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Research Article

An Assessment of Cassava Post-Harvest Losses (PHL) in South-West Nigeria: A Case Study of Oyo-State, Nigeria

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Abstract

The paper is on an assessment of cassava post-harvest losses (PHL) in South-West Nigeria. A multistage sampling technique was used to select 150 farming households for interview on their experiences on post-harvest losses on cassava production and processing. Analysis of the data was done using descriptive statistics and econometric models where necessary. The average percentage post-harvest loss of the harvested cassava was 13% with 96% of farmers indicated experiencing PHL from harvesting to marketing. Improved varieties experience more losses (75%) than local varieties (25%). Losses based on seasons show that more cassava were lost in dry season (61.4%) compare to rainy season (38.6%). The highest PHL was from gari processing and the percentage of households that have processing equipment was low but accessibility was high. Data from the field was modeled using Tobit regression model to determine factors influencing PHL among cassava farmers. Results show that being a female farmer/household head ($P < 0.01$), years of membership of association ($P < 0.05$), higher dependency ratio ($P < 0.01$), use of local cassava stem ($P < 0.05$) and having non-farm occupation ($P < 0.05$) reduced the probability and intensity of PHL significantly. The result shows that the higher the number of members of household ($P < 0.01$) used for farming activities the more the PHL. Factors influencing post-harvest losses among farmers that processed cassava tuber to other products were determined using Tobit model. The dependent variable was the percentage of cassava tuber reserved for processing lost during processing. The Tobit model result revealed that married households incurred more PHL ($P < 0.1$) than single ones, access and obtaining credit ($P < 0.05$) and the percentage of annual cassava root processed ($P < 0.01$) were positively correlated with PHL. Belonging to an association ($P < 0.05$) and use of family labour ($P < 0.01$), being a member of association ($P < 0.05$) were negatively and significantly relayed to PHL. In regard to types of products processed by farmers, only fufu and starch processing had tendency to reduce PHL although not significantly correlated. In another vein, processing of garri and lafun (cassava powder) had tendency of increasing PHL. In case of lafun, the tendency was significant ($p < 0.01$). The study considered the use of siever, knife_peeler, grater and presser machines; all the equipment except presser (significant at $P < 0.1$) had tendency to increase PHL. Use of knife for peeling cassava ($P < 0.01$) significantly increased PHL. Stakeholders should consider those factors influencing post-harvest losses under production, and adapt it to curb PHL where necessary. Extension agents should consider the three stages of production function and pass it on to farmers on how to employ resources in an optimal way. There is also seasonal variation in PHL, measures to reduce PHL during dry season should be considered and researchers along with extension institutions should work on improved cassava varieties with durable ability not to spoil after maturity, not just having higher yield. On processing, there are now processing machines like mechanical peelers that can be used to reduce PHL, Ministry of Agriculture can assist farmers both at federal and state levels to assist farmers in acquiring them or assisting them through subsidy. Better measures of producing cassava products should be considered as to reduce wastage during their processing.

Keywords: Post-Harvest Losses (PHL); Tobit Regression Model; Dependency Ratio; Processing Machines; Seasonal Variation

Introduction

In Sub Saharan Africa (SSA), 36% of food harvested is lost, equating to an average 167 kg/cap per year where only 7 kg is at the consumer level [1]. The losses mainly occur at harvest: 12.5%, post-harvest 12.7%, processing and packaging 4.5%, distribution 4.6% [2]. Food losses take place at various stages in the food supply chain which include production, post-harvest and processing [3]. The distribution of losses across the value chain in developed economies differs from that in developing economies. In the latter, more losses occur towards the production stage, while in the developed economies more occur towards the consumption stage [4]. Substantial food losses occur at the post-harvest stages; during marketing and processing in developing countries [5]. Food losses occurring at the end of the food chain (retail and final consumption) are better categorized as food waste, which relates to retailers' and consumers' behavior [6]. In the opinion of [4], the term 'food loss' can refer to a loss of quantity and/or quality; loss of quantity is measured in terms of weight and volume while loss of quality requires subjective evaluation, in most cases in the absence of appropriate standards and tools; loss of weight due to a reduction in moisture content cannot be described as loss since the nutritional quality of the food remains intact.

[1] distinguished between food loss and food waste: Food waste generally relates to behavioural issues and is often defined as edible food that has been unutilized as a result of human action or inaction. Food loss on the other hand is food that has decreased in quality and is no longer fit for human consumption due to inadequate supply chain systems [6]. defined food losses as the decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption while [7] submitted that losses occur all along the value chain. *According to [8], g*reat losses are sustained from the moment the food crop is ready to be harvested until it reaches the consumer's table. In her perspective, these can be attributed to two major causes which are infestation by microorganisms, insects, and rodents; and the fact that crops are living plant tissues which during storage undergo metabolic and physiological activities that utilize nutrients, these activities being adversely affected by various environmental conditions with resultant large losses of food*.*

Literature review

[9] noted that Nigeria's diverse climate, from the tropical areas of the coast to the arid zone of the north, make it possible to produce virtually all agricultural products that can be grown in the tropical and semitropical areas of the world, adding that yearly, farmers produce a lot to boost the economy but most are lost at post harvest stage. The post-harvest technological scenario in cereals, grain legumes, oilseeds, fruits, vegetables, tubers, roots etc. of Nigerians present a dismal picture and are mostly comprised of traditional techniques practiced by growers, traders and the processors resulting in considerable deterioration of physical and nutritional qualities of harvested crops [10] as cited in [9]. In the opinion of [11], the most important losses in agricultural production which involve the greatest costs on the farm economy occur post-harvest, adding that it is estimated that worldwide between 10 and 40% losses of agricultural produce occur post-harvest. In developing countries, the lack of access to cold chain systems and reliable energy sources required to power them, results in large post-harvest losses - 10-50% food loss - [1]. In accordance with the above, [12] added that in some developing countries post-harvest losses can amount to as much as 40% of production. Once harvested, roots and tubers are more perishable than grains; this is related to their higher moisture content, greater susceptibility to physical damage and higher metabolic activity [13]. Several species of fungi and in some cases bacteria participate in post-harvest deterioration and rots of tubers and agro-produce [11].

Cassava is an important regional food source for 200 million people. This is nearly one-third of the population of sub- Saharan Africa. In Nigeria, it is one of the most important food crop. It is the most widely cultivated crop that provides food and income to over 30 million farmers and large numbers of processors and traders [14]. Cassava (Manihot esculenta) has a shelf life that is generally accepted to be of the order of 24-48hrs after harvest [9]. It was reported by [13] that cassava has a particularly short shelf-life (1-3 days). Roots and tubers contain over 65% moisture when harvested but lose up to 40% after 2 – 3 months in storage, with cassava roots degrading physiologically after 5 days [15]. Apart from respiratory losses, cassava tissue becomes soft and rotten after exposure to the atmosphere for only a few days [16] in [9]. Fresh cassava tubers are very highly perishable under ambient conditions [11]. During transport and processing, losses of cassava roots quality and quantity can occur with consequences on prices and returns along the value chain. From delayed harvesting to transport and processing, cassava roots may lose value. In addition to physical loss of the crop, post-harvest deterioration causes a reduction in quality, which has implications on marketing of cassava leading to price discounts [17]. It has been argued that in the case of subsistence farmers, post-harvest losses are negligible since, when cassava is for household consumption, the farmers harvest just the quantity necessary for the preparation of individual dishes or immediate processing [13,17] added that as storage of roots is rare, the most common and sensible way to minimize losses is to consume or process them as soon as possible after harvesting. It was reported further that this unfortunately, does not always happen and significant amount of roots spoil or incur various degrees of quality deterioration. These losses can have a broad range of negative impacts such as loss of income and food intake and represent an obstacle for transforming cassava from subsistence to a cash crop, particularly in Nigeria. Against this background, an understanding of the various features of cassava post-harvest losses in Nigeria becomes very important as part of research initiatives to contribute to food security. The main objective of this research was to assess post-harvest losses at different nodes along the value chain using a platform where the farmer produces and processes cassava (short value chain). The more complex versions will include some intermediaries, transporters before reaching the processors who can also be of different sizes then to local or export markets. The remainder of this report includes the objectives of this research, of the methodology used for measuring post-harvest loses and a section on the main results and subsequent discussions for each of the value chain actors interviewed and finally, the report presents conclusion and implications.

Methodology

This study was carried out in three zones in Oyo state, namely Oyo, Saki and Ogbomosho and it adopted a cross-sectional research approach. Farmers as actors along cassava value chain were randomly selected and interviewed by means of structured questionnaires. On farming households, a total of 150 farm household respondents were randomly selected from the list made available by zonal Agricultural Development Program Managers and 50 respondents from each of the zone were interviewed. A structured questionnaire was used to collect responses from farmers on their experiences on post-harvest losses on cassava production and processing. Analysis of the data that were done using descriptive statistics and econometric models where necessary.

Theoretical model

In statistics, a Tobit model is any of a class of regression models in which the observed range of the dependent variable is censored in some way. The term was coined by Arthur Goldberger in reference to James Tobin, who developed the model in 1958 to mitigate the problem of zero-inflated data for observations of household expenditure on durable goods. Tobin's idea was to modify the likelihood function so that it reflects the unequal sampling probability for each observation depending on whether the latent dependent variable fell above or below the determined threshold. For a sample that, as in Tobin›s original case, was censored from below at zero, the sampling probability for each non-limit observation is simply the height of the appropriate density function. For any limit observation, it is the cumulative distribution, i.e. the integral below zero of the appropriate density function. The tobit likelihood function is thus a mixture of densities and cumulative distribution functions. Tobit analysis is used to estimate the likelihood of PHL (of cassava), and the intensity of PHL (in term of percentage cassava/cassava products lost). Tobit is preferable to Ordinary Least Squares (OLS) estimation because it allows for inclusion of observation with non PHL. The model expresses farmers' PHL as a function of a linear combination of observable explanatory variables, some unknown parameters and an error term (μi). The simple model can be presented as:

$Y_i^* = \beta X_i + \mu i$……………………………………………..1

Algebraically expressed for the ith farm operator:

$Yi = \beta 0 + \beta iX1i +, \ldots \beta NXN, i = 1, \ldots, N$………… 2

Such that:

$Y_i = 0$ if $Y_i^* \leq T$

$Y_i = Y_i^*$ if $0 < Y_i^* < 1$ $(i = 1, \ldots, N)$

$Y_i = 1$ if $Y_i^* > T$

Where

Y_i = is the observed dependent variable, e.g., the PHL on cassava/cassava products.

Y_i^* = is the non-observable latent variable representing the PHL

T = is the critical (cut off) value which translates into $Y_i^* > T$, as farmer losses cassava tuber or products and $Y_i^* \leq T$, as farmers don't have losses

N = is the number of observations.

X_s are vectors of explanatory variables as explained below (Table 1).

Empirical model

Tobit model was fitted with the data collected. The dependent variable is the percentage of cassava/cassava products lost at harvest or during processing (PHL). In order to justify the use of Tobit, an OLS estimates of the model was done where necessary and the results presented. The empirical model was specified below for cassava production and processing in implicit forms.

PHL (Production) = F (FEMALE, MARRIED, FARM_EXPERIENCE, NONFARM_OCCUPATION, YRS_ASSOCIATION, CREDIT, IMPROVED_CASSAVA, SPOIL_VARIETY, AREA_CULTIVATED, PHL_SEASON, FAMILY_LABOUR, CASSAVA_PROCESSING, DEPENDENCY RATIO, μ_i)

Variable	Variable Symbol	Description	Unit	A priori expectations.
Dependent variable				
Post-harvest losses	PHL (Production)	Percent of cassava tuber lost at production	Percent	
Independent variables				
Gender	Gender	Dummy variable: 1 = Male, 0 = Female	Dummy	±
Marital status	Married	Dummy variable: 1 = Married, 0 = Otherwise	Dummy	±
Farm experience	Fexperience	Experiences in cassava and farming operations	Years	-
Major occupation	Moccupation	1 = Farming; 0 = non farm job	Dummy	-
Membership of association	YRS_association	Years in association	Years	-
Credit	Credit	1 = Obtained credit; 0 = Otherwise	Dummy	-
Type of cassava	Cassavat	1 = improved cassava; 0 = Local variety	Dummy	±
Tuber spoilt after maturity	Spoil_variety	1 = Yes; 0 = No	Dummy	-
Area of cassava cultivated	Area	Area of land occupied by cassava planted	Hectares	±
Season of cultivation	Phl_season	1 = Dry; 0 = Rainy	Dummy	±
Family labour	Flabour	Per capita money spent in buying food items	Local currency (Naira)	±
Do you process cassava	Cprocessing	1 = Yes; 0 = No	Dummy	-
Dependency ratio	Dependencyr	Ratio of dependent to those working in the family	Ratio	-

Table 1: Definition of Variables and A priori expectations.

PHL (processing) = F (AGE, GENDER, MSTATUS, ASSOCIATION_MEMBERSHIP, CREDIT, FAMILY_LABOUR, $FAMILY\_LABOUR^2$, ANNUAL CASSAVA_PROCESSED, GARRI, LAFUN, FUFU, STARCH, SIEVER, KNIFE_PEELER, PRESSER, GRATER, μ_i) -

Description of variable

Gender

According to [18] all aspects relating to post-harvest issues can be "gendered". Thus in the agricultural management of crop, understanding gender relation is important. Various studies have indicated that gender is an important variable affecting agricultural activities, which have a bearing on post-harvest loss (PHL). Generally, reviewed literature is not in consensus on how gender influences post-harvest loss [19]. stated that despite the main challenges faced by women farmers, empirical study found that the effect of gender on households post-harvest cereal loss was substantial; the findings indicated that it is especially female-headed households that experienced lower rates of post-harvest losses; this is also supported by [20]. These show that women levels of post-harvest loss is minimal regardless of the challenges they are facing. However, the influence of gender on post-harvest loss seems to have divergent views from the studies of [21] and [22]; in determining the factors that affect post-harvest losses at the farm level, [21] and [22] showed that female headed farm households experience higher levels of PHL than the male-headed ones.

Age

The influence of age on agricultural activities and mainly production in developing countries have shown varying and sometimes contradicting views on the role of age on agriculture. There is no consensus on the contribution of age to agriculture and majority of the studies done are directed on production and sometimes on post-harvest loss [20]. In Jamaica where agriculture occupies an important place in the life course of many elderly people, [23] reported that the rural concentration of elderly population has negative consequences for agricultural production and post-harvest losses. According to [24] in central American countries, the probability of adoption of improved storage systems and other innovations to improve production and curb post-harvest losses declines with the age of the household head. This is consistent with findings of other studies in both developing and developed countries [25,26], which show that older individuals are more reserved and rigid regarding the introduction and acceptance of innovations due to declining cognitive and learning abilities and thus influence their agricultural activities as well as post-harvest loss of cereals. However, [27] hold a different view. Agricultural knowledge and skills in agriculture, such as production, operation, and management, increase with age. The accumulated knowledge and skills help farmers to maximize the efficient use of agricultural input, such as pesticides and fertilizers, as well as labor input and overall reduced post-harvest loss. Due to the accumulated knowledge, older farmers are able to deal with post-harvest challenges that may lead to post-harvest losses. [18] note that in addition to gender, communities can be dis-aggregated by age, wealth, household composition, and health status, among other. This diversity is important.

Non-Farm Occupation

The influence of alternative source of income on post-harvest cereal loss has been reviewed by a number of authors. In Ghana adoption of new technologies aimed at increasing productivity and reducing post-harvest losses of household's farmers was associated with resources [28]. The wealthier farmers are better able to bear risks and thus, are more likely to try new technology. This is in consensus with a study in Zambia by [29] which indicated that alternative source of income in a household can be invested in agriculture, thereby allowing the farmer to tend to the production needs and measures to curb losses. This leads to increased yields and food availability within the households. In Ethiopia, livestock ownership, which is an alternative source of income has influence on cereal productivity and post-harvest cereal loss [30]. In the study, farmers with more livestock, which could be readily converted to money, were able to buy modern farm inputs to prevent loss than those who owned fewer livestock units. Similarly, in Uganda, smallholder farmers with cash savings at the beginning of harvesting and post-harvest periods had a longer storage period [31]. In an impact analysis study, [32] found major differences in socio-economic and other baseline characteristics between adopters and non-adopters of metal silos in Kenya and they found out that these technologies are still only within reach of the relatively more affluent or productive farming households.

Season (Dry and Rainy)

Climate and other conditions attract a huge number of factors, which influence post-harvest loss since they contribute to the destruction of crops [33]. The interaction between moisture and temperature is vital, molds can grow on produces over a wide range of temperatures, but the rate of growth is lower with lower temperature and less water availability. Humidity as a factor influencing post-harvest losses was studied by [34]; according to them there is movement of water vapor between stored food and its surrounding atmosphere until equilibrium of water activity in the food and the atmosphere. A moist food will give up moisture to the air while a dry food will absorb moisture from the air. Dried or dehydrated products need to be stored under conditions of low relative humidity in order to avoid adsorbing moisture to the point where mold growth occurs [34]. Rainfall influences both the quantity and the quality of produces produce leading to post-harvest loss as [35] observed. According to [36] pre-harvest rainfall patterns help to proximate the total harvested quantities and humidity conditions. Rainfall during and after the harvest, has an influence on post-harvest loss of produces; at the harvesting and drying stages, climatic factors (particularly lower temperatures and rainfalls during the wettest periods) lower PHL substantially [19].

They further foster early pest infestation and affect the dry matter content before storage, there increasing post-harvest cereal loss when post-harvest rainfall is higher [36]. The condition is inevitable in sub-Saharan Africa where both small- and large-scale farmers rely almost exclusively on natural sun-drying process. Therefore, any rainfall or damp weather during pre-harvest, harvest and post-harvest periods can be a serious cause of post-harvest losses [18]. This was earlier observed by [37] in a study in Swaziland where rainfall being high during harvesting or close to harvesting leads to a lot of produces not properly dried and therefore rotting. A study in Eastern Kenya by [38] identified weather changes as a factor contributing to post-harvest losses especially during storage. These losses impact on food security, since quantity is reduced and quality, which is poor makes it unfit for consumption. The study identified poor drying of grain/produce and excessive rains during harvesting, which dampen the crop resulting in formation of fungus and high temperatures, and high humidity during drying those further favors development of fungus. The study focused on the weather changes and their influence on post-harvest loss.

Farm experience

Farming experience confers on the farmers the techniques of minimizing losses and improving productivity. The analysis of the determinants of tomato post-harvest losses by [39,40]. showed that the t-ratio of farming experience was negative and statistically significant ($p < 0.01$). The implication is that increase in farming experience reduced the quantity of post-harvest losses in tomato. This is in line with work of [21] and [41].

Farm area

[39] also showed that farm size significantly ($p < 0.01$) increased the quantity of post-harvest losses in tomato. Due to the perishability of tomato crop, large farm size would increase pressure on farmers, and since the farmers are largely uneducated, large farm size would increase losses, this is also in line with the paper of [42,22]. The principal determinants for PHL at farm level were sex of household head, household size, education, monthly production, and proportion of land under banana.

Education

According to [22], being educated is expected to reduce post-harvest losses, since educated farmer is informed with information that will enable him manage his enterprise profitably Household size.

Contrary to findings [19,22,40,42] finds that household size has a positive and significant coefficient on PHL. This could be that larger households (a proxy for labor) are more likely to grow more banana, and in turn, more likely to experience higher PHL, especially during surplus seasons.

Production level: quantity produced

PHL have been found to be positively associated with the level of production [22,42]

Variety

According to [39], tomato fruit should be harvested at mature green state for long distance marketing and full ripen for fresh consumption in order to reduce post-harvest losses [43]. The variety

Variable	Variable symbol	Description	Unit	A priori expectations.
Dependent variable				
Post-harvest losses	PHL (Processing)	Percent of cassava tuber lost during processing	Percent	
Independent variables				
Age of the farmer	Age	Age of the farmer	years	±
Gender of the farmer	Gender	Dummy variable: 1 = Male, 0 = Female	Dummy	±
Marital status	Mstatus	Dummy variable: 1 = Married, 0 = Otherwise	Years	±
Association membership	Massociation	Membership of association	Dummy	-
Obtaining credit	Credit	Obtained credit for farming	Years	-
Family labour	Flabour	Family members participating in processing activities	Number	±
Square of family labour	$Flabour^2$	Squared of FLABOUR	Number	±
Annual cassava tuber processed	Cassavap	Total quantity of cassava processed	Tonnes	±
Processing garri?	Garri	Is the family processing garri?	1 = Yes; 0 = No	±
Processing lafun	Lafun	Is the family processing Lafuni?	1 = Yes; 0 = No	±
Processing fufu	Fufu	Is the family processing Fufu?	1 = Yes; 0 = No	±
Processing starch	Starch	Is the family processing Starch?	1 = Yes; 0 = No	±
Own siever	Siever	Family own siever	1 = Yes; 0 = No	±
Own peeling knife	Pknife	Family own PKnife	1 = Yes; 0 = No	±
Own presser	Presser	Family own Presser	1 = Yes; 0 = No	±
Own grater	Grater	Family own Grater	1 = Yes; 0 = No	±

Table 2: Definition of Variables and A priori expectations.

of tomato cultivated affects the level of post-harvest losses as different varieties have different characteristics such as firmness, diseases resistance among others.

Association

[21,40,44] supported that being a member of association like farmers' group reduces PHL

Results and Discussion

Post-harvest losses at farm level

Socioeconomic characteristics of cassava farmers

Demographic and socioeconomic characteristics play a key role in determining the livelihood of rural people. Table 3 below generally shows that cassava is mainly cultivated by male headed households among the sampled population with the highest percentage of 91.3% compare to female headed households also their marital status shows that they are married, which is 94.7%. It can be deduced from the table that credit accessibility for cassava production and processing issues is below average (33.8%); thus, only one-third of the study participants mentioned having a reliable source of credit for producing or processing of cassava.However, the fact that up to half of the respondents are membership of different association is a relief as the associations can sometimes serve as a panacea to fund shortage on farmers' agricultural activities.

Variables	% of Farmers
Gender (%)	
Male Household head	91.3
Female Household head	8.7
Marital status of Household head (%)	
Married	94.7
not-married	5.3
Association membership (%)	50.0
Credit access for cassava production/processing (%)	34.0
Averages years of association membership	5.9 (8.4)
Averages age of household head	47.0 (13.0)
Averages years of farming experience	23.0 (13.0)
Averages years of cassava farming experience	21.0 (12.0)
Averages household size	8.0 (4.0)
Averages family labour (Number)	3.6 (2.6)
Averages female family labour (Number)	1.4 (1.3)
Averages male family labour (Number)	2.2 (1.9)
Averages total cultivated area (Ha)	9.2 (10.4)
Averages cassava area (Ha)	5.2 (8.0)

Table 3: Socioeconomic characteristics of cassava farmers.

Analysis from survey data 2017

NB: In brackets are the standard deviation (SDs).

Examination of table 3 shows that the average age of household head was 47 which is an economic active age; the mean cassava farming experience was 21 years meaning that the farmers are skilled either locally or technologically in cultivation and management of cassava farm. The average household size was 8 persons, an average of 3.6 adult persons per household. The average cassava farm size/household was bigger than the estimated national average of 2 ha/household. Some of the family members provide labor support for cassava production (average of 1female and 2 males); same was applicable for cassava processing.

Cassava production, post-harvest losses (PHL) and their causes

Cassava production and general losses

In table 3, average area of cassava cultivated by a household was 5.2ha, the result show wide disparity among household as the standard deviation was 8ha. Average cassava harvested was 32tons; however more was harvested in dry season (17tons) than in rainy season (14tons). In general, the standard deviations were larger than average showing large disparity among households. The percentage post-harvest loss of the harvested cassava was 13% (with very narrow disparity among farmers since the standard deviation was 12.7); this is on a larger side compare to literature where less than 10% is recommended for most crop. In terms of losses, 61.3% of the households experienced spoilage of their cassava tuber after maturity, thus the need for immediate harvest after maturity. Also 96% of farmers indicated experiencing PHL from harvesting to marketing. Among cassava varieties, improved varieties experience more losses (75%) than local varieties (25%). There is need for researcher to intervene in helping in curtailing these losses if there is to be sustainable production and development. Losses based on seasons show that more cassava were lost in dry season (61.4%) compare to rainy season (38.6%). 78.8% of the farm households processed part of their cassava and almost (78.6%) of them experienced losses during processing.

Variables	Value
Average cassava harvested (tons)	32.3 (39.6)
Average cassava harvested (rainy season) in tons	14.3 (20.3)
Average cassava harvested (dry season) in tons	17.1 (25.3)
Average cassava quantity loss in tons	4.2 (6.7)
General experiences	
Farmers cultivating improved variety%	72.7
Farmers with cassava spoiling after maturity%	61.3
Farmers experiencing losses (from harvesting to marketing) %	96.0
Losses experience (Variety) %	
Improved	75.0
Local	25.0
Losses experience based on Season%	
Rainy	37.3
Dry	62.7
% Of loss on total cassava harvested	13.2 (12.7)

Table 4: Cassava production and farm experiences.
NB: In brackets are the standard deviations (SDs).

Stages of Post-Harvest Losses (PHL)

Four stages of PHL considered were: Harvesting and assemblage of cassava tuber, Transportation, Processing and Marketing stages. A farmer always experiences losses in more than one of the stages to give multiple response answers. Farmers' response is shown in figure 1 below. The figure shows that more farmers experienced losses of cassava tuber more during harvesting and assemblage of cassava tuber (88%) and this losses reflected in the average percentage lost in table 5, where average percentage lost was 7.53 and was highest for 'harvesting and assembly stage. The result even shows that it can be as high as 100%.

Figure 1: Stages of PHL in cassava production.
N: Number of farmers.

Stages	Minimum %	Maximum %	Average %	% Of the Total
Harvesting & Assembly	0	100	7.53	46.4
Transportation	0	20	2.22	13.7
Processing	0	25	3.74	23.0
Marketing	0	33.3	2.75	16.9

Table 5: PHL under different stages %.

Causes of losses in cassava production

Causes of losses in cassava tuber under different stages were considered; as shown in table 6, the highest for harvesting and assembly stage was 'dry and stony soil' (40.8%), followed by 'cattle problem' (30.2%). In case of transportation stage, the main causes of loss was 'Rough handling of roots during transport' (54%) followed by 'Lack of reliable source of supply'. At processing stage 'Inappropriate processing technologies' (20%) constituted the highest causes, followed by Low access to processing facilities (26.2%). Marketing stage has only one main cause of losses, 'poor pricing at the village level' (58.3%) followed by 'High supply at the village' (16.7) causing glut.

Causes/Sources of Loss	Harvesting and Assembly	Transportation	Processing	Marketing
Variety type	3.0	1.0		
Dry and stony soil	40.8		2.8	
Late harvest	2.4		0.9	1.4
Discard of small and woody tuber	8.3		6.5	
Inappropriate harvesting/processing technologies	3.6	4.0	28.0	
Rough handling of roots during harvesting and transport	9.5	54.0	0.9	8.3
Lack of reliable source of supply	1.2	40.0	0.9	5.6
Cattle problem	30.2		0.9	1.4
Pest/disease	1.2		1.9	2.8
High supply at the village		1.0		16.7
Delay in processing			15.0	
Low access to processing facilities			26.2	2.8
Machine breakdown at the processing centre			7.5	
poor pricing at the village level			1.9	58.3
Other ruminants			3.7	
Others			2.8	2.8
Total	100.0	100.0	100.0	100.0

Table 6: Causes of Losses during different stages %.

Household processing level

Processing characteristics of the farm households

The socioeconomic characteristics of the farmers have been discussed in table 3. Table 7 is complementing table 3; in table 7, farmers that processed cassava were 78.8% and 78.6 of them professed to experienced losses. There were members of farm household that provide labour at farm level processing as stated in the table.

Variables	Respondent values
Average family labour for processing	3 (3)
Average family labour for processing (Female)	1 (1)
Average family labour for processing (Male)	2 (2)
Farmers that processed cassava (%)	78.8
Farmers that experienced Loss (%)	78.6

Table 7: Processing characteristics of the processing households.

NB: Numbers in brackets are the standard deviation (SDs).

Processed products from cassava and equipment for processing them

Processed products from cassava

Popular products in Oyo state processed from cassava tuber include: gari, lafun, fufu and starch; of this starch is processed least by farming households. The highest PHL was from gari processing.

Products	%Farmer	Minimum % PHL	Maximum % PHL	Average % PHL
Gari	62	0	25	5.48 (5.85)
Lafun	62	0	40	5.20 (6.96)
Fufu	23.3	0	20	1.77 (3.73)
Starch	1.3	0	1	0.04 (0.20)

Table 8: Products processed by Farmers.

NB: Numbers in brackets are the standard deviation (SDs).

Equipment for processing cassava

Getting equipment for processing can be through 'ownership right' of the equipment or having access to it in the community. The percentage of households that have grater, presser, and sieve as processing tools were low but accessibility was high. Sieve and Knife as processing tools have the highest percentage of ownership which was 43.2% and 75.3% respectively. Gender wise, female had highest accessibility in all equipment and highest ownership share of Fryer, Sieve and Knife/peeler (Table 9).

Regression analysis

Regression analysis at farm levels

Determinants of PHL in cassava production was regressed in two forms against the set of independent variables in table 7. First, a Tobit form was estimated using percentage of cassava tuber lost by farmer from harvesting to marketing; secondly, a linear regression using ordinary least square was estimated as an additional test of the robustness to the Tobit results (Table 10). The Tobit model result revealed that the log-likelihood value (-543.605), the pseudo R^2 (0.0239), and the Chi-square value (26.66) were significant ($P < 0.05$) which indicates that the overall model was well fitted and the explanatory variables used in the model were collectively able to explain post-harvest losses in cassava production among farmers. Some of the included variables were significant for determining factors influencing PHL among cassava farmers. Being a female farmer/household head reduced the probability and intensity of PHL significantly ($p < 0.10$) by 6.4%; female farmers were more meticulous in managing their cassava farm than their male counterpart. This is in line with studies conducted by [19,20] where female-headed households experienced lower rates of post-harvest losses in cereal production. Having non-farm occupation (NONFARM_OCCUPATION) as a major occupation was negatively and significantly correlated with PHL for cassava farmers ($P < 0.05$): as non-farm job as a major job decreased the probability and intensity of PHL by 10.0%; this is in consensus with a study in Zambia by [29] which indicated that alternative source of income in a household can be invested in agriculture, thereby allowing the farmer to tend to the production needs and measures to curb losses. Years of membership of association significantly ($P < 0.05$) reduced PHL in cassava production by 0.31%; [21,40,44] supported that being a member of association like farmers' group reduces PHL (Post harvest loss).

The higher the dependency ratio, the lesser the PHL in a farm family; the dependency ratio reduced the probability and intensity of PHL in cassava production by 2.24%; this is logical since there are many mouths to feed, thus wastage is curbed. The use of local cassava varieties reduced PHL significantly ($P < 0.05$) by 5.5%; [39] in his paper on tomato production is of opinion that the variety of tomato cultivated affects the level of post-harvest losses as different varieties have different characteristics.

The result shows that the higher the number of members of household (FAMILY_LABOUR) used for farming activities the more the PHL, as the variable is significantly correlated with PHL at 1% probability level, [22] paper supported this claim, finding that household size has a positive and significant coefficient on PHL. Meaning that third phase of production function is applicable here, whereas you use more resources, diminishing returns set inn due to poor management of resources. On the other hand 'hired labour' can be employed, as a labourer will want to do a good job in order to be paid, but family labour is free.

PHL in cassava tuber processing among cassava farmers

This study shows that some farmers engaged both in cassava tuber production and cassava tuber processing into other secondary products. Factors influencing post harvest losses among farmers that processed cassava tuber to other products were determined using Tobit model. The dependent variable was the percentage of cassava tuber reserved for processing lost during processing. The Tobit model result revealed that the log-likelihood value (-458.57), the pseudo R^2 (0.069), and the Chi-square value (68.19) were significant ($P < 0.01$) which indicates that the overall model was well fitted and the explanatory variables used in the model were collectively able to explain post-harvest losses in cassava processing among farmers. Socioeconomic characteristics shows that married households incurred more PHL than single ones ($p < 0.10$); being married led to 9.23% increase in PHL. Marriage brings increased responsibilities compared to a single household head that has diversion of attention bringing better focus on managing production activities. Access and obtaining credit led to increase in PHL ($p < 0.10$), obtaining credit increase probability and intensity of PHL by 5.44%. Having credit means more resources but the resources can be diverted to other production activities or enterprises instead of using it to manage post harvest losses, thus increase in PHL.

Belonging to an association was negatively correlated with PHL ($p < 0.05$); being a member of association decrease the probability and intensity of PHL by 5.88%, this is supported by the surveys conducted by [21,44,40] that being a member of association like farmers' group reduces PHL. Members of household participating and contributing to processing activities (FAMILY_LABOUR) was negatively associated with PHL ($p < 0.01$), however, as the number of the members increased beyond a critical number ($FAMILY\_LABOUR^2$), then PHL will start to increase. Below the critical number of household, FAMILY_LABOUR will lead to 2.78% decrease in probability and intensity of PHL. The percentage of annual cassava root processed was positively correlated with PHL ($p < 0.01$); a unit increase in the percentage has probability and intensity to increase PHL by 0.09%. (Good management is needed). PHL have been found to be positively associated with the level of produce [42,22]. In regard to types of products processed by farmers, only fufu and starch processing had tendency to reduce PHL although not significantly correlated. In another vein, processing of garri and lafun (cassava powder) had tendency of increasing PHL. In case of lafun, the tendency was significant ($p < 0.01$); processing of lafun had probability and intensity of increasing PHL by 8.34%. The effect of processing equipment variables on PHL was also considered. The study considered the use of siever, knife_peeler, grater and presser

		Tobit model				Linear regression model			
Explanatory variable	Variable code	Coefficient	t	P > |t|	Marginal effectdy/dx	Coefficient	t	P > t	Elasticity
Male	Gender	-6.437***	-1.67	0.098	-6.301	-6.189	-1.55	0.123	-0.506
Married	Married	-1.179	-0.23	0.819	-1.154	-1.043	-0.20	0.845	-0.087
Farm_Experience	Fexperience	-0.019	-0.23	0.82	-0.019	-0.024	-0.27	0.788	-0.045
Major Occupation	Moccupation	-10.303**	-2.07	0.04	-10.085	-10.265**	-2.00	0.048	-0.869
YRS_Association	YRS_Association	-0.316**	-2.21	0.029	-0.31	-0.324**	-2.19	0.03	-0.202
Credit	Credit	2.496	0.99	0.322	2.443	2.432	0.94	0.351	0.072
Improved_Cassava	Cassavat	-5.517**	-2.36	0.02	-5.401	-5.612**	-2.33	0.022	-0.4
Spoil_Variety	Spoil_variety	1.742	0.82	0.412	1.705	1.69	0.77	0.44	0.086
Area_Cultivated	Area	-0.094	-0.72	0.472	-0.092	-0.079	-0.58	0.56	-0.065
PHL_Season	PHL_season	-2.846	-1.34	0.183	-2.786	-2.691	-1.23	0.222	-0.099
Family_Labour	Flabour	0.721***	1.71	0.089	0.706	0.678	1.56	0.121	0.202
cassava_Processing	Cprocessing	4.034	1.57	0.119	3.949	4.181	1.57	0.118	0.252
dependency Ratio	Dependencyr	-2.290***	-1.87	0.063	-2.241	-2.076*	-1.66	0.099	-0.16
Constant	Constant	32.703***	4.23	0.000		32.372***	4.05	0.000	
Sigma		11.712	10.31	13.11					
No Of Observation		142				142			
LOG Likelihood		-543.605							
CHI Square		26.66							
PROB>CHI^2		0.0139							
PSEUDO R^2		0.0239							
F (13, 128)							2.04		
Prob > F							0.0227		
R^2							0.1713		
Adjusted R^2							0.0871		

Table 10: Determinants of Post-Harvest Losses in Cassava Production.

Note: P < 0.01 = ***; P < 0.05 = **; P < 0.10 = *

machines; all the equipment except presser had tendency to increase % PHL. Use of knife for peeling significantly increased PHL ($p < 0.01$); it had the probability and intensity to increase PHL by 10.55%. However, presser machine significantly ($p < 0.10$) reduced PHL; it had probability and intensity of decreasing PHL by 7.01%.

Variables		Coef.	t	P > t	dy/dx
Age	Age	0.119	1.110	0.267	0.091
Gender	Gender	-0.230	-0.040	0.966	-0.176
Mstatus	Mstatus	12.051*	1.690	0.094	9.231
Association_Membership	Massociation	-7.675**	-2.000	0.048	-5.879
Credit	Credit	7.099*	1.800	0.074	5.437
Family_Labour	Flabour	-3.634***	-2.780	0.006	-2.784
Family_labour2	$Flabour^2$	0.308***	2.630	0.01	0.236
Annual Cassava_Processed	Cassavap	0.119***	2.600	0.01	0.092
Garri	Garri	5.006	1.280	0.201	3.834
Lafun	Lafun	10.885***	3.100	0.002	8.338
Fufu	Fufu	-0.300	-0.090	0.931	-0.230
Starch	Starch	-0.874	-0.080	0.937	-0.670
Siever	Siever	3.197	1.100	0.275	2.449
Knife_peeler	Pknife	13.778***	2.770	0.006	10.553
Presser	Presser	-9.159*	-1.670	0.097	-7.016
Grater	Grater	7.992	1.430	0.155	6.121
Constant	Constant	-29.841***	-2.980	0.003	
Sigma		14.555			
Number of Observation		141			
LR chi2 (16)		68.19			
Prob > chi2		0.000			
Pseudo R2		0.069			
Log likelihood		-458.57			

Table 11: Determinants of PHL in cassava processing at a farm level.

Note: P < 0.01 = ***; P < 0.05 = **; P < 0.10 = *

Summary and Conclusion

The paper is on an assessment of cassava post-harvest losses in southwestern Nigeria using Oyo-State, as a case study. A multistage sampling technique was used with 3 agricultural zones randomly selected and 50 respondents from each of the zone were randomly selected and interviewed from the list made available by zonal Agricultural Development Program Managers. A structured questionnaire was used to collect responses from farmers on their experiences on post-harvest losses on cassava production and processing. Analysis of the data was done using descriptive statistics and econometric models where necessary. The average cassava farm size/household was bigger than the estimated national average of 2 ha/household with an average cassava harvested of 32tons;the percentage post-harvest loss of the harvested cassava was 13% with 96% of farmers indicated experiencing PHL from harvesting to marketing. Improved varieties experience more losses (75%) than local varieties (25%). There is need for researcher to intervene in helping in curtailing these losses through development of varieties that are resistant to losses if there is to be sustainable production and development.

Losses based on seasons show that more cassava were lost in dry season (61.4%) compare to rainy season (38.6%). 78.8% of the farm households processed part of their cassava and almost

(78.6%) of them experienced losses during processing. Popular products in Oyo state processed from cassava tuber include: gari, lafun, fufu and starch; of this starch is processed least by farming households. The highest PHL was from gari processing. The percentage of households that have processing equipment was low but accessibility was high. Data from the field was modeled using Tobit regression model to determine factors influencing PHL among cassava farmers. Being a female farmer/household head, years of membership of association, higher dependency ratio, and having non-farm occupation as a major occupation reduced the probability and intensity of PHL significantly. The result shows that the higher the number of members of household used for farming activities the more the PHL. Meaning that third phase of production function is applicable here, where using excess resources lead to diminishing returns due to poor management of resources.

In the same vein, Factors influencing post harvest losses among farmers that processed cassava tuber to other products were determined using Tobit model. The dependent variable was the percentage of cassava tuber reserved for processing lost during processing. The Tobit model result revealed married households incurred more PHL than single ones,access and obtaining credit and the percentage of annual cassava root processed were positively correlated with PHL. Belonging to an association and use of family labour, being a member of association were negatively correlated with PHL; however as the number of the family labour increased beyond a critical number, then PHL will start to increase (quadratic function a variable - family_labour). In regards to types of products processed by farmers, only fufu and starch processing had tendency to reduce PHL although not significantly correlated. In another vein, processing of garri and lafun (cassava powder) had tendency of increasing PHL. In case of lafun, the tendency was significant ($p < 0.01$). The effect of processing equipment variables on PHL was also considered. The study considered the use of siever, knife_peeler, grater and presser machines; all the equipment except presser had tendency to increase PHL. Use of knife for peeling significantly increased PHL. However, presser machine significantly reduced PHL.

Stakeholders should consider those factors influencing post-harvest losses under production, and adapt it to curb PHL where necessary. Extension agents should consider the three stages of production function and pass it on to farmers on how to employ resources in an optimal way. There is also seasonal variation in PHL, measures to reduce PHL during dry season should be considered and researcher along with extension should work on improved cassava varieties with durable ability not to spoil after maturity, not just having higher yield. On processing, there are now processing machines like mechanical peelers that can be used to reduce PHL, Ministry of Agriculture can assist farmers both at federal and state levels to assist farmers in acquiring them or assisting them through subsidy. Better measures of producing cassava products should be considered as to reduce wastage during their productions.

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Bibliography

1. Wink worth-Smith., *et al.* "The Impact of Reducing Food Loss in the Global Cold Chain (2014).
2. FAO. Food wastage footprint: Impacts on natural resources (2013).
3. Parfitt J., *et al.* "Food waste within food supply chains: quantification and potential for change to 2050". *Philosophical Transactions of The Royal Society B Biological Sciences* (2010).
4. Oguntade. "Food losses in cassava and maize value chains in Nigeria Analysis and recommendations for reduction strategies" (2013).
5. Godfray HC., *et al.* "Food Security: The Challenge of Feeding 9 Billion People". *Science* (2010): 327.
6. FAO. Global Food Losses and Food Waste, Extent Causes and Prevention. Study conducted for the

   International Congress, SAVE FOOD! at Interpack, Düsseldorf, Germany (2011).
7. GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). "Reducing postharvest losses conserves natural resources and saves money. Report of GFFA Expert panel discussion held on in Berlin (2013): 30.
8. Orraca-Tetteh R. "A note on post-harvest physiology and storage of Nigerian crops". *Food and Nutrition Bulletin* 1.1 (1978): 40-43.
9. Olayemi FF., *et al.* "Assessment of post harvestlosses of some selected crops in eight local government areas of rivers state, Nigeria". *Asian Journal of Rural Development* 2.1 (2012): 13-23.

10. Oni and Obiakor. "As Rivers State; Nigeria". *Asian Journal of Rural Development* (2002): 13-23

11. Enyiukwu DN., *et al.* "Potentials of Hausa Potato (Solenostemon rotundifolius (pour) J.K. Morton and Mansemnt of its Tuber Rot in Nigeria". *Greener Journal of Agronomy Forestry and Horticulture* 2.2 (2014): 027-037.

12. FAO. "Food Loss Assessments: Causes and Solutions" (2014)

13. Natural Resource Institute (NRI). "The Dynamics of Agricultural Biotechnology Adoption: lessons from series rBST Use in Wisconsin 1994-2001". *American Journal of Agricultural Economic*, 86.1 (2014): 61-72.

14. Abdoulaye T., *et al.* "Awareness and use of improved cassava varieties and processing Technologies". *Journal of Development and Agricultural Economics* 6.2 (2014): 67- 75.

15. Rahmawati RS., *et al.* "Postharvest physiological deterioration in cassava: potential problems, possible inhibition, and resistant level identification". *Earth and Environmental Science* 694 (2021): 012035.

16. Knoth J. "Le stockage traditionnel de l'igname et du manioc et son amelioration". Hambourg, GTZ-Post-harvest Project (1993): 95.

17. Naziri Diego., *et al.* "The diversity of post-harvest losses in cassava value chains in selected developing countries". *Journal of Agriculture and Rural Development in the Tropics and Subtropics* 115 (2014): 111-123.

18. Zorya S., *et al.* "Missing food: the case of post harvestgrain losses in sub-Saharan Africa" (2011).

19. Kaminski J and Christiaensen. "Post-harvest loss in sub-Saharan Africa-what do farmers say?" *Global Food Security* 3.3 (2014): 149-158.

20. Wanjiku Agnes Njoki. "Socio-cultural and economic factors influencing household post-harvest cereal loss in wikililye location, kitui county, kenya; unpublished thesis submitted in partial fulfillment of the requirements for the award of the degree of master of arts in sociology in the school of humanities and social sciences, south eastern kenya university (2018).

21. Mebratie MA., *et al.* "Determinants of Post-harvest Banana Loss in the Marketing Chain of Central Ethiopia". *Food Science and Quality Management* 37 (2015): 52-63.

22. Enoch Mutebi Kikulwe., *et al.* "Post-harvest Losses and their Determinants: A Challenge to Creating a Sustainable Cooking Banana Value Chain in Uganda". *Sustainability* 10.2381 (2018): 14-19.

23. Woodsong.

24. Bokusheva R., *et al.* "Factors determining the adoption and impact of a post harveststorage technology". *Food Security* 4.2 (2012): 279-293.

25. Barham BC., *et al.* "A comparative analysis of recombinant Bovine Somatotropin Adoption Across Major U.S. Dairy Region". Paper ssrn.com (2004).

26. Ersado L., *et al.* "Productivity and land enhancing technologies in northern Ethiopia: Health, public investments, and sequential adoption". *American Journal of Agricultural Economics* 86.2 (2004): 321-331.

27. Guo G., *et al.* "The impact of aging agricultural labor population on farmland output: from the perspective of farmer preferences". *Mathematical Problems in Engineering* (2015).

28. Morris ML and Doss CR. "How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana". In annual meeting of the American *Agricultural Economics Association,* Nashville, August (1999): 8-11.

29. Simatele MC. "Food production in Zambia: The impact of selected structural adjustment policies" (2006).

30. Heshmati A. "Economic Transformation for Poverty Reduction in Africa: A Multidimensional Approach". Taylor and Francis (2017).

31. Omotilewa OJ., *et al.* "Impacts of Improved Storage Technology among Smallholder Farm Households in Uganda. 121 In 2016 AAAE Fifth International Conference, September 23 to 26, 2016, Addis Ababa, Ethiopia". *African Association of Agricultural Economists* (AAAE) (2016).

32. Gitonga ZM., *et al.* "Impact of metal silos on households' maize storage, storage losses and food security: An application of a propensity score matching". *Food Policy* 43 (2013): 44-55.

33. Jones RK., *et al.* "Planting date, harvest date, and irrigation effects on infection and aflatoxin production by Aspergillus flavus in field corn". *Development* 19 (1981): 32.

34. Pessu PO., *et al.* "The concepts and problems of post harvest food losses in perishable crops". *African Journal of Food Science* 5.11 (2011): 603-613.

35. Grolleaud M. "Post-harvest losses: discovering the full story. Overview of the phenomenon of losses during the post-harvest system (2002).

36. Hodges RJ., *et al.* "post-harvest losses and waste in developed and less developed countries: opportunities to improve resource use". *The Journal of Agricultural Science* 149.1 (2011): 37-45.

37. Asaye OA. "Post-Harvest Handling of Food Crops in a Changing Climate: an Outlook on Food Research in IAR and T". Being a Lead paper delivered at the 2018 Annual In-House Review Exercise of the Institute of Agricultural Research and Training, Moor Plantation Ibadan (2018).

38. Recha J., *et al.* "Climate Related Risk and Opportunities for Agricultural Adaption and Mitigation in Semi-Arid Eastern Kenya" (2012).

39. Aidoo R., *et al.* "Determinants of Postharvest Losses in Tomato Production in Offinso North District of Ghana". *Journal of Development and Agricultural Economics* 6.8 (2014): 338-344.

40. Joko DN and Dzahan Hilary Liambee. "Determinants of post-harvest losses among tomato farmers in gboko local government area of benue statecard". *International Journal of Agricultural Research and Food Production* 2.4 (2017).

41. Basavaraja H., *et al.* "Economic Analysis of Post-harvest Losses in Food Grains in India: A Case Study of Karnataka". *Agricultural Economics Research Review* 20 (2007): 117-126.

42. Moneruzzaman., *et al.* "Effect of harvesting and storage conditions on the post harvest quality of tomato (Lycopersicon esculentum Mill) cv. Roma VF". *Australian Journal of Crop Science* 3.2 (2009): 113-121.

43. Adewumi MO., *et al.* "Analysis of Post-Harvest Losses among Plantain/Banana Marketers in Lagos State, Nigeria". *Nigeria Journal of Food, Agriculture and Environment* 5 (2009): 35-38.