 0.25 kg per farmer at the threshing stage (25%). These findings differ from the 2%, 6% and 7% obtained by Appiah et al. (2011) for drying, threshing and storage respectively. Mejia (2001) further noted that losses from drying ranged from 1 to 5% while Ren-Yong et al.(1990) puts the losses from storage at 6.2% compared to 8% and 7% obtained from these attributes under the study.

Causes of Post-harvest Losses

Table 3 details the causes of post-harvest losses in the study areas and their rankings. The attribution variables covered ranged from poor handling on the part of the respondents to lack of requisite processing equipment. The results revealed that lack of harvesting equipment was the major cause of post-harvest losses as indicated by 92.5% of respondents. PrOpcom (2007) revealed that most rice farmers (93%) financed their rice threshing through personal savings and complained bitterly of not being able to receive financial support from the government. Meanwhile, poor handling constituted the least cause of harvest losses, as affirmed by 35.8% of the respondents.

Costs and returns profile of respondents' rice enterprise

Table 4 puts that the average revenue per farmer at ₦206, 523.43 with labour cost, constituting the highest variable cost, which stood at an average of ₦71, 385.97 per planting season, transportation was the lowest variable cost at ₦1, 117.36. Mean revenue per farmer stood at ₦206,523.43, while average gross margin was ₦111, 733.27, implying that rice production in the study areas was profitable.

Table 4. Costs and returns profile of respondents' rice enterprise.

Variable	Average(₦) /Hectare
Variable Cost Items	
Fertilizer	11, 668.87
Pesticide	2,646.61
Herbicide	3,075.72
Seeds	2,063.88
Insecticide	2,831.75
Transportation	1,117.36
Hired Labour	24,850.56
Family Labour	46,535.41
Total Variable Cost	**94,790.16**
Average Quantity Produced	2,579.61
Average Price per Kg	80.06
Revenue	**206,523.43**
Gross Margin	**111,733.27**

Source: Authors' Field Survey, 2014 *** = Significance at 1%,**= Significance at 5%.

Table 5. Ordinary least squares regression result estimates.

Variable	Linear (Y)	Exponential (LnY)	Cobb-Douglass (LnY)	Semi. Log (Y)
Constant	-154166.1 (-0.67)	11.34759 (16.65)	12.19744 (3.46)	-74328 (-0.07)
Harvesting loss (Naira)	15.95421 (0.10)	.0008033 (1.40)	.3357649 (1.17)	15511.29 (0.18)
Threshing loss (Naira)	-145.1184 (-0.89)	-.0013497 (-2.68)***	-.4164918 (-1.55)	-121477.8 (-1.34)
Parboiling loss (Naira)	3.886633 (0.02)	-.0009149 (-1.26)	-.4209802 (0.107)	-18688.22 (-0.21)
Drying loss (Naira)	-146.1682 (-0.54)	-.0010002 (-1.12)	-.1928298 (-0.81)	-48228.85 (-0.63)
Winnowing loss (Naira)	31.0795 (0.68)	.0002249 (1.70)	.1300438(0.64)	20982.74 (0.32)
Storage Loss (Naira)	130.6458 (0.43)	-.0275594 (-1.39)	.0328694 (0.13)	28009.07(0.33)
Transportation loss (Naira)	-101.153 (-0.36)	.0126553 (0.71)	.006826 (0.02)	-73336.74 (-0.82)
Milling Loss (Naira)	124.8049 (0.50)	-.000513 (-0.64)	-.0486675 (-0.17)	51955.25 (0.63)
Household Size (No)	33802.43 (1.57)	.0671848 (2.36)**	.7207343 (1.93)	73954.22 (0.58)
Age(years)	4423.467 (0.96)	.0023028 (0.12)	.2235754 (0.32)	250257 (1.02)
Years spent in School(yrs)	-4298.815 (-0.64)	-.0115355 (-0.54)	-.0812345 (-0.57)	-68325.47 (-1.46)
F	0.1331	0.0002	0.0380	0.1608
R^2	0.0485	0.3160	0.2188	0.045
R^2 adjusted	0.0485	0.2315	0.1100	0.0453

Ordinary least squares regression analysis result

The result of the regression estimates shown in Table 5 was used to explain the effect of post-harvest losses on rice farmers' income in the study areas. Four functional forms were tried, which included linear, semi-log, double log and exponential forms. Expectedly, the model was examined in terms of appropriateness as confirmed by the F-statistic. The functional forms were also examined in terms of the value of the values of the coefficient of multiple- determination (R^2), the adjusted R^2 and the significance, magnitude and signs of the coefficients of regression estimates. Ascribing from the above criteria, the exponential functional form was found to be the best goodness of fit and was chosen as the lead equation for further analysis in the study. The equation was significant

at 1% alpha-level with a coefficient of determination of 0.3160. The value of the R^2 implies that about 32% of the variation in the income of the rice farmers is explained by the eleven variables included in the model altogether. Two variables were significant, with their coefficients conforming to the a priori expectations. Threshing losses (X_2) was significant at 1% and negative, implying that an increase in threshing losses will reduce rice farmers' income by the value of the coefficient. This result confirms the alternate hypothesis of this study which stated that post-harvest losses influence farmers' income in the study areas. The outcome is in line with the results obtained by Essiet (2014), who observed that post- harvest losses cause a reduction in rice farmers' income. In a related development PrOpcom (2007) revealed that a significant and positive correlation exist between income and the quantity of rice threshed. However, the results run contrary to that of Folayan (2013), who showed that gender, source of information and type of storage facilities were some of the determinants of post- harvest losses in maize, a cereal crop. On the contrary, household size (X_9) was significant at 5% probability level and positive, implying that with increase in the household size, farmers' income on rice will increase. This development could possibly relate to the influence of family labour in household rice production in the study areas.

The estimated exponential function is given as:

$$Y = 11.34759 - .0008033X_1 - .0013497 X_2 - .0009149X_3 - .0010002X_4 + .0002249X_5 -$$
$$(16.65) \quad (1.40) \quad (-2.68)^{***} \quad (-1.26) \quad (-1.12) \quad (1.70)$$
$$.0275594X_6 + .0126553X_7 - .000513X_8 + .0671848X_9 + .0023028X_{10} - .0115355X_{11}$$
$$(-1.39) \quad (0.71) \quad (-0.64) \quad (2.36)^{**} \quad (0.12) \quad (-0.54)$$

$R^2 = 0.3160$, F ratio = 0.0000

CONCLUSONS AND RECOMMENDATIONS

The study concluded that threshing losses has a negative influence on rice farmers' income in the study areas. Losses from this source also constituted the bulk of losses encountered by rice farmers representing 25% of post-harvest losses, while the lack of processing equipment hindered processing operations. Arising from these, the study recommended renewed and continuous awareness campaigns through radio, pamphlets, leaflets, demonstrations on rice post-harvest handling and loss prevention by the Extension Component of the Niger State Agricultural Mechanization and Development Authority (NAMDA), the concerned Local Government Authorities and Niger State Ministry of Agriculture, with a view to ameliorating the magnitude of post-harvest losses. It has also become imperative for NAMDA to link more rice farmers to the rice processing demonstration centers that abound in the State, under the National Programme for Food Security and the on-going Agricultural Transformation Agenda Rice Value Chain Initiative. NAMDA will also have to link farmers with small scale and affordable agro-processing equipment (particularly for threshing) available at the National Cereal Research Institute, Badeggi and the National Agricultural Mechanization Center, Ilorin, Kwara State. In addition, rice farmers should take advantage of effective cooperative membership, with the view to taking the benefits of economies of scale, which will likely come from group ownership of agro-processing equipment.

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