Determinants of Post Harvest Losses of Rice *(Oryza Sativa)* among Rice Processors in Benue State, Nigeria

Dzahan, Hilary Liambee Ph.D

Department of Agricultural Business and Extension, Akperan Orshi Polytechnic, Yandev, Gboko, Benue State, Nigeria

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ABSTRACT

Determinants of post harvest losses of rice among rice processors was conducted in Benue state, Nigeria. The objectives were to describe the socio-economic characteristics and determine factors influencing post-harvest losses of rice processors; the study employed the use of purposive, multi stage and simple random sampling procedures to select 150 rice processors using Taro Yamane's proportionate sampling. Simple descriptive statistics and multiple linear regressions was use for data analyses. The result revealed that, mean age was 41 years, 47.33% were married, 44.67% processed between 7 - 10 100kg bags of rice per week. The result showed that 74.67% attended formal education, 36.67% had experience of between 10-15 years, Result of multiple regression analysis revealed that, R^2 was 57%, losses due to inadequate drying facilities, inadequate transportation facilities, scale of operation were statistically significant at 1% and positive implying increase in these variables leads to increase in the dependent variable by the magnitude of their coefficient 23%, 26% and 0.3% . Milling technology and education were statistically significant at 1% but negative implying decrease in these variables will increase the value of the dependent variable by the magnitude of their coefficients -0.74% and -0.33%. The study concludes that, improving drying facilities and transportation efficiency. providing training on post harvest management and improving processing technology can significantly reduce post harvest losses by rice processors. The study recommends that; Government and NGOs should invest in modern drying facilities; provide training on post harvest management for rice processors and improve transportation network and efficiency.

Keywords: Post harvest losses, Rice processors, processing losses

INTRODUCTION

Nigeria is currently the largest rice producing country in West Africa (Danbaba *et al.*, 2019). The problem of rice losses poses serious implications for food security in Nigeria, with the country losing about $9 billion annually due to post-harvest losses (Oba, 2020). According to *(Gesellschart Fur Internationale Zusammenarbeit* (GIZ), 2013), food losses in crops value chains as at 2013, during processing, storage, transport and marketing amounted to around ₦144 million. In 2016, study reveals that about 700,000 tonnes of tomatoes rot was wasted annually out of Nigeria's yearly harvest of about 1.5 million tonnes (Nigerian Agricultural Promotion Policy (NAPP), 2020). Post-harvest losses account for direct physical losses and quality losses that decrease the economic value of the crop or may make it unsuitable for human consumption. In severe cases, these losses can be up to 80% of the total production (Fox, 2013). The post-harvest loss of rice includes the rice loss across the entire rice supply chain from harvest until its consumed (Aulakh *et al.*, 2013). The losses have been broadly categorized as weight loss due to spoilage, quality loss, nutritional loss, seed viability loss, and commercial loss (FAO, 2012). The magnitude of post-harvest losses in the rice supply chain varies considerably among different varieties**.** 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 ecosystems and or have little access to affordable imported foodstuffs. Hence, the elimination of post-harvest losses of Agricultural products is important to boost food security and availability (FAO, 2016). When 20 % of harvest is lost, the actual crop lost is just part of the problem, also wasted are 20 percent of all factors that contributed to producing the crop, 20 %of land used to grow the food, 20 % of water used to irrigate it along with human labour, seeds, fertilizer and everything else. In other words, post-harvest food loss translates not just into hunger and financial loss to farmers but into tremendous environmental waste as well (Chukwunta,2014). Interventions in post-harvest losses reduction are seen as an important element in the efforts of many agencies to reduce food insecurity, shore up farmer's income and the prosperity of the nation. Post-harvest losses due largely to the socio-economic characteristics of rice farmers, the absence of viable storage and processing facilities are some of these challenges, which have impoverished farmers and dampened their enthusiasm for farming. Coker and Ninalowo (2016) 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. Rice processors in Benue State face significant post harvest losses, estimated to range between 20-30% of the total production, resulting in substantial economic losses and food insecurity. The losses occur due to inefficient handling, storage, and processing practices, inadequate infrastructure and limited Technical capacity. However, a huge supply and demand gap already exists in domestic rice production and processing, which has led to high prices for the commodity in the country. Consequently, if post-harvest losses are not checked, household food and nutrition security will be worsening, as evident in the magnitude of the menace. Therefore, an understanding of post-harvest losses among smallholder rice processors is important owing to the persistent, severity and huge impact of post-harvest losses on the economy.

Objectives

1. Describe the socio-economic characteristics of smallholder rice processors;
2. Determine the factors influencing post-harvest losses of rice at the processing stage;

LITERATURE REVIEW

Post harvest loss estimation

Milling or processing operations vary for different grains, but the operation involves removing some of the grain and possibly grinding the grain to make it more suitable for consumption. Milling is traditionally performed manually by women pounding the grain. Commercial mills can reduce the time and labour associated with hand milling but vary widely by scale and efficiency. Village milling can result in 20 to 30% weight losses in rice and commercial milling losses can range from 5 to 30% (Kiaya, 2014). According to estimates provided by the African Postharvest Losses Information System (APHLIS), physical grain losses (prior to processing) can range from 10 to 20 percent. Estimates of the Postharvest losses of food grains in the developing world from mishandling, spoilage and pest infestation are put at 25% (Sadiya and Hassan, 2018). This means that one-quarter of what is produced never reaches the consumer for whom it was grown, and the effort and money required to produce it are lost-forever. However, estimates of quantitative losses will eventually give a broad picture of where the losses are occurring, their relative scale, and how rice was handled during the post-harvest operation. Losses are often estimated as a percentage of the amount remaining from the previous stage of postharvest operation (Abraha; *et al* 2018).

Crop production is estimated to account for roughly 70 percent of typical incomes, of which grain crops account for about 37 percent, on average. Recorded production amounts to 112 million tons per year, although records for some crops and some countries are not available. Most grains are produced and consumed by small farming households (WB, 2011). Postharvest losses in food crops occurring during harvesting, threshing, drying, processing, storage, transportation etc, has been estimated to claim between 30 and 40% of all food crops in developing countries (Saunders *et al,* 1980).

Economic Impacts of Post harvest Losses

According to estimates provided by the African Postharvest Losses Information System (APHLIS), physical grain losses (before processing) can range from 10 to 20 percent. Typically, the magnitude and location of Post Harvest Losses assessments are based on ad-hoc measurements resulting in wide ranges. The APHLIS information platform draws in post-harvest losses estimates from national researchers that are well below the 40–50 percent, frequently cited in the development community.

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However, they are still too high to ignore; and in Eastern and Southern Africa alone, based on APHLIS estimates, they are valued at US$1.6 billion per year or about 13.5 percent of the total value of grain production (US$11 billion). There are no similar regional weight loss estimates available for grains in Central or West Africa except for anecdotal estimates (APHLIS, 2015). However, assuming losses of a similar magnitude, the value of PHL losses in SSA could potentially reach nearly US$4 billion a year out of an estimated annual value of grain production of US$27 billion (estimated average annual value of production for 2005–07) (FAO, 2013).

Causes of Post-Harvest Losses

Severe losses occur because of poor facilities, lack of knowledge, poor management, market dysfunction, or simply the carelessness of farmers or workers. Post-harvest losses may also occur at consumers' homes, in the kitchen or on dining tables. However, losses after produce have left the retail market are generally difficult to control by agricultural means. Idah *et al,* (2007) believed that improper post-harvest sanitation, poor storage and packaging practices and mechanical damages during harvesting, handling, and transportation resulting from vibration by undulation and irregularities on the road and mechanical can enhance losses. It is important to note that lack of proper information or poor decisions could lead to food loss, for example, agricultural policy, which overestimates production, may cause glut, which in turn leads to greater food and economic losses to actors in production and marketing system. It has been contended by most researchers on this topic that many post-harvest losses are a direct result of production management. Vegetables that are affected by weeds, pests and diseases, inappropriately irrigated and fertilized, generally are of poor quality before harvesting or harvested past optimum maturity can never be improved by post-harvest treatments. Furthermore, Barret (2015), and Mohanty, *et al* (2012) stated that biological (internal) causes of deterioration include respiration rate, ethylene production and action, rates of compositional changes (associated with colour, texture, flavour, and nutritive value), mechanical injuries, water stress, sprouting and rooting, physiological disorders, and pathological breakdown.

Strategies to Reduce Post-harvest Losses

Developed countries

Stuart (2009) provides an expanded list of ideas about how consumers, retailers, governments and other groups can reduce food waste, although financial costs, logistical hurdles and consumer preferences may stand in the way. In developed countries, food loss has declined in recent decades (Buzby *et al.*,2018) and new loss-reducing technologies are under development. Research and reliable loss estimates for the different foods and stages in the post-harvest chain are needed to identify where food waste might be minimized efficiently (WFP, 2013). More research is needed to know how agricultural policies, such as output-based subsidies, might promote over production and thus increase food waste and whether other policies could provide meaningful incentives to reduce food waste. The Waste and Resources Action Programme (which operates as WRAP) is a registered UK charity (WRAP) programme and is mapping waste along the food supply chain for selected foods in the UK, which should lead to recommendations for improving supply chain management. Interdisciplinary research is also needed to understand how improvements in supply chain management and technology implementation can decrease PHLs, particularly regarding pre-harvest and post-harvest linkages (FAO, 2015).

Less Developed Countries

The post-harvest systems of Less Developed Countries (LDCs) need considerable investment to create more markets that are formal and improve their performance to a point where Post-harvest losses are minimized. Some of these improvements need to take the form of public goods including infrastructure such as the development of networks of all-weather feeder roads so that crops can get to market, a problem especially severe in Africa where transport costs can be five times those in Asia (World Bank, 2017). Suitable market institutions need to be developed and promoted to enable marketing groups and individuals to best respond to market demand. Collective marketing can take various forms and for grains may include inventory credit schemes and Warehouse Receipt Systems to accelerate the efficient removal of the crop from the farmer into

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safe, centralized storage (Coulter and Onumah, 2002). Successful markets depend on a consistent supply of better-quality produce, and this can be achieved by adopting/adapting improved technologies that also lower Post-harvest losses. There is a wide range of such technologies (World Bank, 2014), but these are beyond the scope of this review. New technologies and approaches can be introduced through innovations systems and learning alliances World Bank and FAO, (2011), but adoption will depend on producers seeing a clear director in direct advantage, particularly financial benefit, and potentially on their access to credit. For a sustainable approach to Post-harvest losses reduction, an intervention planned within the context of the relevant value chain, and more than one type of intervention may be required. External agencies (public or private sector) need to develop and manage the introduction of interventions, but it is only the behaviour of actors within the value chain that can assure sustainability, market-orientated interventions need to be managed wholly or partly by the private sector while public–private sector partnerships are necessary to share investment costs and risks. To date, significant resources has been allocated for reducing food loss and waste (FLW/PHL) post-harvest losses around the world, although, most interventions in sub-saharan Africa were not focused directly on farm-level losses, under the assumption that most losses occur or start after farm operations. Most interventions focus on downstream links in the food supply chain, at least not with specific attention to the post-harvest losses implications (Saran *et al.*, 2012).

Innovative strategies for rice post-harvest loss reduction in Africa

Innovative production is a concept that describes an on-going re-engineering process with the major aims of evolving products and production engineering from prevalent trends based on advances in research for development (Romero *et al.*, 2017). Innovative rice post-harvest loss reduction trends in Africa is being re-engineered by evolving new value added products based on prevalent research trends. Since production innovation strengthens the productivity and resource use efficiency of production system, recent trends in Africa in the field of rice post-harvest system development is the innovative approach to the utilization of rice processing by-products as a strategy to strengthen the productivity of rice and resource use efficiency.

Interventions to Reduce Storage Losses for Smallholders

Although a huge challenge, storage losses can be mitigated by use of efficient storage technology, updating infrastructure and storage practices. It was observed that losses in the traditional storage structures were much higher than those reported in the literature, because the storage period was longer than that commonly used by farmers in these countries. It is important to understand their usefulness, technical efficacy, and limitations to promote their adaptability among the consumers. Irrespective of their effectiveness, the synthetic insecticides suffer from limitations such as high costs, development of genetic resistance in the treated pests, health hazards due to toxic residues, and environmental contamination (WFP, 2014). Residuals from synthetic fumigants could cause considerable loss of seed viability (Mutungi *et al.*,2014). Due to long use of phosphine, some insects have gained resistance to chemical fumigation in some countries (Abedin *et al*.,2012). Use of these chemical fumigation methods is even challenging in the traditional storage structures used in the developing countries, as most of them are open to re infestation. Another challenge with these chemicals is knowledge and training to apply these pesticides at the correct time and at the correct dose. The delayed treatment, adulterated chemicals, and incorrect dosage can reduce the efficacy of the treatment and result in high storage losses.

METHODOLOGY

The Study Area

Benue state is Located along longitude 8^{o}4’E and10^o E. Latitude 6^o 30’E and 8^{o}10^o’N, the state is endowed with abundant agricultural resources. About eighty percent of the total population depends on agriculture for their sustenance and livelihood. The state has favourable climatic conditions and fertile soils conducive for the rearing of animals and cultivation of virtually all crops grown in Nigeria. Most prominent among the animals reared are pigs, goats, poultry and cattle while major crops grown are cassava, yam, rice, soybeans, sesame, maize, citrus, mangoes, vegetables and sugarcane. There is also available large capacity for fish production as a result of wide expanse of natural water bodies in the state. Benue state is located in the middle belt of Nigeria

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and derives its name from river Benue which is the second largest river in Nigeria. The state has the following features:

Administration: Benue state was created in 1976 with Makurdi as the headquarters. At present, the state has 23 local government areas namely: Ado, Agatu, Apa, Buruku, Gboko, Gwer-East, Gwer-west, Guma Katsina-Ala, Kwande, Konshisha, Logo, Makurdi, Oju, Obi, Otukpo, Okpokwu, Ohimini, Tarka, Ukum, Ushongo, Vandeikya, And Ogbadibo. All these local governments are actively involved in agricultural activities. Demography: at present, the state has an estimated population of 5,663,355 million people, (NPC, 2021) and 4530.684 farm families. The average farm family size is seven (7) persons. Also, about eighty (80) percent of its current estimated 5.7 million people, that is about 4530684 persons earn their living from farming and other agricultural activities (SIB, 2012). The Estimated Land: the state has a land area of 33, 95sq.km.the land is level and made up of undulating plains at elevations ranging from 150m-300m above sea level. Climate: the state enjoys a tropical climate with two distinct seasons. The rainy season is from April to October while the dry season is from November to March. Annual rainfall varies from 1,750mm in the southern part to 1250mm in the north. Average annual temperature varies from 32^{O}c-38^{0}c.

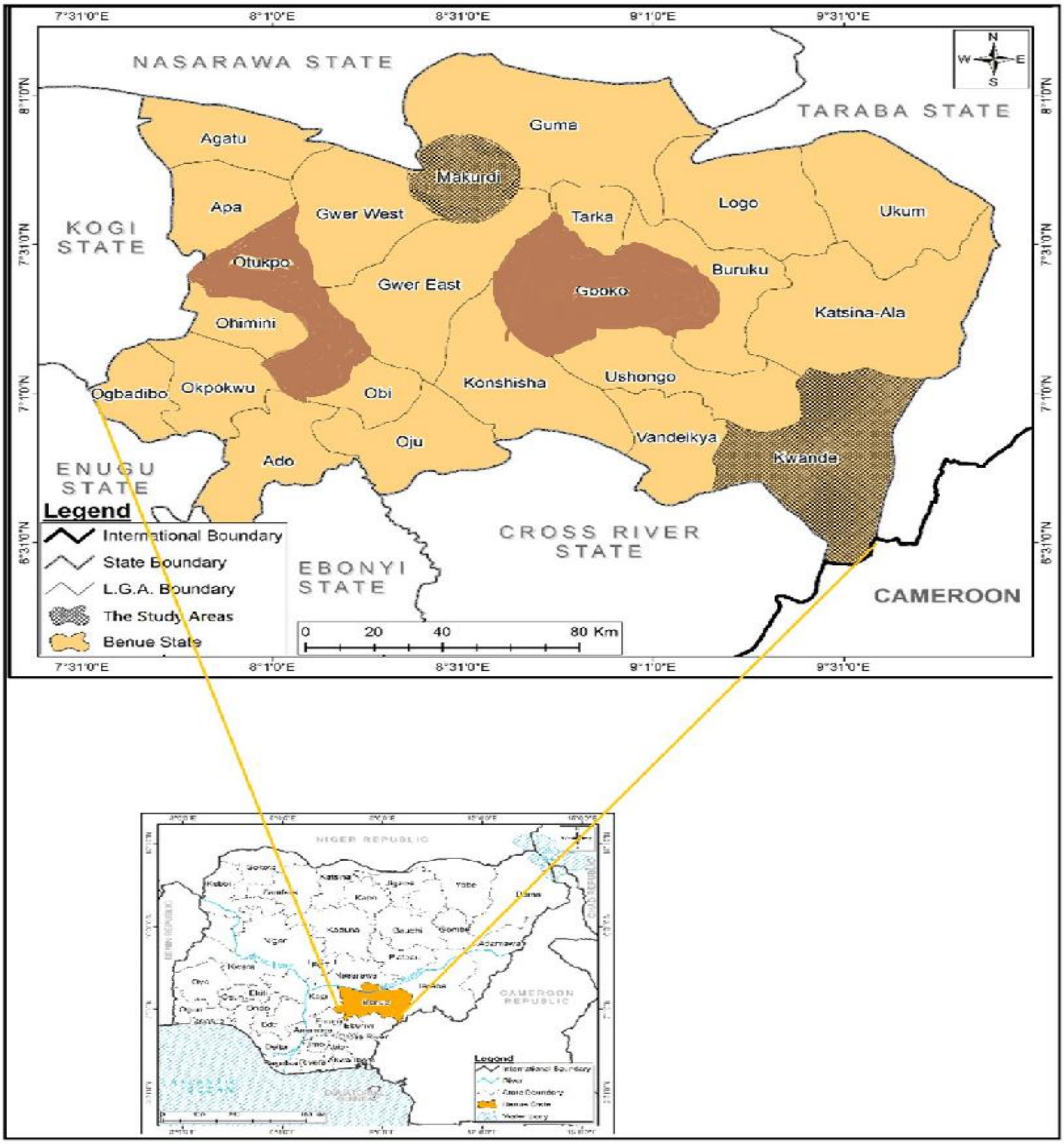

Figure 3: Map of the Study Area (Benue State) showing the Local Governments sampled

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Population and Sampling Technique

The population for the study will be rice processors in Benue state, Multi stage, purposive and simple random sampling procedures will be use for the selection of samples for this study. in the first stage, the three ADP zones in the state will be selected, while in the second stage, two rice processing local government areas will be selected purposively in the northern zone while one rice processing local government area will also be selected in each of the eastern and central ADP zones of the state which will give a total of four local government areas for this study, in the third stage, two rice producing communities within the local government areas will be selected purposively to give a total of eight rice producing communities for the study. Simple random sampling technique will be used to select 150 rice processors for the study using Yaro Yamane's formula. They LGAS include: Kwande, Gboko Makurdi and Otukpo Local Government Areas in Benue State.

Sample Size Selection

The sample size for this study was determined based on the 238 Rice processors obtained from the preliminary survey conducted in Benue State using Yaro Yamane's formula:

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

n = required sample size

N = population sample

e = error limit at 5% (standard error of 0.05)

1 = constant value.

Table 1: Sample Selection (Sampling)

BNARDA ZONES	LGAs	Communities	Sampling Frame	Sample Size%	Interval
Central Zone	Otukpo	Otukpo Rice mill	52	33	1.595
Eastern Zone	Kwande	Adikpo Rice Mill	79	50	1.595
Northern Zone	Gboko	Gboko Rice mill	107	67	1.595
Total			238	150	

Source: Preliminary Field Survey, 2024.

Methods of Data Collection

Data for the study will be from primary source. The primary data will be collected through the administration of structured questionnaires to the respondents.

Analytical Techniques

The analytical techniques used in this study included:

1. Descriptive Statistics;
2. Inferential Statistics

Descriptive Statistics

The descriptive statistics such as frequency distribution tables, means, and percentages will be employed for this study; these tools will be used to describe the socio-economic characteristics of the respondents, estimates of post-harvest losses by smallholder rice processors, and identify perceived causes of post-harvest losses by smallholder rice processors.

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i. The mean is expressed as:

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

Where

$\bar{x}$ = Mean

f=frequency

x=observations

fx=frequency of observations

S_i=losses at each activity during processing

i= 1,2 .n

Σfx = sum of individual observations

n = sample size

Inferential Statistics

Multiple linear regression model

This model was used to analyse factors influencing post-harvest losses of rice during processing

The model is stated in its implicit form as

$$Y_i = \beta_i x_i + \varepsilon_i,\ i = 1,2.....n \qquad (4)$$

Y_i = total post-harvest losses recorded by respondents in kg/ha

x_i = independent variables ranging from 1,2,3………………12

β_i = parameter estimates

n = number of observations

ε_i= error term

The explicit form of the model is:

$$Y_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + ei \qquad (5)$$

Where:

Y_i= Processing losses of rice (kg)

X_1 = Milling Technology (Dummy: 2 modern 1 Traditional)

X_2 = Sex of the respondents (Dummy: 2 for male 1 for female)

X_3 = Source of raw materials (Dummy: 2 from the farm 1 purchased from the market)

X_4= Educational status (years)

X_5 = Scale of operation (Dummy: 2 for large scale 1 for small scale)

X_6 = Drying Quality (2 well dried 1 Not well dried)

X_7 = Processing experience (years)

X_8 =Storage quality (Dummy: 2 well stored 1 not well stored)

X_9 = Transportation losses (Kg)

X_{10} = Training Received (Dummy: 2 Training received 1 Training not received)

$X_{11=}$ Level of Funding (₦)

$\beta_1 - \beta_{11} =$ parameter estimates

e_1 = Random error term

RESULTS AND DISCUSSION

Age of the respondents

The age distribution of the respondents is shown in Table 2. The result shows that 43.33 % of the respondents fell within the age group of 43-50 years of age, 31.33% fell within the age group of 31-44 years of age, and 14.67 % fell in the age group of 59-72 and above. The mean age of the respondents was 41 years. This therefore could be attributed to the high interest of youth in the processing of agricultural products. This group comprised of youths in their prime age, it indicates the availability of energetic workforce that is required in the farm processing activities. This implies that the youths that are energetic, were more engaged in the processing of rice in the study area.

Sex of the respondents

The result of the sex distribution of the respondents is shown on Table 2. Sex is important in agriculture; it determines the type of farming activity a farmer performs (Iorzua *et al.*, 2020). Agricultural processing activities that require fewer efforts are performed by both male and female farmers, while female farmers mostly perform activities like winnowing, processing and transportation. The result shows that 63% of smallholder rice processors were male while 37% were female. This shows that both male and females are involved in the rice milling operations. Sex involvement in rice processing and post-harvest handling is well recognised among smallholder rice millers (Iorzua *et al.*2020). In many cases, women are more active in these operations. In Benue State, men, women and the youths are the major players in rice milling and women do handling of parboiling of rice and most post-harvest handling activities of rice. Besides there is division of labour which exists among the sexes, also, gender has become a cross cutting issue in terms of promoting equity. The issues highlighted liaising male and female farmers to appropriate programmes, which target the improvement in household food security, and poverty reduction. Ayoola *et al.* (2011) stated that women were more involved in food processing, marketing and maintenance of the homestead farm.

Marital status of the respondents

Marital status means living singly or in a matrimonial relationship, which includes past and presents situation concerning whether one is single, married, separated, or divorced (Ibrahim and Alero, 2012). The result in Table 2 Shows that 47.33% of the respondents were married, while 26.67% of the respondents were divorced or divorcee. The result also shows that, 16.67 % of the respondents were single, not yet married; the result also shows that, only 9.33% of the respondents were widows/widowers. Majority of the farmers were married implying that, they may have a sense of sharing responsibilities that could foster agricultural production more especially in the use of recommended Trainings on rice post-harvest losses reduction in the study area. Being married in an African society signifies the sign of maturity and responsibilities according to Daneji, (2011). Thus, since majority of the respondents were married, it implied that they may be responsible and respectable in the society. Also, because of the responsibility of providing daily needs of the family, the married farmers could be more compelled to invest more in agricultural production than unmarried ones since agriculture is the major source of livelihood. This finding is in agreement with Egbo and Chukwu (2015) which noted that

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majority of farmers were married. The major reason for marriage by farmers could be attributed to getting additional helping hands both at home and on the farm thereby providing family labour required for agricultural production. Taiwa and Omifolaji (2013) also reported that marriage confer some level of responsibility and commitment on individuals who are married. These shows that majority of the respondents administered questionnaires for this study were married and have responsibilities. This result also corroborates previous research outcome on marital status of farmers in Nigeria Mustapha *et al*. (2012) reported that married persons could be responsible people who have family to cater for.

Scale of operation

This is the number of bags of rice processed by the respondents. This was measured in number of 100kg bags. Table 2, shows the distribution of respondents according to number of 100kg bags processed. The result shows that majority of the respondents 44.67% processed 7 to 10 of 100kg bags of rice per week; 4 to 6% of the respondents processed 4 to 6 of 100 kg bags of rice per week, while 16.67 % of the respondents processed 1 to 3 of 100 bags of rice per week in the study area. The result revealed that, 6.66% of the respondents processed 11 to 13 of 100kg bags of rice per week and only 5.33% processed 14 of 100kg bags of rice and above. This is a pointer to the fact that, rice milling or processing in the study area is still at subsistence level and dominated by small scale processors. This can be attributed to inadequate capital. Since processors lack the means to procure modern processing technologies

Level of education of the respondents

Education is regarded as an avenue for attaining managerial skills; this then increases their awareness in respect of new technology and practices that in turn increases their output. It is true that a person who is well educated is more likely to approach more positively, logically and analytically towards different things in different matter (Khan *et al.,* 2020). This was measured in terms of the total number of years of schooling. More processors that are educated are assumed to be able to process information and search for appropriate technologies to alleviate their processing or milling constraints. The belief is that education gives millers the ability to perceive, interpret, and respond to new information faster than their counterparts without education. The educational qualification of the respondents presented on Table 2 shows that most of the respondents have attained some level of formal education. The result shows that about 36.66% of respondents attained secondary school education while 25.33% of the respondents had no formal education. The result shows that, 22.00% of the respondents attended primary education and only 16.00% of the respondents attended Tertiary education. The mean number of years spent in formal education was 4 years. In all, about 74.67% of the respondents attended formal education and could read and write. The high percentage of literate processors among the sampled respondents implied that, they are capable of adopting innovations and could at least, read and write and have the ability to reduce losses. Education in rice farming is a key factor used by governments around the globe and have routinely advocated investment in education. In addition, information is consistently an essential pillar in the development of farmers in Nigeria because their livelihoods can be improved Information and education raise a positive return to agriculture (Adebayo *et al*., 2012). Therefore, farmer's accessibility to information has the tendency to influence the behaviour towards handling of agricultural produce. In addition, adoption of better access to rough rice handling is dependent on the extent of farm education a farmer engages with. Constant interaction with information source will have an effect on the adoption behaviour of the farmer. Farm education will give the rice farmer a first-hand approach to adjust from poor handling of rough rice to a more improved way of handling the food commodity during and after harvest. In addition, rice farmers need applicable information and knowledge on postharvest handling techniques and opportunities to increase output and to sell their surplus (FAO, 2013). This implies that the more educated a respondent is, the easier the adoption of post-harvest technologies could become. This agreed with Yusuf and Fakayode (2012) who found that low level of literacy among the respondents could reduce the adoptability of innovations and effective use of post-harvest technologies.

Distribution of the respondents according to Milling or processing experience

Milling and processing experience is the measure of the period or number of years an individual has been involved in processing. According to Mubi *et al,* (2012) farm experience enables farmers to adequately

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organise and manage their farm enterprise in expectation of higher profits. The distribution of the respondents according processing experience is shown in Table 2, it can be seen that 36.67 % of the respondents had experience of milling rice for 10 to 15 years, 30.00% of the respondents has been milling rice for 6 to 10 years, while 21.33% of the respondents has been milling rice for 16 years and above and 12.00% of the respondents milled rice for 1-5 years. The mean number of years of milling rice was approximately 10 years. This means that, the respondents have experience in rice processing. This also implies that, the respondents were not only involved in rice processing activities but were also well experienced in rice processing, his experience also increase because of long years of processing.

Table 2. Socio Economic Characteristics of the Respondents

Variable	**Frequency**	**Percentage**	**Mean**
Age			
17 – 30	16	10.67	
31 – 44	47	31.33	
45 – 58	65	43,33	37.5
59 – 72 and above	22	14.67	
Total	**150**	**100**	
Sex			
Male	102	68.00	
Female	48	32.00	
Total	**150**	**100**	
Marital Status			
Married	71	47.33	
Single	25	16.67	
Divorced	40	26.67	
Widow/widower	14	9.33	
Total	150	100	
(No. of bags processed/week)			
<1-3 bags	25	16.67	
4- 6 bags bags	40	26.67	
7-10 baggs	67	44.67	30
11-13bags 14 bags and above	10 8	6.66 5.33	
Total	150	100	
Educational Attainment			
No formal Education	38	25.33	
Primary Education	33	22.00	
Secondary Education	55	36.66	9.8
Tertiary Education	24	16.00	
Total	**150**	**100**	
No. of years Processing rice			
<1-5 year	18	12.00	
6-10 years	45	30.00	
10-15years	55	36.67	4.33
16 years and above	32	21.33	
Total	**150**	**100**	

Source: Field Survey, 2024

Factors influencing Post Harvest Losses by the respondents

The result of factors influencing post harvest losses of rice by rice processors in Benue State is presented on table 4. Four functional forms were tried, which included linear, semi-log, double log and exponential forms.

The models were examined in terms of appropriateness. The linear functional form was found to be the best fit. The equation was significant at 1% level with a coefficient of determination (R^2) of about 57.The value of the R^2 implies that about 57% of the losses incurred by the respondents is explained by the eleven variables included in the model. Four variables were significant with their signs conforming to econometric criteria, meaning a positive relationship exists between these variables and the dependent variable, increase in the coefficient of any of these variables leads to an increase in the dependent variable which is processing losses of rice at the processing stage. Scale of rice processing, Post harvest losses due to inadequate drying facilities, and inadequate transportation facilities were statistically significant at ($p \leq 0.01$) and positive implying an increase in losses caused by Scale of Operation, drying inadequate drying facilities, and inadequate transportation facilities will lead to an increase in the total post harvest losses of rice at this stage by the magnitude of their coefficients. The result of the study revealed that, 26% of the losses during processing of rice by rice processors is as a result of scale of operation of rice processing, majority of those interviewed were small scale rice processors with limited processing capacity, basic equipments and often manual or semi mechanized operations. This implies that, small scale processors may experience higher post harvest losses due to limited access to modern equipments and technology, insufficient training and expertise in processing and storage, inadequate infrastructure, such as storage facilities and transportations. The interaction is that, small scale rice processors may not have access to modern drying facilities leading to higher moisture content and increased losses. Result also revealed that, 23% of the post harvest losses of rice during processing was caused by inadequate drying facilities in the study area, the implications of inadequate drying facilities is that, inadequate drying facilities lead to high moisture content in rice, causing mold growth, fungal infections, and ultimately, a decrease in rice quality. Drying facilities interact with transportation and storage conditions, if rice is not properly dried, it may be more susceptible to damage during transportation or storage. The result also revealed that 0.3% of the losses during processing are caused by Transportation, small scale rice processors often rely on manual transportation, increasing the risk of physical damage and losses. Milling technology, small scale processors often use basic milling equipments, but limited capacity and maintenance issues still lead to losses The coefficient of milling technology was statistically significant at 1% but negative implying that, outdated or inefficient milling technology can result in high levels of breakage, poor grain quality and reduced yields. Additionally inadequate milling technology can lead to contamination and adulteration. Milling technology interacts with drying facilities and transportation, if rice if not properly dried, it may be more challenging to mill efficiently , leading to increased breakage and losses, decrease in the use of improved milling technology will lead to increase in the value of the dependent variable by the magnitude of its coefficients -0.74 %. Educational attainment was also statistically significant at 1% but negative implying that, lack of training and capacity building for rice processors can lead to inadequate knowledge and skills, resulting in poor handling, processing, and storage practices. Training and capacity building, they had some access to training programs but limited resources and inadequate follow up still lead to knowledge gaps. Training and capacity building interacts with all other factors, as proper training can improve handling, processing, and storage practices, ultimately reducing post harvest losses, decrease in the number of years of education will lead to increase in the value of the dependent variable by the magnitude of its coefficients -0.33%. Source of raw materials, funding level of rice milling business and number of years of milling rice or experience were statistically not significant but negative implying that these variables are contributing negatively to the dependent variable Storage losses was also statistically not significant but positive implying that, as storage losses increase, the dependent variable which is post harvest losses will also increase at the magnitude of the coefficient, while coefficient of sex was also statistically not significant and negative ..

Table 3 Factors influencing post-harvest losses incurred by smallholder rice processors in the study area;

Processing losses	Coefficient	Std. Err	t	P>|t|	95% conf. Interval	
Training received	-4.17431	7.912133	-0.53	0.599	-19.819	11.47038
Milling technology	-17.87544	5.293074	-3.38	0.001***	-28.34145	-7.409422
Source of raw Materials	-5.639387	7.766002	-0.73	0.469	-20.99513	9.716357
Education	-0.7418504	0.4749148	-1.56	0.121*	1.680901	-.1972004
Scale of Operation	26.2234	5.410991	4.85	0.000***	15.52423	36.92258
Drying Losses	23.37694	7.443348	3.14	0.002***	-38.09469	-8.659178
Processing experience	-0.3651131	0.3676445	-0.99	0.322	-1.092058	0.3618316

Storage losses	0 .0225568	0.0768136	0.29	0.769	-0.129327	0.1744406
Transport	0.336611	0.0563419	5.97	0.000***	0.225206	.448016
Sex	2.620477	4.09341	-0.64	0.523	-5.473438	10.71439
Funding level	0.0012	0.003201	-0.37	0.708	-0.0051292	.0075293
_cons	69.06609	20.58618	3.35	0.001***	28.36096	109.7712

Source: Field Survey, 2024

Number of obs= 150 F(11, 138) =17.09 Prob > F =0.0000 R-squared = 0.5766 Adj R squared = 0.5429

******* Significant at 0.01% ** significant at 0.05%

CONCLUSION

This study concludes that, Post harvest losses among rice processors in Benue State, Nigeria are substantial. Improving drying facilities, storage conditions, and transportation efficiency as well as providing training on post harvest management and increasing funding can significantly reduce post harvest losses in the study area. This study therefore recommends that, there should be increased investment in modern drying facilities and storage infrastructure, provide training on post harvest management for rice processors, improve transportation networks and efficiency, increase funding for post harvest management initiatives and develop and implement effective pest and rodents management strategies.

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