

ECONOMIC ANALYSIS OF CASSAVA POSTHARVEST LOSS ALONG THE CASSAVA VALUE CHAIN IN KWARA STATE, NIGERIA

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Abstract

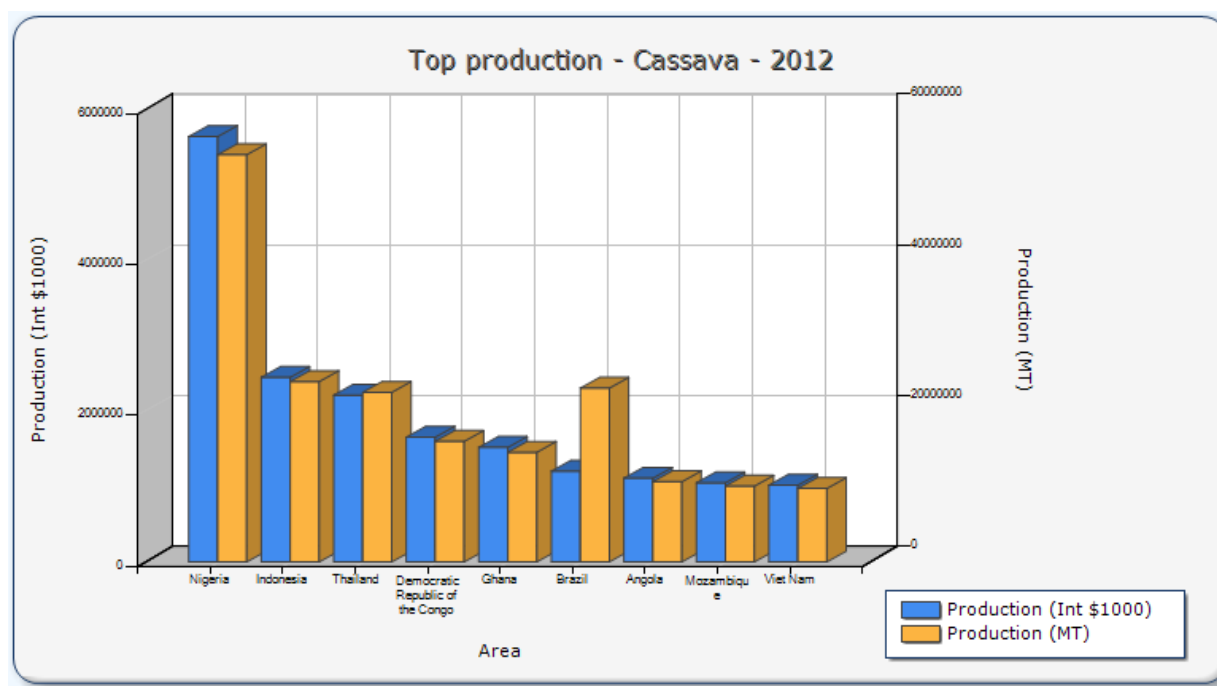
Cassava (*Manihot spp*) has been identified as Africa's second most important staple food after maize, in terms of calories consumed, with Nigeria as the World leading producer. This study estimated postharvest loss of cassava along the cassava value chain in Kwara State, Nigeria. A three-stage random sampling technique was used to select 120 cassava farmers whom were administered well-structured questionnaire to elicit data for the study. Data were analyzed using the descriptive statistics, Shannon's diversity index and Tobit regression model. The results of the analysis showed that 23% of the loss estimated to be about 2.44tonnes/ha occurred at the harvesting stage. Analysis of the environmental impact of the loss showed that the carbon footprint of the loss was 3.26kgCO₂e/ha (for garri) and 1.70kgCO₂e/ha (for starch) while the economic cost implication of the loss was valued at ₦36,600/ha. Also the quantity expected at harvesting, household size and the age of the farmer were the significant factors that affect cassava postharvest loss in the study area. The results also showed that most of the cassava farmers mitigate their postharvest loss by processing the roots and reburying unused roots into the soil as a method of storage. From all the analysis of the study, it can be deduced that the size of cassava postharvest loss in Kwara state is very high which in turn brought about the high environmental carbon footprint and as such, concrete steps need to be taken in order to reduce this loss so as to improve the economic status of cassava farmers-processors. The study therefore recommended that there should be further researches on methods of reducing postharvest loss (especially at harvesting stage) and the need to process cassava roots in more alternate products so as to avail more opportunities in the cassava market.

Keywords: Cassava, Postharvest loss, Economic, Environmental, Value chain

Introduction

Cassava (*Manihot esculenta*) is a member of the family of *Euphorbiaceae*, and is one of the oldest cultivated crops by human beings although the early history of cassava is still a mystery (Gulick, *et al*, 1983). It was reported that cassava has been cultivated in northern Amazonia more than 1000 years ago (Jones, 1959). So also, until some years back it was postulated that cassava is likely to be originated from wild *M. esculenta* populations along the southern region of the Amazon basin (Olsen, *et al.*, 2001). Portuguese explorers introduced cassava to Africa during the 16th

and 17th centuries through their trade with the African coasts and nearby Islands. Africans then spread cassava further, and it is now found in almost all parts of tropical Africa. Today, Nigeria and Democratic Resepublic of Congo are the largest producers of cassava in Africa alongside Brazil in South America and Carribeans and Thailand in Asia (Department of Agriculture, Forestry and Fisheries, South Africa, 2010). Figure 1 shows the world production of cassava and the revenue generated from the sale of the commodity in dollars.



Source: FAOSTAT, 2013.

Figure 1: Top Cassava Producers in the World

Cassava (*Manihot* spp) is Africa's second most important staple, after maize, in terms of calories consumed, with Nigeria as the world leading producer (Nweke, 2004). This can be attributed to cassava's combined abilities to produce high yields under poor conditions and the ability to store its harvestable portion underground until when needed. This has made it a classic "food security crop" (Nweke, 2003). Its importance as a food crop in Africa can be clearly seen when consumption data from Africa is compared with other cassava growing regions of the world, majorly the Latin Americans. Cassava is very important in the diet of an average Nigerian. It has comparative production advantage over other staples; as a result this serves to encourage its cultivation even by the resource-poor farmers. Studies on cassava has shown that it accounts for about 70% of the total calorie intake of more than half of Nigerians (Nweke and Enete, 1999) with its starchy roots producing more food energy per unit of land than any other staple crop in the country (de Figueroa *et al.*, 2001).

However, despite cassava being a major constituent of the diet and also major source of income to farmers in Nigeria as a whole and specifically Kwara state, economically, it represents a wasted investment

that can reduce farmers' incomes and increase consumers' expenses (Lipinski *et al.*, 2013). It is equally important to note that, even with Nigeria's status as the leading producer of cassava in the world, Nigeria is still behind Thailand in the exportation of cassava products, and still import some by-products of cassava processing such as industrial starch. Moreover, environmentally, postharvest losses from cassava inflict a host of impacts, including unnecessary greenhouse gas emissions and inefficient use of water and land, which in turn can lead to diminished natural ecosystems and the services they provide (Lipinski *et al.*, 2013).

Considering the fact that, despite the prevalence of postharvest food loss in Nigeria, there are limited studies that quantified the losses of roots and tubers, specifically cassava in Nigeria. Therefore, there is a need for a research on the postharvest losses of cassava as a major constituent of Nigerian diet. Thus, the knowledge of the level and extents of postharvest losses of cassava along the cassava supply chain and their major effects becomes imperative. This is because it would provide policy makers with the required findings to enact and implement policies needed to prevent/or mitigate these losses, and as such ensure victory in the war against food insecurity

in Kwara state specifically, and global warming, in general.

In the light of the foregoing, the study was carried out to estimate the size/index of postharvest loss of cassava along the supply chain in the study area, analyse factors responsible for the postharvest losses of cassava along the supply chain, analyse the environmental and economic cost implication(s) of postharvest losses in the study area and examine the strategies employed in the mitigation of postharvest losses in the study area.

Materials and Methods

Study Area

The study was carried out in Kwara State whose capital is Ilorin. Kwara State of Nigeria was created on the 27th of May, 1967 along with 11 other states of the federation. The state was originally called west central state, having been carved out of the defunct northern Nigeria. At the time of creation, the state had a landmass of 60,380km² but this has reduced to 34,804.72km² following the boundary adjustments that accompanied excision of a segment of its eastern part to Benue State in 1976 and 6 local government areas to the present Kogi State and Niger State in 1991. However, recent survey shows that the state has a total land area of about 32,500km², which is about 3.5% of the total land area of the country, which is put at 923,768km² (KWSG, 2006). Considering the geographical location, Kwara State occupies a vantage position on the map of Nigeria. Situated between latitudes 7°45'N and 9°30'N of the equator and longitudes 2°30'E and 6°25'E of the equator, it lies midway between the Northern and Southern parts of Nigeria. Kwara State is also divided into four agricultural zones by the Kwara State Agricultural Development Project (KWADP) in consonance with ecological characteristics, cultural practices and project's administrative convenience. These are: Zone A: Baruteen and Kaima Local Government Areas; Zone B: Edu and Patigi Local Government Areas; Zone C: Asa, Ilorin East, Ilorin South, Ilorin West and Moro Local Government Areas; and Zone D: Ekiti, Ifelodun, Irepodun, Offa, Oyun, Isin and Oke-ero Local Government Areas. The State shares boundaries with Osun, Oyo, Ondo, Kogi, Niger and Ekiti States as well as an international

boundary with the Republic of Benin in the West.

Sampling Procedure

The study was carried out in 2014 and a three-stage random sampling technique was used to select the farmers for the study. In the first stage, one (1) out of the four (4) agricultural zones in Kwara State was selected at random, while ten (10) villages were randomly selected from the list of villages in the selected zone in the second stage. The final stage involved the random selection of twelve (12) cassava farmers from each of these villages, making a total of one hundred and twenty (120) farmers sampled and administered questionnaire for the purpose of the study. However, only the data from one hundred and seventeen (117) farmers were analyzed while the remaining three (3) were discarded due to incomplete information provided.

Primary data were collected through the use of interview schedule method. Information was collected on the socioeconomic characteristics of the farmers in the study area such as age, gender, education, farm size, e.t.c. Also, information were collected on quantities of cassava harvested and processed, losses incurred along the supply chain, amongst others. Secondary data was obtained from Oguntade (2013) on the emission of CO₂ and other greenhouse gases at each level of production (cassava value chain) and the CO₂ emission potential of petrol and diesel.

Data Analysis

Data collected were analyzed using descriptive statistics, Shannon's diversity index and tobit regression model based on the objectives of the study.

The Shannon's Diversity Index(H): This was applied to measure the spread of the postharvest loss across the cassava value chain i.e. harvesting, processing and marketing. The Shannon Diversity Index (H) is based on communication theory. This stems from a common question in communication; "How predict the next letter in a message/communication? This uncertainty is measured by the index (Spellerberg&Fedor, 2003). This index was adapted for this study due to its ability to quantify losses at each stage of the value chain and also provide the degree of evenness of the losses at each stage. The index of postharvest losses was obtained from the formula:

$$H = -\sum_{i=1}^n p_i \ln p_i$$

Where, H = Shannon's diversity index for postharvest loss,
 n = number of stages in the value chain from which losses are recorded, and

$$p_i(kg) = \frac{N_i(\text{average loss at each stage of the value chain})}{\text{total postharvest loss}}$$

$\ln P_i$ = natural logarithm of P_i

Tobit Model: The tobit regression model is a statistical model which describes the relationship between a non-negative dependent variable and an independent variable and supposes that there is a latent (observable) variable. The observable variable is defined to be equal to the latent variable whenever the latent variable is above zero (but not more than 1) and zero otherwise. This model was used in the determination of the latent variable due to

the presence of several observed percentage losses as a proportion of expected output which was below 25% and hence represented as zero (0).

The econometric model for the tobit regression is implicitly stated as:

$$y_i^* = \beta x_1 + \beta x_2 + \beta x_3 + \beta x_4 + \beta x_5 + \beta x_6 + \beta x_7$$

y_i^* = Percentage loss as a proportion of expected output ($0 \leq y_i^* \leq 1$)

β = Coefficient to be estimated

x_1 = Age of respondents (years)

x_2 = Household size (AE)

x_3 = Quantity Expected at Harvesting (kg)

x_4 = Use of Unsold Roots

x_5 = Causes of Loss

x_6 = Measures to Control Loss

x_7 = Processed outputs (kg)

Table 1: Description and Measurement of Variables

Variables	Description	Measurement
Use of Unsold Roots	This is the various uses to which unsold cassava roots were put to	0=Processed to cassava roots 1=Served to animals 2=Discarded as waste 3=Buried back into the soil as manure 4=Sold at lesser prices than usual
Causes of losses	These are the factors that causes losses in the processing of cassava tubers	0= Poor processing facilities 1=Small size of roots 2=Poor storage 3=Woody cassava roots 4=Losses during packaging and transportation of processed products 5=Poor handling(e.g. over-peeling)
Measures to control loss	These are the measures put in place to control postharvest losses.	0=Use of skilled workers 1= Use of improved facilities 2=Delayed harvesting after maturity 3=Use of agrochemicals during storage 4=Harvesting only what is required 5Use of improved cassava varieties

Results and Discussion

Socioeconomic Characteristics of Cassava Farmers

The results in table 2 showed the socioeconomic characteristics of cassava farmers in the study area. The results show that 66.7% of the respondents were male and 33.3% female. The male dominance in cassava production and processing as against processing alone, which is female dominated (Ezedinmaet al, 2007 and Muhammad-Lawalet al, 2013) could be majorly attributed to the combination of the cassava production and

processing stages by value chain actors in the study area. The table further revealed that more than 60% of the respondents are more than 35 years but not older than 55 years of age and majority of the farmers were married and have at least a year of formal education. Also, it can be seen from the table that the modal group for years of farming experience was between 15 and 24 years while that of annual income falls between ₦25,001 and ₦181,000.

Table 2: Distribution of Cassava Farmers by their Socioeconomic Characteristics

Variables	Frequency	Percentage (%)
Sex		
Male	78	66.7
Female	39	33.3
Age (years)		
≤ 25	1	0.9
25 – 35	1	0.9
36 – 45	27	23.1
46 – 55	50	42.7
56 – 65	32	27.3
≥ 66	6	5.1
Marital Status		
Single	1	0.9
Married	105	89.7
Widowed	9	7.7
Divorced	2	1.7
Years of Schooling		
0	26	22.2
1 – 6	39	33.3
7 – 12	39	33.3
13 – 16	9	7.8
≥ 17	4	3.4
Farming Experience (years)		
≤ 5	4	3.4
6 – 14	29	24.8
15 – 24	34	29.1
25 – 33	25	21.4
34 – 43	19	16.2
≥ 44	6	5.1
Annual Income (₦)		
≤ 25,000	9	7.8
25,001 - 181,000	80	68.4
181,001 - 337,000	23	19.7
337,000 – 493,000	3	2.6
≥ 649,001	2	1.7

Source: Field Survey, 2014.

Estimation of Postharvest Losses along the Value Chain

Estimation of the size of cassava postharvest loss showed that the average

$$\text{Average postharvest loss per hectare} = \frac{\text{Average amount of postharvest loss of cassava}}{\text{Average land under cassava cultivation}} = \frac{6427.7}{2.63\text{ha}} = 2.44\text{tonnes/hectare}$$

It can thus be deduced from table 3 that, the average size of cassava postharvest loss is 6427.7kg which when expressed in percentage of total quantity expected is 19.83%. The chain of highest loss is at harvesting which accounts for about 23% of the total quantity expected, followed by the loss at processing, 18% and then loss at marketing, 13%. The loss across the value chain is not uniformly distributed as revealed by a relatively low H-value. The

postharvest loss of cassava per hectare of farmland under cassava cultivation in the study area was 2.44tonnes/ha.

intensity of the loss at harvesting stage, being the highest, is in line with the report of Bokanga (1999) where he stated that postharvest loss of cassava is highest at harvesting in dry season due to hardness of the soil which results in heavy breakage of the roots. This further confirms the findings of Jaspreet *et al* (2013) which postulated that food losses occur majorly at the field-market stage.

Table 3: Shannon's diversity index for size/level of postharvest loss in the study area

Stages of the cassava value Chain	N_i (Average loss at each stage, kg)	P_i	$\ln P_i$	$H = - (P_i \times \ln P_i)$	Loss as a proportion of total loss (%)	Loss as a proportion of expected harvest (%)
Harvesting	4352.14	0.68	-0.39	0.26	68	23
Processing	1425.56	0.22	-1.51	0.33	22	18
Marketing of roots	650	0.10	-2.29	0.23	10	13
Total	6427.7			0.82	100	

Source: Data Analysis, 2014.

Factors Influencing Cassava Postharvest Losses

Tobit regression model was used to determine the factors responsible for cassava postharvest loss. The result shows that the quantity expected at harvest, household size and age of the farmers are the significant factors that influence cassava postharvest loss in the study area. The results revealed that these factors significantly influence cassava postharvest loss at 5% level of significance. It can be deduced from the table that both the quantity expected at harvest and household size positively influence the postharvest loss of cassava. This implies that the higher the quantity of cassava expected at harvesting, the more the margin of postharvest loss all things being equal. This is in conformity with the finding of Atanda et al (2011) who reputed that postharvest loss could result when there is a bumper harvest which could overload the post-harvest handling system or exceed the consumption need and cause excessive wastage.

In a similar way, the household size was found to have a positive significant effect

Source: Data Analysis, 2014; ** indicate statistical significance of the coefficients at 5% level

Table 4: Tobit regression result for the factors responsible for cassava postharvest loss

Items	Coefficient	Standard Error	t- value
Processed Outputs (Kg)	-0.59	1.52	0.39
Measures to Control Loss	-0.87	1.16	-0.75
Causes of Loss	2.20	1.36	1.61
Use of Unprocessed Roots	-0.12	1.85	-0.06
Quantity Expected at Harvesting (Kg)	2.80e-4**	1.10e-4	2.54
Household Size	1.36**	0.47	2.90
Age (years)	-0.33**	0.15	-2.18
Constant	26.05	7.98	3.27
Sigma	12.94	0.89	

Environmental and Economic Implications of Cassava Postharvest Losses The analysis carried out to examine the environmental and economic cost implication of the cassava

on cassava postharvest loss at 5% level of significance. This implies the larger the household size of cassava farmers, the higher the percentage of cassava postharvest loss in the study area, leaving all other factors constant. Also found to significantly affect the level of cassava postharvest loss in the study area at 5% level was the age of cassava farmers but with a negative relationship. From table 3, one can infer that a one year increase in the age of respondent would result in 0.33% reduction in postharvest loss. This is true especially when the increase in age comes with more farming-processing experience and large household size. The experience, in turn, results in improved harvesting-processing practices; experience is also known to have positive effect on processors' managerial capacity, technical know-how, and adoption of extension packages (Achem and Akangbe, 2011). All these lead to a reduced level of postharvest losses. However, the remaining factors modeled were found to be insignificant to the level of cassava postharvest loss in the study area.

postharvest loss shows that the average CO₂ emission per hectare of land under cassava cultivation is 3.26kgCO₂/ha and 1.70kgCO₂e/ha for garri production and

starch production respectively and economic cost implication of ₦36,600.00/ha as shown below.

Adopting the results of Oguntade (2013) on the environmental influence of cassava

Average CF per hectare of land under cassava cultivation (where garri is final product)

$$= 2.44 \text{ tonnes/ha} \times 1.337 \text{ kgCO}_2\text{e/t}$$

$$= 3.26 \text{ kgCO}_2\text{e/ha}$$

Average CF per hectare of land under cassava cultivation (where starch is final product)

$$= 2.44 \text{ tonnes/ha} \times 0.6978 \text{ kgCO}_2\text{e/t}$$

$$= 1.70 \text{ kgCO}_2\text{e/ha}$$

Cost of 1 (one) tonne of cassava = ₦15,000.00

Average postharvest loss = 2.44 tonnes/ha

Therefore, Cost of postharvest loss = ₦15,000.00/tonnes $\times$ 2.44 tonnes/ha
= ₦36,600.00/ha

Based on the work of Abduraheem and Toluwase (2013), cassava farmers earn ₦68,662.50 per hectare, therefore the postharvest loss is about 53.3% of the income earned on a hectare.

Measures Employed to Control Postharvest Losses

Table 5 shows the relative percentages of the respondents that practice each postharvest control measures. The respondents utilize a combination of the postharvest loss control measures as this could imply that the use of just one of the above could be insufficient for the control of the loss. It can be deduced

cultivation and processing; the carbon footprint (CF) for cassava is 1.337kgCO₂e/t of garri produced and 0.6978kgCO₂e/t of starch produced.

from the table that, the most widely used measure by cassava farmers in the study area was harvesting the roots when required while the least used measure was use of agrochemicals. This implies that majority (40.2%) of the cassava farmers in the study area prefers to harvest the roots as at when required to mitigate the potential postharvest loss associated with cassava. This may be attributed to the fact that harvesting of roots when required will give no room for excesses as the desired quantity will be harvested and all possible efforts will be put in place to make sure any postharvest loss is kept at barest minimum.

Table 5: Distribution of the Respondents According to Measures Employed to Control the Post-Harvest Loss

Measures Employed	Yes		No		Total	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Freq.	%
Use of Skilled Workers	12	10.3	105	89.7	117	100.0
Improved Facilities	17	14.5	100	85.5	117	100.0
Delayed Harvesting	20	17.1	97	82.9	117	100.0
Use of Agrochemicals	6	5.1	111	94.9	117	100.0
Harvesting When Required	47	40.2	70	59.8	117	100.0
Use of Improved facilities	25	21.4	92	78.6	117	100.0

Source: Field Survey, 2014.

Summary, Conclusion and recommendations

The study has shown that the size of the cassava postharvest loss in Kwara state is very high and drastic steps have to be taken in order to reduce this loss so as to improve upon the economic status of cassava farmers-processors. The concentration of losses at the harvesting stage calls for concern as there is the need for improved methods of mechanizing the harvesting process to reduce the losses at harvesting. Hence, reducing the losses at harvesting by a great percentage would imply a great reduction of the loss across the value

chain. The factor responsible for postharvest loss like expected output (losses increase with increase in expected output) foretells a need to improve postharvest technology as this implies there are no adequate facilities to contain the excesses that may be harvested. From the result of the analysis, an estimated CO₂ emission of about 3.26kgCO₂/ha of farmland under cassava cultivation (if finished product is garri) and 1.70kgCO₂/ha for starch is very high and has to be reduced as well as the economic cost of the loss (₦36,600.00/ha), which if mitigated and reinvested into the economy would add a required impetus to boost farmers' income and

other agribusiness concern and encourage farmers for better productivity. Also, it can be deduced from the findings of the study that the methods of cassava postharvest loss mitigation adopted by farmers are not adequate enough as there are still quite a number of losses at harvesting. Hence, there should be improvements in existing methods of mitigating losses.

The study therefore recommends that there should be increased study on the alternative uses of cassava roots (e.g. ethanol

production) in order to reduce the already choked garri, flour and starch market. Also, concerns on losses at harvesting and methods of mitigating such losses should hold central point in economic policy development and researches. Also, reasonable policies should be implemented to help the farmers reduce the losses, especially by enforcing the use of cassava flour in confectionaries across the nation. This would ensure the optimal use of cassava, hence reducing its postharvest losses.

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