BMZ Federal Ministry for Economic Cooperation and Development

Future-Makers. Building the future. Let's join forces.

Securing food. Harvesting the future!

Food losses in cassava and maize value chains in Nigeria

Analysis and recommendations for reduction strategies

Published by giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Table of Contents

List of tables

List of Figures

0 Executive Summary and Conclusion

Each year, a significant proportion of food produced for human consumption is lost or wasted. Annual losses have been estimated at about 1.3 billion tonnes by the FAO (2011)[1]. In light of rising food prices, growing pressure on natural resources and severe famine in parts of eastern and western Africa in recent years, avoidable loss and waste of food cannot be tolerated. The world's natural resources, such as soil, water, fossil energy and nutrients, are limited, and must be used in a more efficient and responsible manner.

The term food wastage, as used by the FAO, encompasses both food loss and food waste. Wastage occurs along the entire food/value chain and varies in extent depending on the product and region. The concept of food wastage is defined differently in different parts of the world. In developed countries, food waste arises at the consumer stage and concerns food which is processed and ready to eat. In developing countries, food losses occur at the post-harvest stages; during marketing and processing (Godfray et al., 2010[2]).

This study focuses on food losses at the harvesting, processing and marketing stages. Its **main aim** is to improve data availability concerning food losses in important food value chains in the showcase country of Nigeria, contribute to methodological discourse on the assessment of food losses, and identify options for German Development Cooperation to engage in food loss reduction programmes.

Cassava and maize, which are important staple foods for many Africans both in rural areas and in the rapidly growing cities, were selected as the focus of the study.[3] Both crops are cultivated across different agro-ecological zones in Nigeria, mostly by smallholder farmers. Both are processed into different foodstuffs at household and industrial level. They also serve as feed for animals. There are also industrial utilisations for cassava and maize which are not related to the production of food or feed.

The scope of the study was to describe at least one typical value chain for cassava and maize (from harvest to retailer) along with its system boundaries, provide quantitative and qualitative analysis of food losses, identify hot spots for losses, determine causes of food losses and positive or negative incentives, identify important actors and partners in the private and public sectors and the research and donor communities, and examine the role of these actors in reducing food losses along value chains. Finally, it aimed to provide recommendations for reducing food losses at the operational and policy level and for future engagement of the German Federal Ministry for Economic Cooperation and Development (BMZ).

The survey comprised 400 cassava and maize farmers, 54 marketers and 63 processors. Results show that losses in cassava and maize value chains are significant, but also that their distribution within the value chains is irregular. Data have been obtained by assessment, not by measurement, and are therefore dependent on the perception of the interviewees. In order to ensure the data collected was representative, 400 respondents took part in the study and specially trained field interviewers were used.

Field data have been supplemented with official national statistics, mostly data of the FAO (Food and Agriculture Organisation of the UN), to provide a better overview of national losses in the two value chains studied. The quality of the nationwide data is therefore dictated by the quality of the underlying official statistics. Due to the complexity of interactions in the value chains, the chains have been slightly simplified in order to demonstrate the main resource flows. Short cuts in the value chains have not been considered, which may have led to a tendency to overestimate loss data. Percentage loss data in the value chains are presented for every cluster in the chain (farmers, processors, marketers) and cannot be added up, because they base on different quantities. They show nevertheless significant hot spots and challenges in post- harvest losses.

The results of this study show crude loss data without considering the economics of losses. In reality, it is not feasible to achieve zero losses, as protection measures to secure 100 percent of the harvest will inevitably be disproportionately costly. Losses have to be accepted to a certain extent, depending on market prices and existing infrastructure. Actual losses for farmers, processors and

1 Food and Agriculture Organization of the United Nations, Rome, Italy, 2011: Global food losses and food waste extent: causes and prevention
2 Godfray, H. C. et al. 2010: Food Security: The Challenge of Feeding 9 Billion People; Science; 12 February 2010; 327
3 Nigeria annual production figure; FAOSTAT, 2012 http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor

marketers are therefore smaller than estimated in this study.

The study on losses is followed by a second study which estimates, on the basis of these data, the impact of food losses on natural resources such as soil, water, biodiversity and climate (ecological footprint).[4]

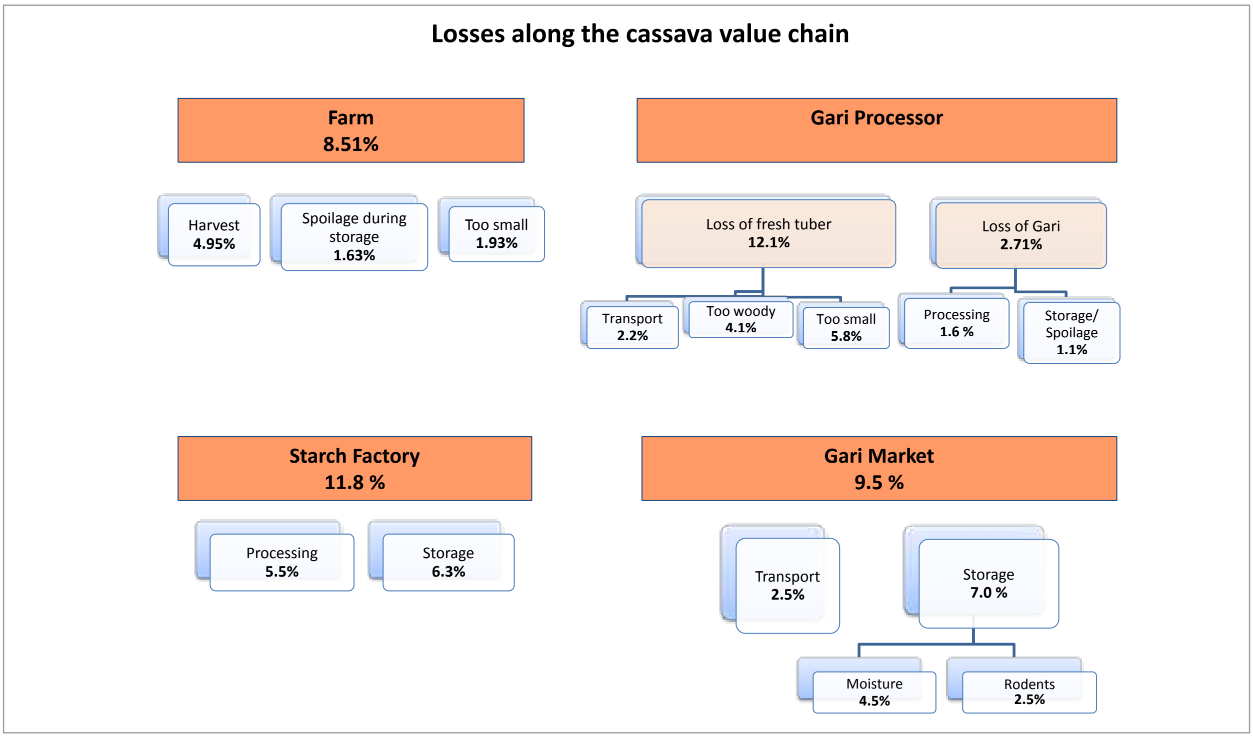
Cassava is a tuber crop that is grown and consumed across all the agro-ecological zones in Nigeria. With an annual production of over 40 million metric tons (mt), Nigeria is widely acknowledged as the largest producer of cassava in the world. The major growers are the southern and Middle Belt states of the Federation.

Cassava is processed into gari for human consumption and into starch for the food and beverage industries. Furthermore, it is used in the pulp and paper as well as the furniture and plywood industries. It is also an important raw material in the textile and pharmaceutical industries in Nigeria. Inability to meet local demand for starch from local sources has led to Nigeria importing significant quantities of corn starch each year.

Losses in the cassava value chain relate to measurable quantitative and qualitative losses in the course of transforming cassava into various products. It is difficult to assess the loss of quality in gari due to the absence of measurable criteria that are easy for consumers to use. In the case of starch used for industrial purposes, quality criteria include moisture content and other impurities.

Cassava farmers indicate that the most significant losses occur during harvest (4.95%), due to inappropriate harvesting technologies (machetes) and poor soil conditions (dry and stony). According to the respondents, the main challenges for gari processors are tubers that are too small (5.8%) and too woody (4.1%), as these cannot be peeled correctly and have to be thrown away. This problem appears to be less significant when gari is processed for home consumption at the farm level. This could be attributed to the fact that farmers are more reluctant to discard their harvest or that they use better adapted peeling technology than gari processors. Improved cassava peeling technology would be a key element in reducing these losses.

Figure 1: Synopsis of losses in the cassava value chain



4 PE International/ GIZ 2013: Life Cycle Assessment of Maize and Cassava: Post-Harvest Losses in Nigeria

The main reasons for losses of gari at the marketing level are moisture (4.5%) and rodents (2.5%) during storage, whereas transportation accounts for around 2.5% of losses.

Losses during starch production are significant, amounting to nearly 12%. The most significant losses occur during processing of tubers (5.5%) and during storage of starch (6.3%).

Extrapolation of the losses from the assessment to the whole of Nigeria indicates that they are significant in both, gari and starch value chains. Loss of fresh cassava tubers at the farm gate and during gari processing amounts to more than 6.3 million mt, corresponding to annual mean losses of 37 kg per capita[5]. This does not include losses of gari during and after processing, which amount to around 800,000 mt a year and losses in cassava starch production of around 106,000 mt per year. The total sum of **monetary losses of cassava** at the farm gate and during processing, storage, transport and marketing amounts to 144 billion Naira, which corresponds to EUR 686 million.

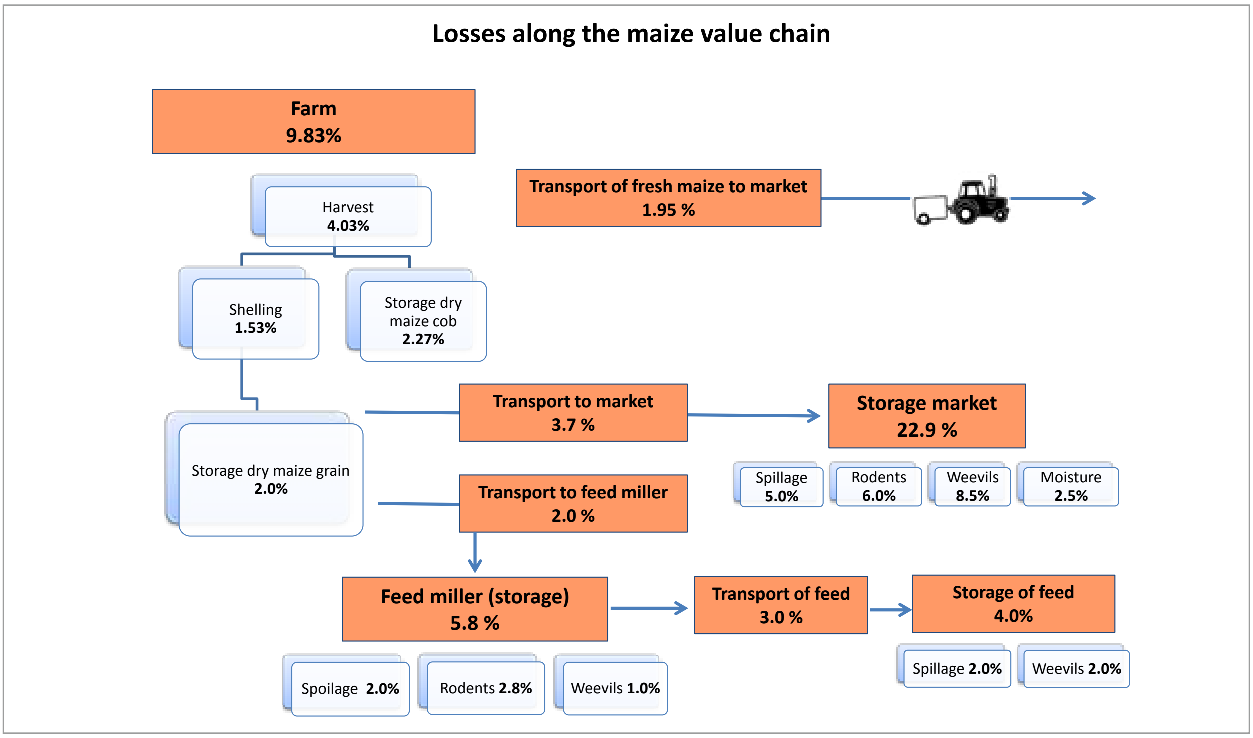
Maize is cultivated in the forest, derived savannah and southern Guinea savannah zones of Nigeria as a sole or mixed crop. It is harvested either as green maize or maize grain. The major end-users of maize are feed and flour mills. The feed mills supply the poultry and aquaculture industry while the products of the flour mills are meant for direct human consumption. The value chain examined in detail in this study is feed production. Although the FAO currently only defines food products which were originally meant for human consumption and are then used for other purposes (e.g. feed, biofuel) as “food waste”, this study also considers losses along the value chain of maize for feed production. Maize is a very important feed in Nigeria and its affect food security indirectly because it competes with the production and use of maize for human consumption.

In the case of maize destined for human consumption, farmers harvest the crop when it is fully ripe. Green maize is harvested before the grain has ripened. Maize to be sold as grain is allowed to dry on the plant and is then further sun-dried to reduce the moisture content and shelled by hand. Shelled grain is bagged and stored until the time of sale. Trade in maize grain is dominated by grain merchants. Retailers buy the product from the wholesale markets and sell it to consumers in small quantities.

The farmers identified four main causes of losses. The most significant losses occur before harvesting and are attributed to pests and disease. As these are not strictly post-harvest losses, they have not been further considered in the study, but the issue should be addressed in any integrated approach to increasing agricultural productivity. Losses during harvesting were estimated at 4.03% of the total harvest, while shelling, storage of dry maize cobs and dry maize grain and transport of fresh maize to the market entailed losses of between 1.53% and 2.27%. Altogether, losses at farm level were around 13.7%.

5 Population of Nigeria approximately 167 million in October 2011, German Federal Foreign Office

Figure 2: Synopsis of losses in the maize value chain



The most significant losses in the maize value chain occur at the marketing stage (26.6%), mostly due to storage problems (spillage, rodents, weevils (*Sitophilus zeamais*) and moisture) and to a lesser extent during transportation (3.7%).

Feed millers cited storage of grain (5.8%) and storage of feed (4%) as the most important areas in which losses occur. Transportation accounts for 3% of losses. Total losses at the feed miller level amount to 12.8%.

The mean period of storage of maize grain before milling is 8.8 weeks and the period before spoilage begins to manifest is around 4.0 weeks. The length of time that products can be stored before spoilage starts to set in is 3.0 months.

Losses of green and dry maize cobs at the farm gate amount to 194,276 mt per year, while 257,885 mt of maize grain are also lost annually. The biggest losses occur during the marketing stage, which accounts for 1,943,271 mt of maize grain per year. This corresponds to a mean per capita loss of 11.6 kg. Feed milling and feed marketing account for around 233,600 mt of feed losses. The total sum of monetary losses in maize value chains amounts to around 120 billion Naira, which corresponds to approximately EUR 576 million.

Options for food loss reduction

Technology: Inappropriate technology appears to be the dominant cause of food losses. In the case of cassava, areas requiring attention are harvesting, peeling and storage of fresh cassava tubers and efficiency in grating and milling. In the case of maize, areas requiring attention are bagging, transportation and storage (especially hygiene). Appropriate technologies could be developed through collaborative research projects conducted by public and private actors, focussing, for example, on the development of a cassava peeling machine. Appropriate packaging and transportation arrangements would have to be made for the transportation of semi-finished products to the starch factory.

Organisation of farmers and the value chain: Due to the decline of farmers' organisations and cooperatives, farmers no longer have the capacity to influence the production, processing, transportation and marketing of agricultural commodities. Farmers can pool their resources and create economic incentives to improve transportation and storage facilities, thus helping to reduce food losses and enhance their own incomes. As groups and cooperatives, they will be able to receive credit from agricultural financial institutions or advance payments from buyers of their produce. It would be advisable for the Department of Cooperatives at the state and federal levels to collaborate with the State Offices of the Nigerian Ministry of Agriculture and Rural Development to promote farmers' organisations.

Processors, public sector actors and donors should collaborate in promoting and strengthening farmers' organisations and cooperative societies and linking them with processors to create efficient commodity supply chains that could reduce losses in the production, processing, transportation and marketing of maize grain and cassava tubers.

Processors of cassava tubers should work with Agricultural Development Programmes in specific states to develop out-grower schemes, which could be used to provide farmers with inputs and technical guidance for efficient cassava production, while the processors undertake the harvesting, collection and transportation of fresh tubers at maturity.

Infrastructure: Poor transportation and storage facilities and lack of other infrastructure contribute to losses in value chains. Areas to focus on are infrastructure for transportation, storage and marketing that is appropriate to the tropical environment and the road network. It appears there are currently no economic incentives for private sector operators to deploy appropriate vehicles for the transportation of farm-fresh products in Nigeria. The establishment of small-scale pre-processing centres located among clusters of cassava farmers and/or farming communities, and thus close to the farm gate, would allow cassava to be transformed into semi-finished, dewatered starch products which could then be transported to starch factories for processing into industrial or food-grade starch. The transportation of fresh tubers to pre-processing centres that are only a short distance away would reduce the potential for loss and minimise the cost of transporting water and fibre (wastes) along with the cassava.

Market: Poor market infrastructure and marketing systems contribute to significant losses, especially in maize value chains. In recent times there have been attempts in some states to improve market infrastructure. Within markets, sections are often created for specific agricultural products. It should therefore be easy to address the market operators for each type of agricultural product in a targeted manner.

Standards for handling and processing of agricultural raw materials (maize grain and cassava tubers) should be established and appropriate informational materials developed to teach actors along the value chain about appropriate handling, packaging, transportation and processing techniques that will minimise losses in the value chains while ensuring cost effectiveness.

Human capacity development: Appropriate advocacy and training can be provided to operators in the wholesale and retail sections of the gari market to improve the handling (especially bagging) and storage of the product with a view to maintaining quality and reducing physical losses.

A thorough *cost-benefit analysis is* the basis of economically sustainable investment. Low prices for commodities frequently restrict investment in improving post-harvest management. In many cases, accepting losses is cheaper than investing in protection. Technology transfer and training can only be successful if there is genuine economic benefit for the farmers. Whether this benefit is generated through higher market prices or, for an intermediate period, through state support and subsidies depends on the situation. Innovations often need initial support in order to become accepted and widespread, but they should be always based on sound economic analysis.

The steady increase in food prices over recent years would seem to offer the right impetus for investment in post-harvest management.

1 Introduction

1.1 Aim of the study

The aim of this study is to improve the availability of data on food losses in important food value chains in the showcase country of Nigeria, more precisely the northern state of Kaduna and the southern state of Ondo. The study aims to contribute to methodological discourse on the assessment of food losses and to identify options for German Development Cooperation to engage in food loss reduction programmes.

1.2 Concept of food losses

Each year, a significant proportion of food produced for human consumption is lost or wasted. Annual losses have been estimated at about 1.3 billion tonnes. In light of rising food prices, growing pressure on natural resources and severe famine in parts of eastern and western Africa in recent years, avoidable loss and wastage of food cannot be tolerated. The world's natural resources, such as soil, water, energy and nutrients, are limited, and must be used in a more efficient and responsible manner.

The term food wastage, as used by the FAO, encompasses both food loss and food waste. Wastage occurs along the entire food/value chain and varies in extent depending on the product and region (FAO 2011)[6]. In developed countries, food waste arises at the consumer stage and concerns food which is processed and ready to eat. In developing countries, food losses occur at the post-harvest stages (Godfray et al., 2010[7]).

This study focuses on food losses at the pre-harvest, harvest, post-harvest and processing stages, which are most relevant in developing countries. Pre-harvest losses are not further considered in this study, because preventing them would require specific crop protection measures. Post-harvest losses take place at the time of harvest and during various post-harvest operations from the farm gate to the first level of the market. They can be of physical nature (weight and quality) and/or economic nature (loss of value due to bad storage facilities or information systems). Losses in food value chains are highly variable, ranging from 5% to 30%.

As Figure 3 shows, 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.

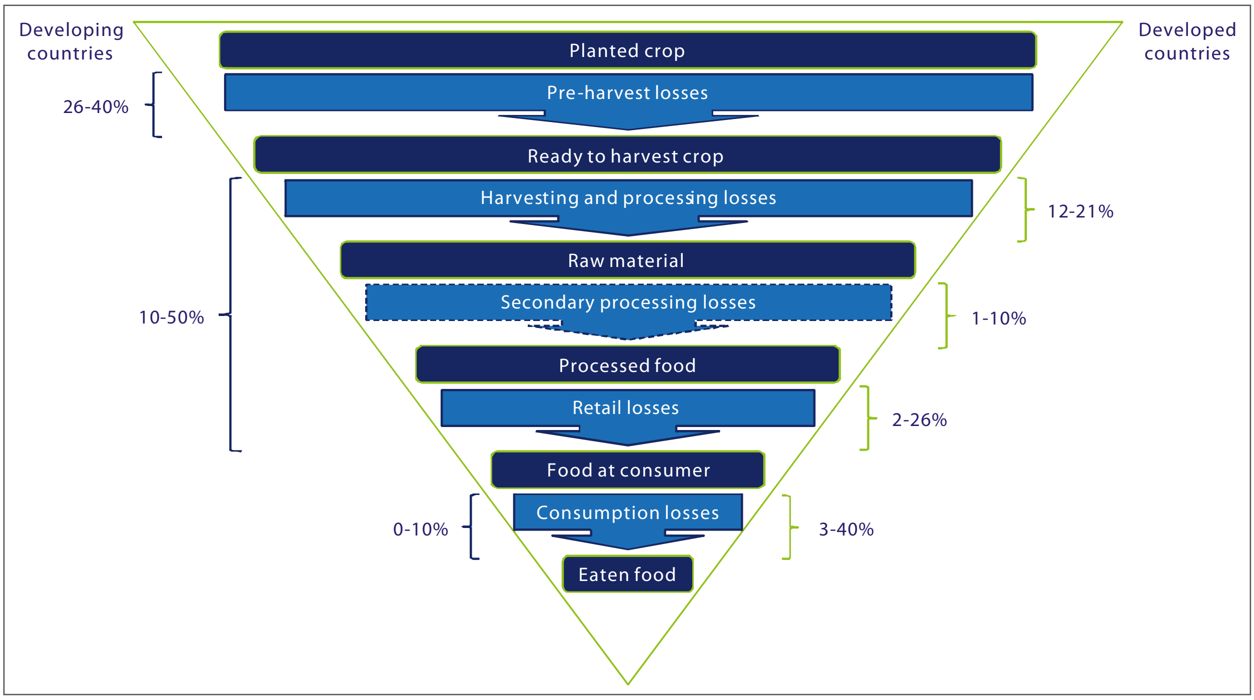
A review of existing literature on the subject showed that accurately monitoring food losses continues to represent a considerable challenge. There are a number of reasons for this, the most important being major differences in crops, the multiplicity of routes a typical crop can follow from farm to end-user and the time it takes a crop to reach the end-user. The situation for cereals differs significantly from that for roots and tubers. There are also variations among the cereals, with the handling and processing routes for maize, for instance, deviating significantly from those that other cereals pass along. Similarly, the handling of maize harvested when green is very different from that of maize harvested as grain.

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. The term 'damage' refers to loss which affects quality more than quantity, though this loss may still result in economic loss. A frequent form of damage is broken grain. In addition to these, losses can occur as a result of spillage from bags, consumption by pests, deterioration and road accidents during long distance transportation.

The main reason why previous projects aiming to avoid food losses have not succeeded is that they have given insufficient consideration to the complexity of causes. Solutions have therefore been too narrow in focus. The underlying causes of food losses (drivers) have to be fully investigated in order to understand why farmers and other economic operators act the way they do. The public and private sectors should share the investment costs and risks involved in carrying out targeted interventions. It should also be borne in mind that the economic impli-

6 Food and Agriculture Organization of the United Nations, Rome, 2011: Global food losses and food waste extent: causes and prevention
7 Godfray, H. C. et al. 2010: Food Security: The Challenge of Feeding 9 Billion People; Science, 12 February 2010, 327

Figure 3: Wastage of food products along the supply chain (WEF)[8]



cations of post-harvest losses (PHL) can motivate operators along the value chains to reduce these losses for the sake of their own profitability.

1.3 Concept of food value chain

A value chain is a sequence of related business activities (functions), beginning with the provision of specific inputs for a particular product, moving through the phases of primary production, transformation and marketing, and ending with the final sale of the product to consumers.

The enterprises (operators) performing these functions comprise producers, processors, traders and distributors of a particular product. These enterprises are linked by a series of business transactions as the product is passed on in stages from primary producers to end consumers. These stages represent the links in the value chain.

Value chain analysis is a useful strategy in understanding overall trends of industrial reorganisation. It can be used to identify key players, change agents and leverage points for policy and technical interventions. Value chain analysis involves breaking a process into its constituent parts in order to better understand its nature, structure and functioning. Actors at each stage of the chain are identified, along with their functions and relationships. This knowledge facilitates and strengthens efforts to influence the chain.

The flow of goods, information and finance through the various stages of the chain is evaluated in order to detect problems or identify opportunities to improve the contribution of specific actors and the overall performance of the chain. The analysis usually goes beyond the production stage. It examines interactions and linkages among key players as well as between the business and policy environment.

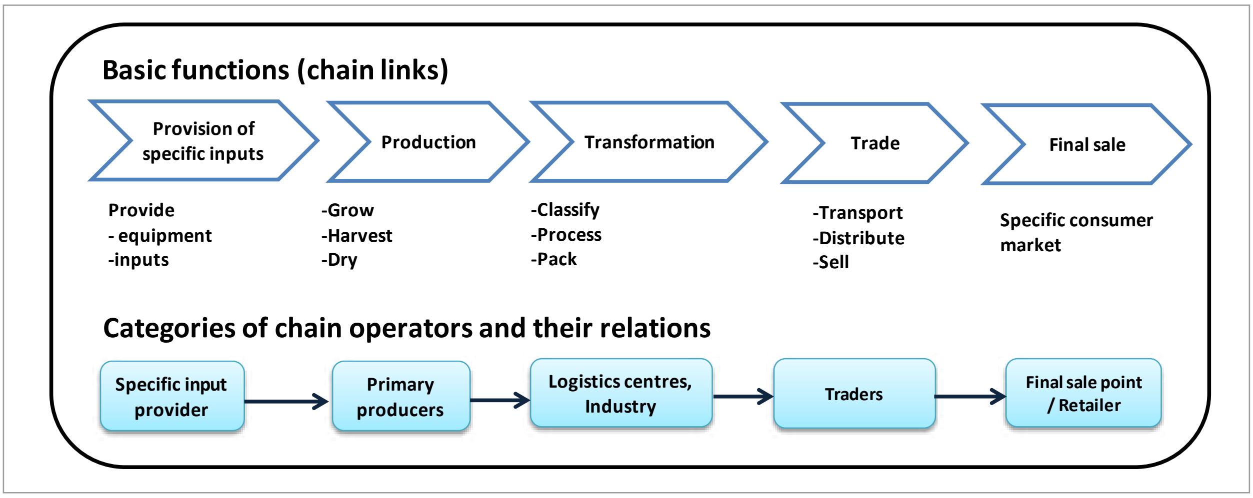
8 World Economic Forum, Driving Sustainable Consumption: Value Chain Waste - Overview Briefing; https://members.weforum.org/pdf/sustainableconsumption/DSC%20Overview%20Briefing%20-%20Value%20Chain%20Waste.pdf

Table 1: Generic food supply chain and examples of food wastage[9]

Stage	Examples of food waste/loss characteristics
Harvesting – handling at harvest	Edible crops left in field, ploughed into soil, eaten by birds, rodents, timing of harvest not optimal: loss in quality
	Crop damaged during harvesting/poor harvesting technique
	Outgrades at farm to improve quality of produce
Threshing	Loss through poor technique
Drying – transportation and distribution[10]	Poor transport infrastructure, loss owing to spillage/bruising
Storage	Pests, disease, spillage, contamination, natural drying out of food
Primary processing – cleaning, classification, dehulling, pounding, grinding, packaging, soaking, winnowing, drying, sieving, milling	Process losses
	Contamination in process causing loss of quality
Secondary processing – mixing, cooking, frying, moulding, cutting, extrusion	Process losses
	Contamination in process causing loss of quality
Product evaluation – quality control: standard recipes	Product discarded/outgrades in supply chain
Packaging – weighing, labelling, sealing	Inappropriate packaging damages produce
	Grain spillage from sack
	Losses caused by rodents
Marketing – publicity, sale, distribution	Damage during transport: spoilage
	Poor handling in wet market
	Losses caused by lack of cooling/cold storage
Post-consumer recipes elaboration: traditional dishes, new dishes product evaluation, consumer education, discards	Plate scrapings
	Poor storage/stock management in homes: discarded before serving
	Poor food preparation technique: edible food discarded with inedible
	Food discarded in packaging: confusion over 'best before' and 'use by' dates
End of life – disposal of food waste/loss at different stages of supply chain	Food waste discarded may be separately treated, fed to livestock/poultry, mixed with other wastes or land-filled

9 Parfitt, J.,Barthel, M., and Macnaughton, S. (2010). Food waste within food supply chains: quantification and potential for change to 2050. Phil. Trans. R. Soc. B 2010 365, 3065-3081. References doi: 10.1098/rstb.2010.0126
10 Drying usually takes place on the farm and/or farmstead. The grain must also be transported to a storage facility and loss can occur in this process.

Figure 4: Generic elements of a basic linear value chain[11]



11 GTZ (2007), Value Links Manual: The Methodology of Value Chain Promotion, First Edition

2 Methodology

This study has been based essentially on information from primary and secondary sources. Most of the information on cross-sector value chain institutions and policy issues was obtained from secondary sources while the information on enterprise-specific value chain issues and the percentage of food losses at different levels came from primary sources. A specially designed questionnaire was developed to collect field data from actors along cassava and maize value chains (questionnaires can be found in annexe IV). These actors comprise cassava farmers, starch processors, marketers of cassava tubers, gari processors, maize farmers, marketers of maize grain and feed millers. The data collected were reviewed and the information required to address the specific aspects of the study was extracted and utilised.

For each actor surveyed, variables on costs, returns, post-harvest losses (PHL), storage, transportation, production, etc. were solicited from respondents. To adequately estimate the net benefits of the ventures focused on in the study, certain assumptions were made regarding aspects such as soil quality and agronomic practices. Smallholder cassava yield ranges between 8 and 12 metric tons (mt) per hectare (ha). However, on experimental stations, the yield could exceed 20 mt per ha.

Wherever information was available, previously documented input-output data were used. This was necessitated by the fact that different measures were being used for business transactions across the sampled states, meaning prices and quantities were difficult to standardise. Various measures are currently in use, such as heaps, portions and baskets of cassava tubers; kongos (mudus) and basins of gari; baskets, wheelbarrows and pick-up vans of cassava, etc. This made it difficult to compute an appropriate and representative cost and returns framework based strictly on the field data. Efforts were therefore made to obtain standard measures and prices from other sources. For example, rather than working with 200 heaps of cassava at a farm gate price of □ 5,000, we used the prevailing cassava tuber purchase price of □ 9,000 per mt set by MATNA Foods Company, a starch factory in Ondo State. To convert prices for gari from Naira per kongo to Naira per kg, we ascertained the weights of different kongos of gari and found out that a kongo of gari weighs 1.1 kg on average. We also found that a kongo of dry maize grain weighs 1.25 kg on average. This information, coupled with the price data collected from the field, was used to calculate and confirm the price of gari and maize per mt. A further finding was that a pick-up van of cassava tubers was equivalent to 400 heaps, which translates to 4.08 mt.

Table 2: Traditional measures and their metric conversions

Product	Local measure unit	Respective value in Kilograms (rounded)
Cassava tubers	1 Pick-up van (≈ 400 heaps)	4080
Maize grain	1 Kongo	1.25
Gari	1 Kongo	1.1

A comprehensive review of existing literature was carried out. Subject areas covered included production, processing, handling, storage and marketing of cassava and maize, value chain analysis, post-harvest losses and food waste.

The value chain maps for cassava and maize were developed based on the literature review. The system boundaries are delineated, in line with Gustavsson et al. (2011)[12], as field (agricultural production), farm storage facilities (post-harvest handling and storage), farm industry (processing and packaging), wholesale and retail markets (distribution) and household food services (consumption).

12 Gustavsson, J., Cederberg, C., Sonesson, U., Otterdijk, R. and Meybeck, A. (2011): Global Food Losses and Wastes, Swedish Institute for Food and Biotechnology (SIK), Gothenburg, Sweden and FAO, Rome, Italy

Specific potential respondents within the value chain were targeted for data collection in accordance with these boundaries.

Data were collected from published sources, through key informants and focus group interviews and where necessary through the use of questionnaires and/or surveys. Data collection covered major participants along the value chain, the major sources and causes of losses and waste, and information on loss quantities. Other information collected included costs and returns for various players in the value chain. To collect data from the farmers, specific questionnaires were developed (annexe IV). The questionnaire was used as an interview guide by trained enumerators to elicit information from the farmers, since many of the farmers were not able to read and therefore could not complete the questionnaire without assistance. A multistage sampling technique was adopted to select the farmers that would constitute the sample. In the first stage two states which are major producers of cassava and maize were selected. These were Ondo in the south and Kaduna in the north. In each of the two states, two local government areas which are high producers of cassava and maize were selected. The study was thus carried out in four local government areas. Lists of cassava and maize farmers were obtained from the respective Agricultural Development Programme (ADP) and 50 cassava farmers and 50 maize farmers were randomly selected for each local government area, making a total of 200 cassava and 200 maize farmers. As shown in Table 3 below, other specific actors along the value chain were also interviewed.

Table 3: Number of respondents in each sample

State	**Ondo**		**Kaduna**		**Total**
Local government area	Ifedore	Akure North	Lere	Gema	
Maize farmers	50	50	50	50	200
Cassava farmers	50	50	50	50	200
Gari processors	10	10	5	5	30
Maize grain marketers	2	2	10	10	24
Fresh cassava tuber marketers	10	10	5	5	30
Feed millers	6		2		8
Cassava starch processors	15		10		25
Total					**517**

The data that were collected from cassava and maize farmers to determine the environmental footprint of food losses include:

1. Type and quantity of fertiliser used per unit area

2. Cropping system: mono-cropping/mixed cropping (crop combinations, percentage of mixture with other crop)

3. Type and quantity of pesticides and fertilisers (if any) used per unit area

4. Extent of mechanisation - type of farm machinery used and for which operations

5. Crop rotation – crop succession on the same plot

6. Type of transport and distances usually covered to reach the store/warehouse, market, retailer, etc.

There appears to be no generally accepted methodology for determining post-production losses in root/tuber crops. A publication by the National Academy of Sciences (USA) from the year 1978 on post-harvest losses[13] makes the following differentiation between assessment, measurement and estimation of losses:

Assessment is a rough quantitative approximation of food loss or the characterisation of the relative points of loss in a particular food supply system. This approach implies a measure of subjectivity resulting from a lack of sufficient information.

Measurement on the other hand is a more precise quantitative observation with less subjectivity. With measurements there is a high expectation of reproducibility without observer bias.

In light of the above, and considering the expected deliverable of this study in respect of quantitative and qualitative analysis of food losses, the work was undertaken as an 'assessment of food losses', using structured questionnaires to elicit information from farmers, marketers and processors (especially in the case of cassava). For industrial users and other actors along the value chain, consultation with experts and key informant interviews were conducted.

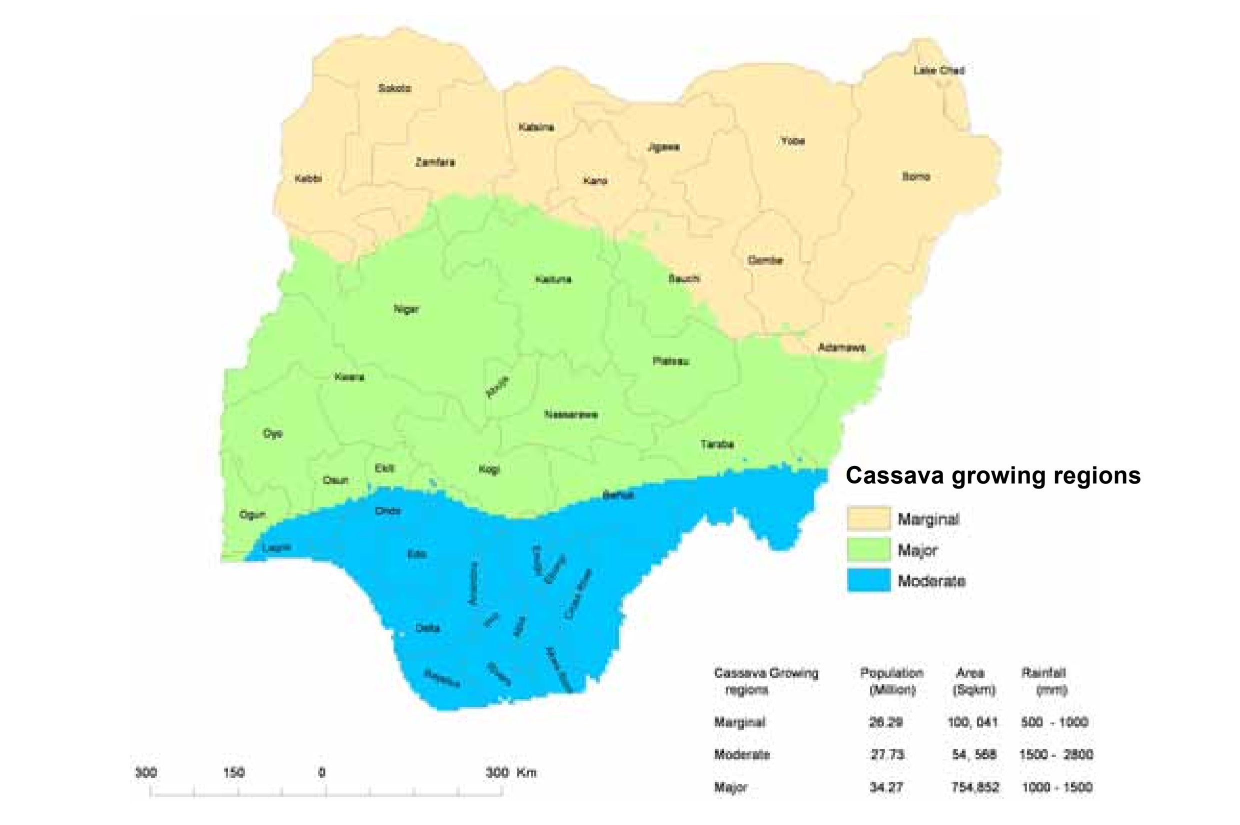
13 National Academy of Sciences: Post-harvest Food Losses in Developing Countries. Washington D.C. 1978, 202p.

3 Cassava

3.1 Cassava in Nigeria

Cassava is a tuber crop that is grown and consumed across all the agro-ecological zones in Nigeria. With an annual production of over 40 million mt, Nigeria is widely acknowledged as the largest producer in the world, also accounting for over 70% of the total production in West Africa. From 1990 to 2005, Cassava production increased from around 20 million mt to around 45 million mt, before falling to around 37 million mt in 2010 (see Figure 6). Cassava is produced across virtually all Nigeria's agro-ecological zones (NBS, 2007)[14]. However, the major growers are the Middle Belt states of the Federation (Figure 5).

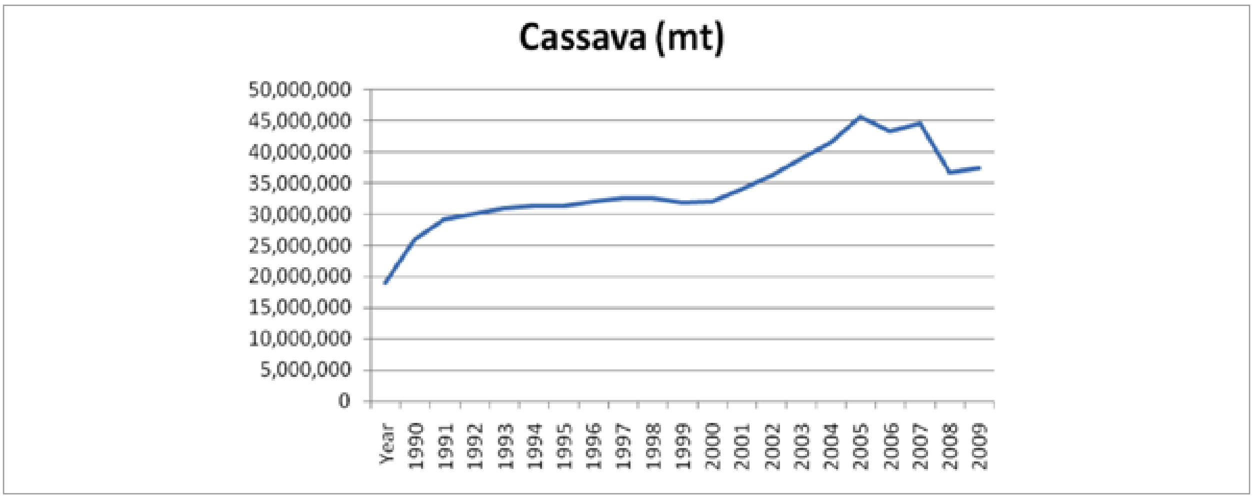
Figure 5: Cassava growing regions in Nigeria[15]



14 NBS (2007) Filling the Data Gaps, National Bureau of Statistics

15 Ezedinma (2006) Structure and Profitability of Cassava Enterprises in Nigeria, paper presented at the Root and Tuber Expansion Programme (RTEP) Training Workshop on Rural Enterprise Management and Community-Driven Development at ARMTI, Ilorin

Figure 6: Output of cassava in Nigeria (1990 – 2010)[16]



There are different varieties of cassava with different attributes and yield levels. Where maize seed can easily be procured from input suppliers, it is often difficult to obtain stem cuttings for cassava. Farmers tend to use stem cuttings from past harvests from their own fields or from friends and family members. Sometimes they are forced to buy them from other farmers. Most farmers find it difficult to distinguish between the different varieties of cassava just by looking at the stem cuttings.

Cassava is cultivated either as a sole crop or mixed with other crops. In mixed cassava-maize plots, maize is usually planted first. When the maize is fully grown, the cassava cuttings are planted on the same ridges as the maize. After the maize is harvested, the cassava takes over the field completely. The cost of land preparation and initial weeding is thus shared between maize and cassava. Under standard agronomic practices, 10,000 ridges (stands) are planted per ha. Whether it is grown as a mixed or sole crop, cassava cultivation is very labour intensive. It comprises four main activities: land preparation (clearing, packing); planting (laying-out, tilling, planting); weeding/farm maintenance and harvesting/ transportation for off-farm activities. With the exception of value-chain-operators involved in land preparation and herbicide spraying, all other farm activities are conducted manually and largely by groups of externally sourced day labourers working with machetes and hoes.

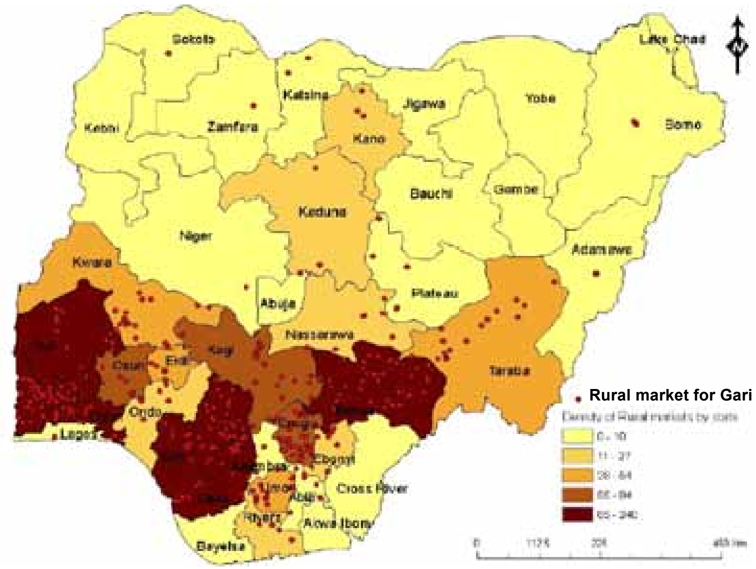
Fertiliser is not commonly applied. However, where cassava and maize are intercropped, the maize may receive some fertiliser from which cassava also benefits. Generally, the belief is that cassava can perform well without fertiliser.

The harvest is brought in within 12-18 months of the planting period. Due to the highly perishable nature of cassava tubers, harvesting of the tubers is staggered in a manner that is consistent with household needs and market demand.

The two broad markets for cassava in Nigeria are traditional food and industrial products. Most of the cassava grown in Nigeria is processed and sold as traditional food. Just as production of cassava is spread across all Nigeria's agro-ecological zones, so too are the markets for the common cassava food products, especially gari. However, the market is particularly dense in the southern states of the Federation (see Figure 7).

16 FAOSTAT 2012

Figure 7: Gari destination markets in Nigeria[17]



The industrial product market for cassava includes the starch, food-grade ethanol and cassava flour markets. Of the three markets, the starch market is the most pronounced. It comprises the native starch and the modified starch markets (Knipscheer, 2003)[18]. Most of the industrial players in this market are also concentrated in the southern states of Nigeria.

3.2 Cassava value chains

The cassava value chains examined in this study were selected based on a review of existing literature, consultation with experts, and previous field work done in the context of this study.

The critical input suppliers for cassava cultivation are farmers, international research institutions (such as IITA or CIAT), Agricultural Development Programs (ADPs), and the Roots and Tubers Expansion Programme (RTEP). They all provide stem cuttings: the most significant input after labour. Cassava cultivation is dominated by smallholder farmers and household members who are engaged in both upstream (production) and downstream (homestead processing and marketing) activities. Different levels of processing can be observed. These include homestead processing by farmers' wives, commercial processing by women who buy tubers for processing and selling in product form, and toll processing in which specialised professionals provide peeling, milling (grating), pressing and frying services. There are also some industrial processors who buy cassava on a large scale for processing into starch and other derivatives for use in other industries as well as gari,fufu and lafun for the domestic market. Between these actors there are middlemen and women who perform various marketing functions.

17 Ezedinma, C., Ojiako, I. A., Okechukwu, R. U., Lemchi, J., R., Umar, A. M., Sanni, L., Akoroda, M., Ogbe, F., Okoro, E., Tarawai, E., and Dixon, A. (2007). The cassava food commodity market and trade network in Nigeria. IITA, Ibadan, ISBN 978-131-200-5. 296 pp.
18 Knipscheer (2003) Opportunities in the Industrial Cassava Market in Nigeria, Winrock/IITA

The value chain map for cassava is presented in Figure 8, and is supplemented by a functional analysis of key variables (Table 4). The map indicates the operators and the products at each stage of the value chain. It also shows links between the operators across the stages. As shown in the map, the end products of cassava transformation in Nigeria are gari, lafun, fufu[19], composite flour, textiles, starch, glucose syrup, medicines, livestock feed and alcohol. These products emanate from both traditional and industrial sectors in the cassava value chain.

For the purpose of providing a detailed description of the traditional and industrial sectors, the following value chains will be considered:

i. fresh cassava tubers passing through the marketing and processing stages and reaching households as gari;

ii. fresh cassava tubers passing through the marketing and processing stages and reaching industry as starch.

These end products (gari and starch) are the most traded of all the cassava products in Nigeria.

19 Gari is a creamy white, partially gelatinised, roasted, free flowing granular flour with a slightly fermented and sour flavour. Fufu is a fermented wet paste widely consumed in eastern and south-western Nigeria. Lafun is a whitish cassava powder which is mixed with hot water to form a paste and is widely consumed in south-western Nigeria.

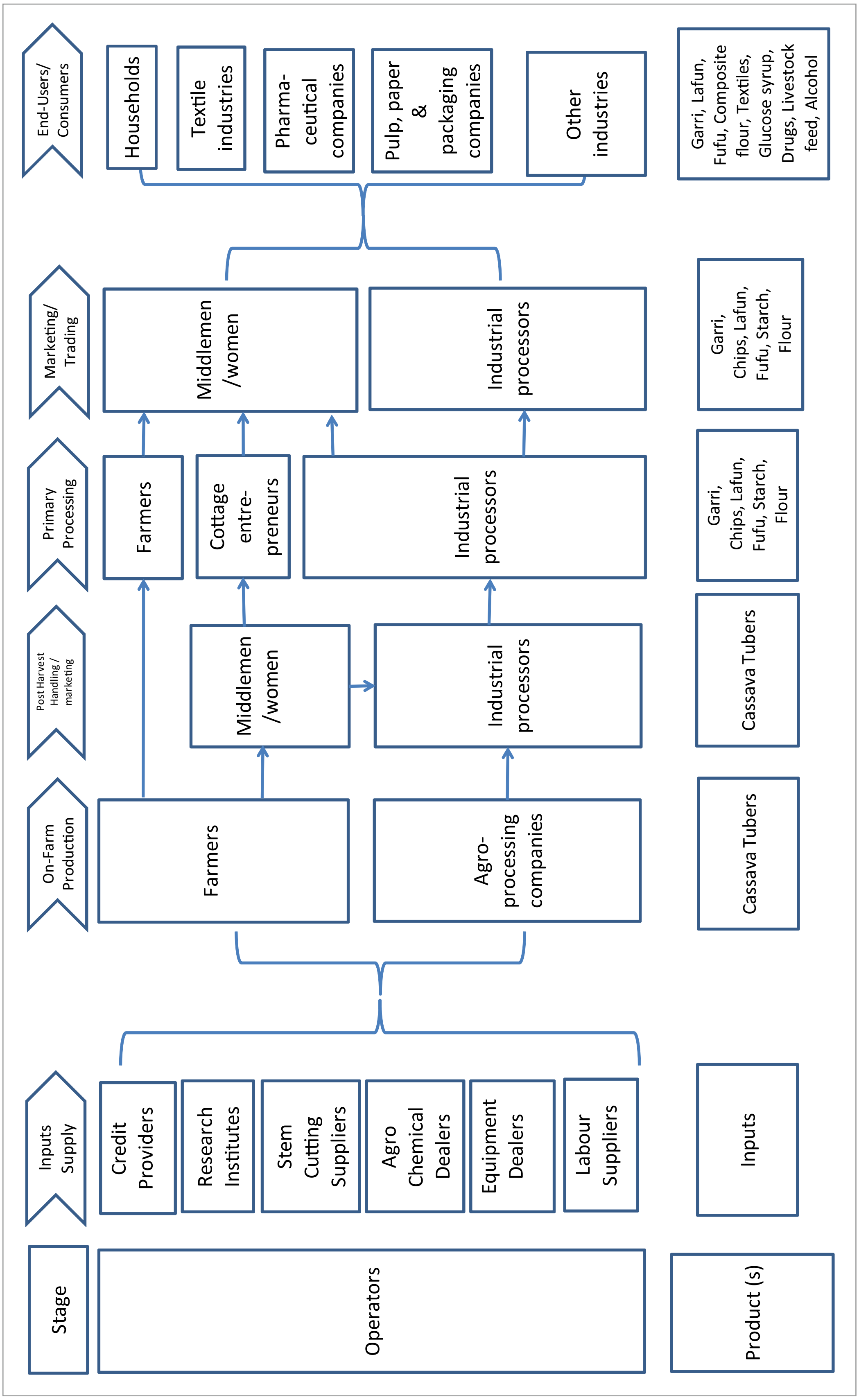


Figure 8: Cassava value chain map

3.2.1 Cassava production

The field survey carried out in the course of this study yielded information on the key variables of cassava production (Table 4).

Table 4: Description of key variables in cassava production per average cassava farm

Variable	Mean
Farm size (all crops) ha	3.75
Farm size (cassava) ha	1.22
Quantity of cassava cuttings (pick-up van)[20]	3.91
Amount spent on cassava cuttings (₦)	8,046.79
Distance from household residence to farm (km)	4.18
Quantity of fertiliser applied (kg)	109.68
Amount spent on fertiliser (₦)	9,948.39
Quantity of insecticide (l)	1.80
Amount spent on Insecticides (₦)	1,513.82
Quantity of fungicide (l)	3.60
Amount spent on fungicides (₦)	684.00
Quantity of herbicide (l)	2.66
Amount spent on herbicides (₦)	4,395.33
Amount of damaged tubers during harvest (%)	4.95
Yield of cassava tubers in a year with very good weather (mt/ha)	7.64
Yield of cassava tubers in a year with normal weather (mt/ha)	5.06

The table shows that the mean size of cassava farms was 1.22 hectares. The yield of cassava tubers was 7.64 tonnes in years with very good weather and 5.06 tonnes in years with normal weather. The table reveals that cassava farmers applied fertilisers and other agro-chemicals. Fertilisers and agro-chemicals are even more used in maize production. When the maize is later inter-cropped with cassava, the cassava crop also becomes a beneficiary of the fertilisers and other agro-chemicals.

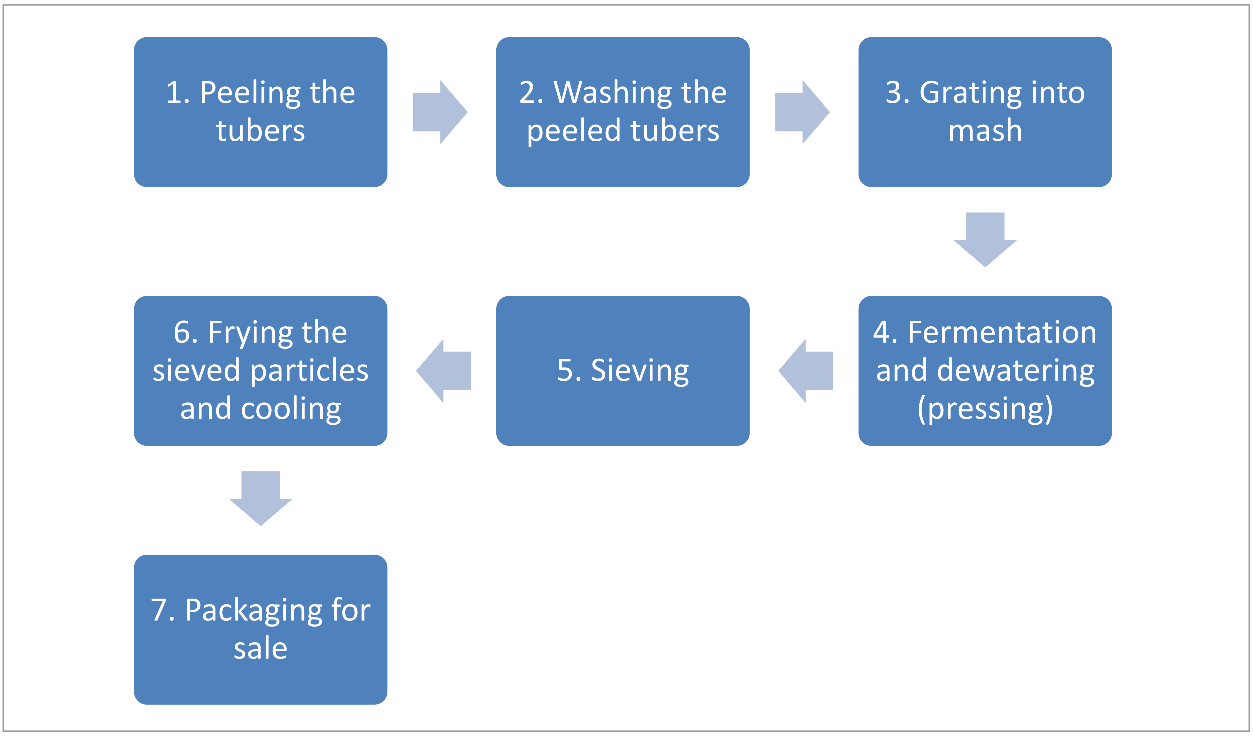
3.2.2 Cassava processing

3.2.2.1 Gari

Gari is the most popular product made from cassava tubers. In recent years, it has become the most important staple food consumed in the southern states of Nigeria. It is also consumed in some of the states in the north of the country. It comes in two forms – creamy white or yellow. The creamy white form is more common. It is partially gelatinised, roasted, free-flowing granular flour. The white form of gari has a slightly fermented and sour flavour.

20 One pick up van carries 40 bundles (200 stems, 1000 stem cuttings, 30 bundles are needed for one hectar

Figure 9: Stages of gari processing



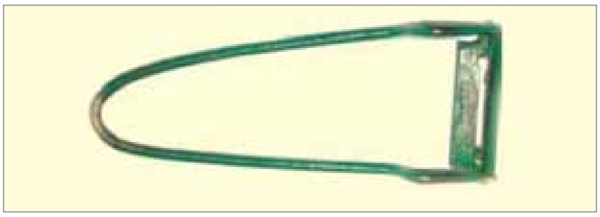
Peeling continues to represent a challenge as it has not yet been successfully mechanised. The equipment and tools that are used in gari processing are shown in the following pictures (Figures 10 – 15).

Figure 10: Cassava peeler (FUTA AKURE)[21]

Figure 11: Cassava peeler (IITA & ARCEDEM)[22]

21 + 22 Ezedinma (2006), Structure and Profitability of Cassava Enterprises in Nigeria, Paper Presented at the Root and Tuber Expansion Programme (RTEP) Training Workshop on Rural Enterprise Management and Community-Driven Development at ARMTI, Ilorin

Figure 12: Cassava hand peeler[23]



Gari processing is undertaken using traditional (household processors) and mechanical or commercial methods. The traditional equipment includes manual hand graters, stones/logs for dewatering, manual sieves and local gari fryers.

Figure 13: Gari frying[24]

There are specialised processing groups comprising mainly women (normally 5-6) that carry out all the processing activities. Usually three of the women are dedicated to frying. The groups are paid according to the number of cassava loads processed, the quantity produced, the wage for a day's labour or payments in-kind (gari) and are often found at the commercial processing centres.

Two main types of equipment are available at the centres for use under a hire arrangement. There is a motorised mechanical grater (mill) and a screw press for dewatering the cassava mash. These are two critical stages that can slow down the processing of cassava into gari. A diesel lister engine serves as the source of power for the motorised mechanical grater. The lister engine for grating is the costliest item of equipment used.

The price per kg of gari at the processing centre was ₦ 78 while the corresponding market price was ₦ 118.30 (2012).

Figure 14: Cassava grater and lister engine[24]

23 Ezedinma (2006), Structure and Profitability of Cassava Enterprises in Nigeria, Paper Presented at the Root and Tuber Expansion Programme (RTEP) Training Workshop on Rural Enterprise Management and Community-Driven Development at ARMTI, Ilorin
24 Kindly provided by Dr. Adegboyega Eyitayo Oguntade

Figure 15: Cassava grater[25]

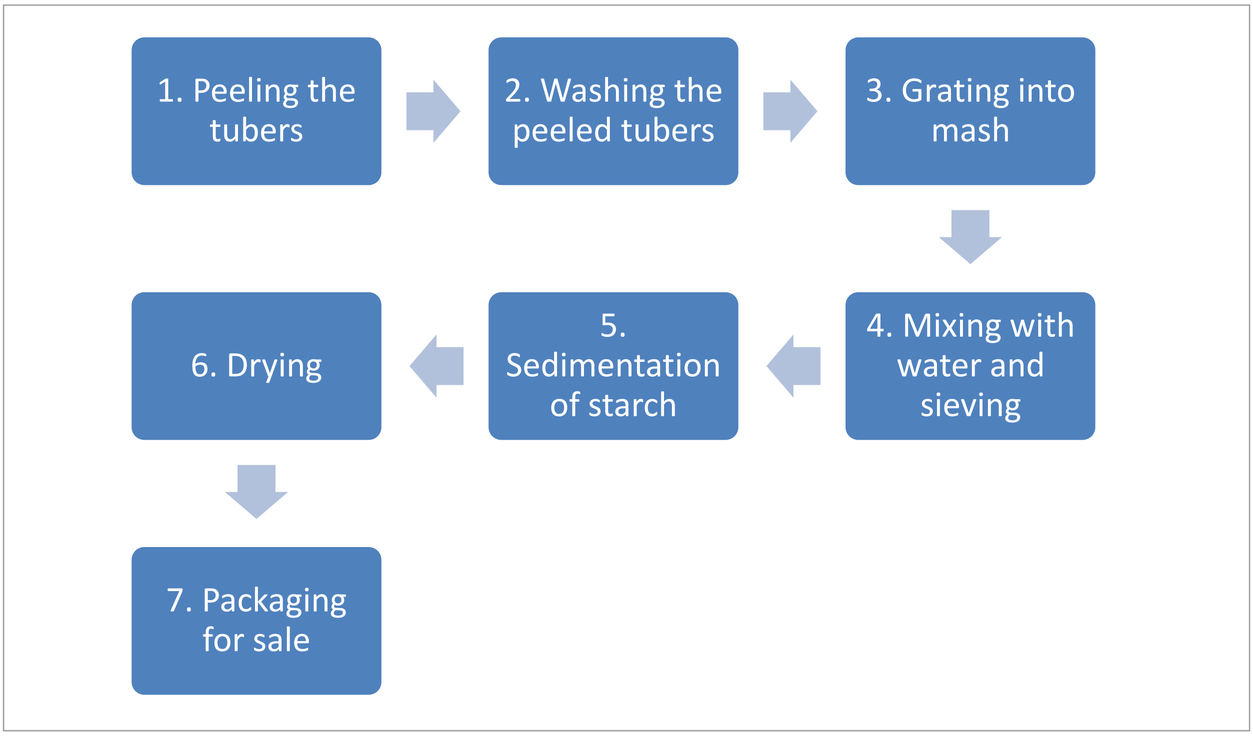
3.2.2.2 Starch

Starch is the major constituent of cassava tubers. Literature indicates that cassava roots have a starch content of between 25-35% depending on their age. The starch has thickening and binding qualities which are used in the food and beverage industries and in the manufacture of convenience and baby foods. Starch is also an important raw material for textile and pharmaceutical products. Furthermore, the modified starch dextrin, which has adhesive properties, is commonly used in the pulp and paper industries in the production of corrugated cardboard and cartons for packaging as well as in the furniture and plywood industries.

Starch is produced using traditional and industrial methods. Some elements of the traditional process are similar to those used in gari manufacturing. The activities involved in the production of starch are:

25 Ezedinma (2006), Structure and Profitability of Cassava Enterprises in Nigeria, Paper Presented at the Root and Tuber Expansion Programme (RTEP) Training Workshop on Rural Enterprise Management and Community-Driven Development at ARMTI, Ilorin

Figure 16: Stages of starch processing



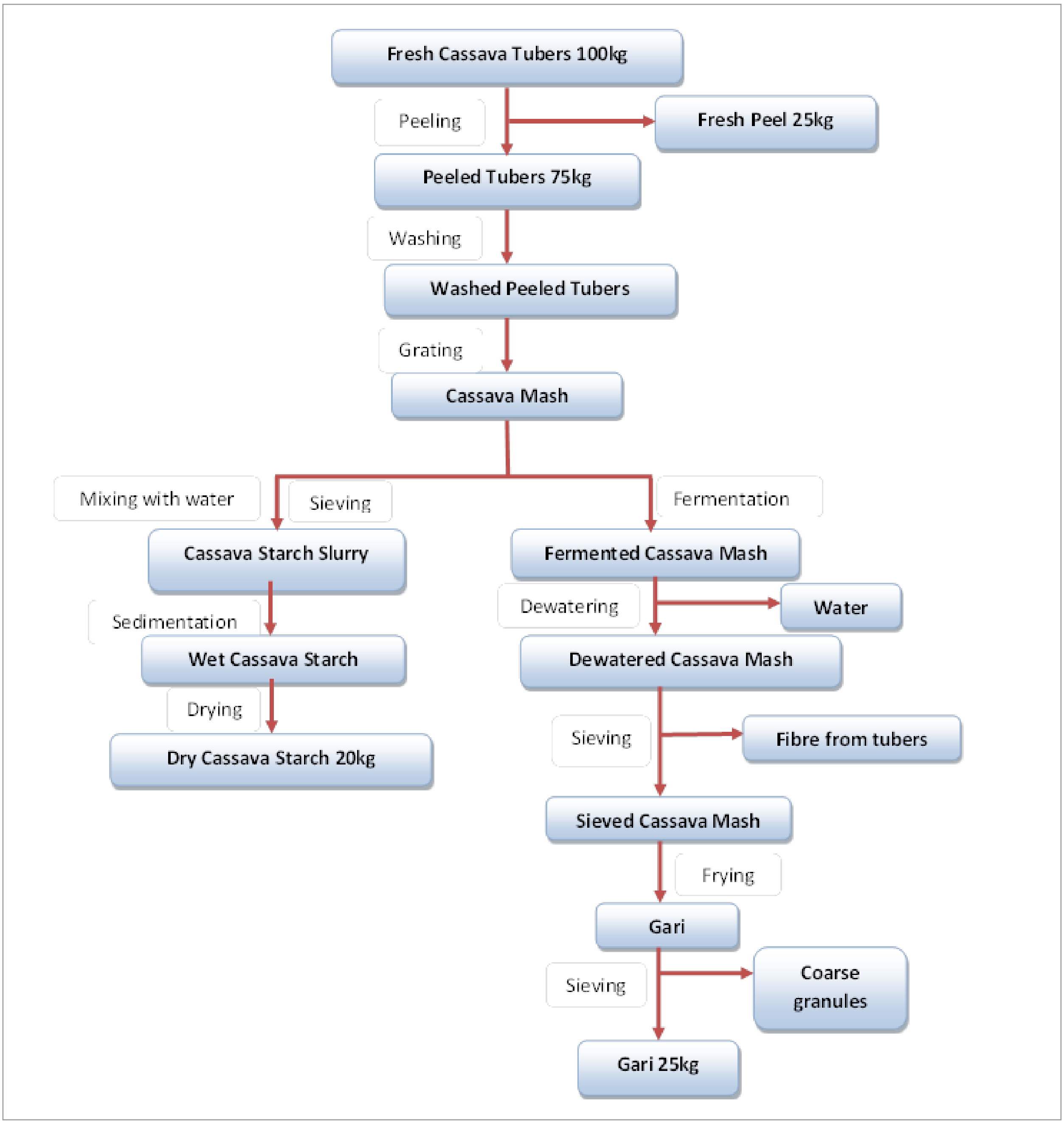
As is the case for gari processing, grating can be carried out manually using hand graters. Alternatively, there are mechanical graters powered by lister engines (mills).

Industrial manufacturers of starch in Nigeria include MATNA in Ogbese, Ondo State, Sunshine Cassava Processing Factory in Ondo, Ondo State, Nigerian Starch Mill in Ihialla, Anambra State and Peak Starch Factory in Abeokuta, Ogun State.

MATNA has an integrated plant with a capacity of 4,500 mt of food grade starch per year. In 2012, MATNA bought cassava tubers at ₦ 9,000 per metric ton at the factory gate. Its customers include multi-national food processing companies, such as Nestlé and Unilever, who use the starch as binders in the manufacture of food seasoning products. Non-food manufacturing companies use starch in the production of dry cell batteries, mosquito repellent coils, and packaging glue.

Figure 17 shows the flow of mass from fresh cassava tubers to gari and starch.

Figure 17: Mass flow from fresh cassava tubers to gari and starch



3.2.3 Cassava marketing

There is some trade in fresh tubers but it is not as widespread as trade in gari and starch. Farmers usually sell their cassava as stands on the farm. Harvesting is the responsibility of the buyer and to that extent it is also the buyer who bears the risk of the yield. Frequently, these customers are female entrepreneurs who then engage labourers to harvest and pack the cassava. They then hire vehicles to transport the goods to processing centres. There are some farmers who sell their cassava to industrial processors like MATNA. In this instance, they bear the cost of harvesting, packing and transportation to the factory gate.

In the case of the most traded cassava product, gari, different operators are involved in production. These include:

- household farmers/gari processors who retail at subsistence level;
- wives of cassava farmers who sell gari as wholesalers on specific market days;
- gari merchants who buy cassava on the farm and sell gari on a wholesale basis;
- commercial millers who also sell to traders and institutional buyers on a wholesale basis;
- market traders (often women) selling gari.

These operators market varying volumes of products at the processing centres and the markets. Competition is keen and it is rarely possible for any category of operator to control the market.

Starch trade at commercial level is more significant than that at subsistence and retail level. This is due to the large demand for starch in industry which cannot be met locally. Large-scale industries tend to buy directly from processors such as MATNA while at the same time utilising the services of contract suppliers. The packing industries that do not require food-grade starch rely more on contract suppliers. Inability to meet demand for starch from local sources has led to Nigeria importing significant quantities of corn starch each year.

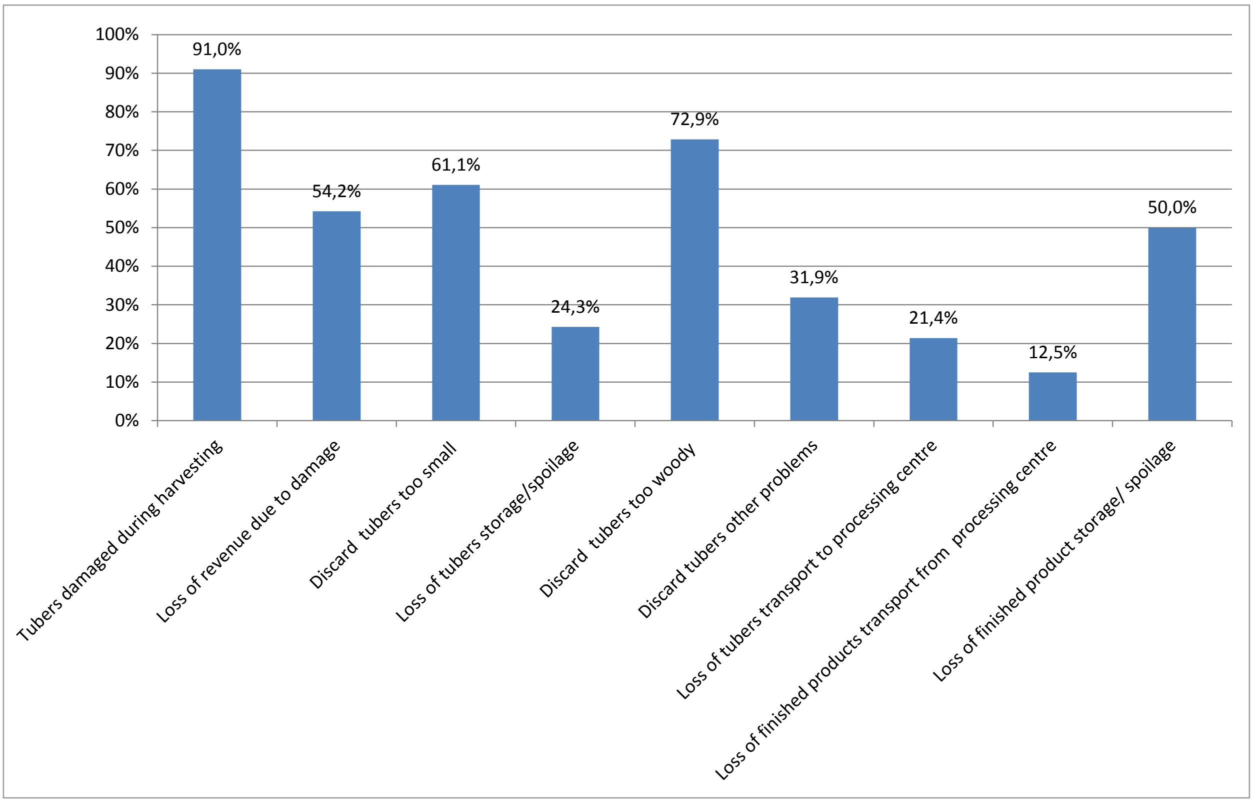
3.3 Quantitative and qualitative analysis of losses in the cassava value chain

When we talk about losses in the cassava value chain, we are referring to measurable quantitative and qualitative losses in the course of transforming cassava into various products. The two products under consideration in this study are gari and starch. Quantitative loss implies a reduction in the physical substance of the product, reflected in weight loss. Loss of product quality (qualitative loss) is also important, but is more difficult to measure and/or quantify. This is because, in the case of gari, there is a lack of quality criteria that are easily measurable and used by consumers. In the case of starch used for industrial purposes, quality criteria are applied which include moisture content and other impurities. Their measurement requires the use of specialised equipment and is beyond the scope of this study. The focus of the study is therefore on quantitative losses along the value chain.

3.3.1 Incidence of losses in the cassava value chain

An investigation into the incidence of post-harvest losses among *cassava farmers* yielded the information presented in Figure 18.

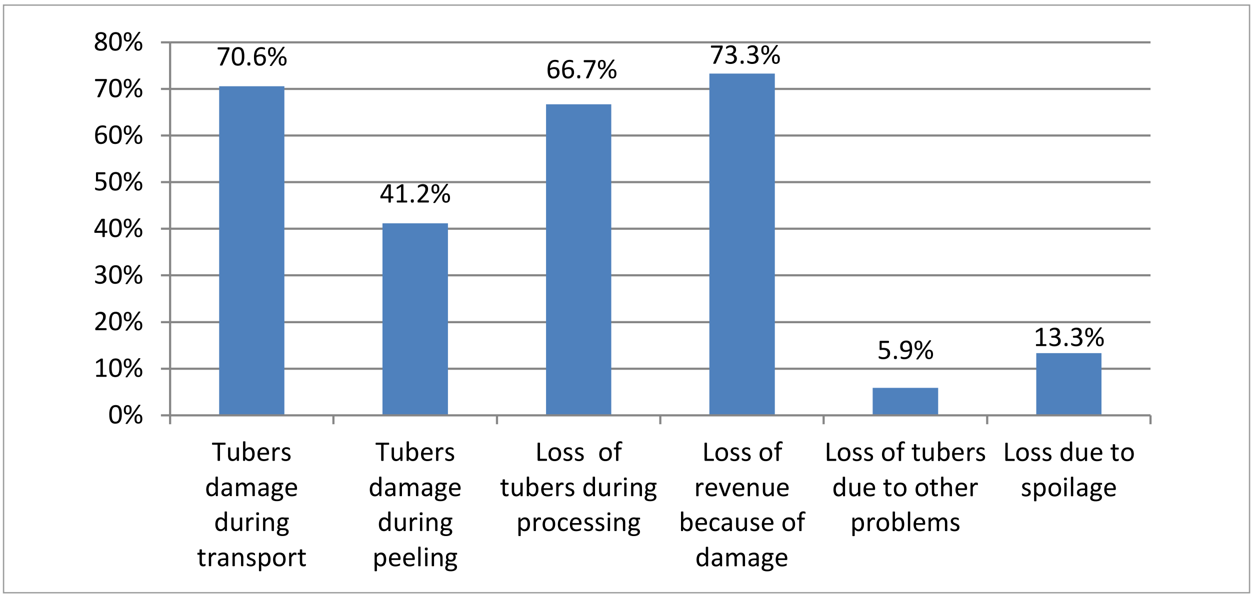
Figure 18: Losses experienced by cassava farmers



When we compare the number of farmers who considered the various issues a problem, it becomes clear that the most significant post-harvest losses among cassava farmers are tubers being damaged during harvesting (91%), tubers being too woody to peel with knife (72.9%) and tubers being too small to peel with a knife (61.1%).

Analysis of the data collected on the incidence of losses among *cassava starch* processors yielded the information presented in Figure 19.

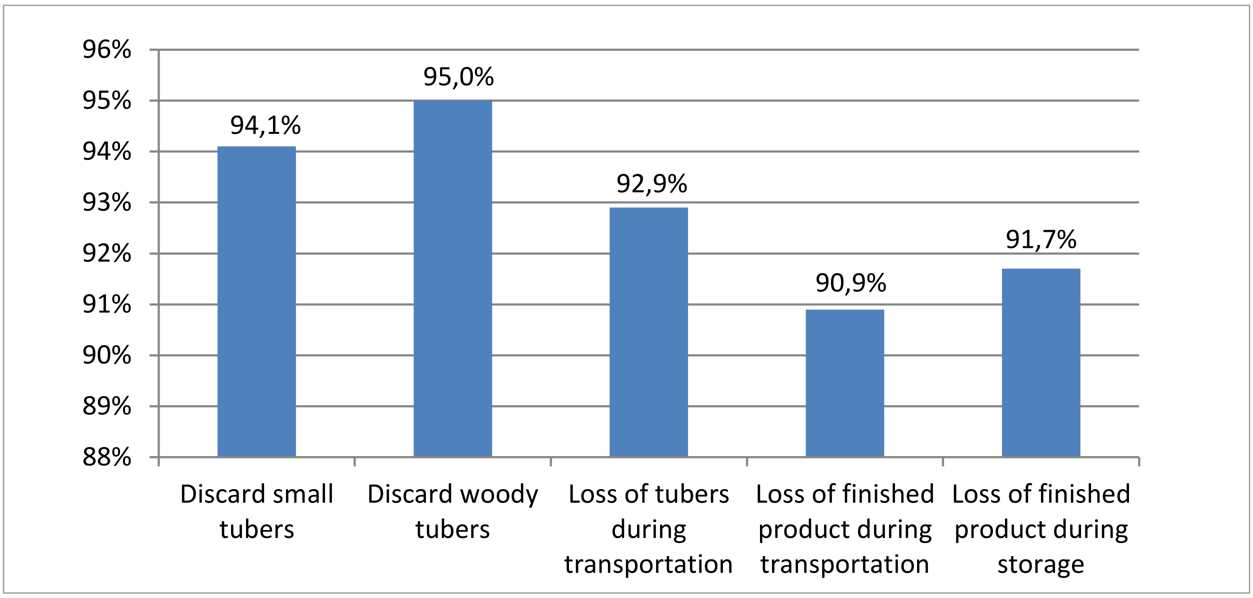
Figure 19: Losses experienced by cassava starch processors



When we look at the percentage of *gari processors* that responded 'Yes' to the incidence of the specific problems, we can see that the most important sources of post-harvest losses among starch processors are tubers being damaged during transportation (70.6%), tubers being lost during processing (66.7%) and tubers being damaged during peeling (41.2%). About 73.3% of the respondents claimed that they experience loss of revenue as a result of the damage to the tubers.

Figure 20 presents information on the incidence of losses in the value chain, as indicated by the responses received from gari processors.

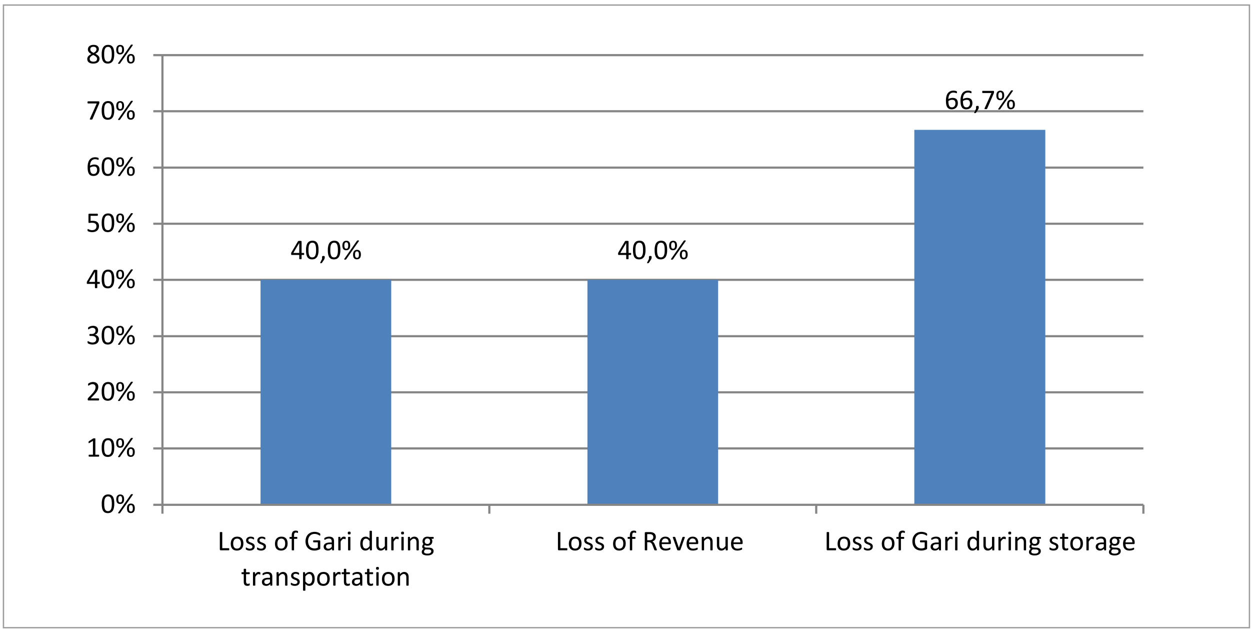
Figure 20: Losses experienced by gari processors



The numbers indicate that the problem of woody (95.0%) and small (94.1%) tubers were the most significant sources of losses being experienced by gari processors. These are followed by tubers being lost during transportation (92.9%) and losses occurring during storage of the finished product (91.7%).

The *gari marketers'* response on the incidence of losses is presented in Figure 21. The numbers indicate that they consider loss of gari during transportation (40.0%) to be the major source of losses. This is probably due to poor handling and transportation facilities in Nigeria.

Figure 21: Losses experienced by gari marketers



3.3.2 Quantification of losses in the cassava value chain

Table 5 presents the *cassava farmers'* assessment of loss percentages from harvesting onwards. The table shows that the most significant losses occurred during harvesting, estimated at 4.95% of the total harvest, followed by losses occurring during storage of the finished product (1.94%) and losses occurring due to small size of the cassava tubers (1.93%).

Table 5: Estimates of losses in the cassava value chain – farmers' assessment

Food loss (farmers)	Mean (%)
Loss during harvest	4.95
Loss due to small size tubers	1.93
Loss due to woody tubers	1.72
Loss during transportation to processing centres	1.25
Loss of finished product during transportation from processing centres	1.17
Loss of fresh tuber during storage	1.63
Loss of finished product during storage	1.94

Losses during harvest are usually the result of the soil structure, the season or the harvester's skill level and equipment. Cassava is usually harvested by digging the roots from the soil or simply pulling the plant out of the ground by the stem, thereby uprooting the tubers. This process frequently results in roots being broken. These damaged roots either remain under the soil or are left on the farm by the harvester. Digging out tubers with machetes can also damage the tubers if not done skilfully. Furthermore, tubers are more difficult to harvest if the soil contains stones. Digging of tubers is also more difficult during the dry season since the soil will invariably be dry and hard. Under these conditions, cassava tubers break easily and some of them are lost in the soil. It is for these reasons that losses during harvesting recorded the highest percentage in the survey.

Losses also occur due to the small size of tubers. When cassava tubers are too small, they are difficult to peel. The very small ones are left on the farms after harvesting or discarded during peeling. When cassava is left on the field for too long, it can become woody. The woody parts of the tubers are discarded during peeling or processing. Farmers tend to keep cassava standing in the field as a form of storage, especially when prices are too low. Sometimes farmers will wait until the next rainy season to avoid the difficulty of harvesting when the soil is dry.

It is common that farmers process some of their cassava into gari for household consumption. Some of them experience losses during the transportation of tubers to the processing centres and during the transportation of gari back to their houses. Some losses are also recorded by farmers during storage of gari at home.

The *gari processors'* assessment of losses during their operations is presented in Table 6.

Table 6: Estimates of losses in the cassava value chain – gari processors' assessment

Food losses (gari processors)	Mean (%)
Loss during transportation of cassava tubers	2.2
Loss of finished product	1.6
Discard of small tubers	5.8
Discard of woody tubers	4.1
Loss during storage due to spoilage	1.11

As the table shows, losses resulting from the discard of small cassava tubers were estimated at 5.8% of the cassava being processed. This was followed by losses resulting from the discard of woody tubers, which were estimated at 4.1%. Losses during transportation of cassava tubers were said to amount to 2.2% of the cassava processed. Losses during the processing of the finished product were 1.6%, while losses during storage of the finished product were 1.11%. It was estimated that spoilage begins to occur at 4.4 weeks. Losses due to the discard of small or woody tubers are smaller at the farmers' level than at the processors' level. The reason for this is unclear. It could be that farmers are more reluctant to discard their harvest or that they apply different techniques or quality standards.

The *starch processors'* assessment of losses in their operations showed that 5.5 % loss occurred during processing of cassava and 6.3 % loss occurred during storage of starch as is shown in Table 7.

Table 7: Estimates of losses in the cassava value chain – starch processors' assessment

Food losses (starch processors)	Mean (%)
Loss during processing of cassava	5.5
Loss of starch during storage	6.3

The *gari marketers'* assessment of losses in their operations is presented in Table 8.

Table 8: Estimates of losses in the cassava value chain – gari marketers' assessment

Food losses(gari marketers)	Mean (%)
Loss of gari during transportation	2.5
Loss of gari during storage due to moisture	4.5
Loss of gari during storage due to rodent pests	2.5

Moisture was indicated as the most significant cause of gari loss during storage, accounting for losses of about 4.5%. Losses during transportation and losses during storage due to rodent pests were each estimated at 2.5%.

3.3.3 Monetary quantification of losses in the cassava value chain

Beyond the harvesting of cassava tubers, some farmers also carry out processing activities, generating outputs of gari for their household's consumption. However, losses during transportation of cassava tubers, losses due to woody content (which can be only determined at the processing stage) and losses of the finished product do not play a role in the calculation of post-harvest losses at the farm gate. Thus, Table 9 does not contain information on these losses. The table presents information on loss due to damage of tubers during harvesting, loss due to tubers being too small and loss of fresh tubers during storage (tubers that are not processed or sold shortly after harvesting).

Table 9: Monetary assessment of losses of fresh cassava tubers at the farm gate

Food loss (farmers' questionnaire)	Mean (%)	Annual prod. (mt)	Qty lost (mt)	Price per mt (₦)	Value of food loss (₦)
Loss during harvest (damaged tubers)	4.95	37,504,100	1,856,453	10,000	18,564,529,500
Loss due to small tuber size	1.93		723,829		7,238,291,300
Loss due to woody tubers	N/A*				
Loss during transportation to processing centre	N/A*				
Loss of finished product during transportation from processing centre	N/A*				
Loss of fresh tubers during storage	1.63		611,317		6,113,168,300
Loss of finished product during storage	N/A*				
Total	**8.51**		**3,191,599**		**31,915,989,100**

* These rows are **not applicable (N/A)** either because the loss does not occur at the farm gate or because the product that is lost is not fresh tubers but gari.

Total losses accounted for 8.51% of the total harvest of about 37.5 million mt of cassava tubers. The quantity of fresh cassava tubers lost at the farm gate was 3,191,599 mt, which has a total value of be ₦ 31.9 billion (₦ 10,000 per mt).

Table 10 indicates that gari processors are experiencing losses of fresh cassava tubers and the finished product (gari).

Table 10: Monetary assessment of losses of fresh cassava tubers during gari processing phase

Food loss (gari processors)	Mean (%)	Annual prod. (mt)	Qty lost (mt)	Price per mt (₦)	Value of food loss (₦)
Loss during transportation of cassava tubers	2.2	26,252,870	577,563	10,000	5,775,631,400
Loss of finished product	N/A*				
Discard of small tubers	5.8		1,522,666		15,226,664,600
Discard of woody tubers	4.1		1,076,368		10,763,676,700
Loss during storage due to spoilage	N/A*				
Total	**12,1**		**3.176.597**		**31.765.972.700**

* These rows are not applicable (N/A) either because the loss does not occur at the farm gate or because the product that is lost is not fresh tubers but gari.

The total loss of fresh cassava tubers during processing amounted to around 12.1%. The total quantity of cassava processed into gari was estimated at 26.25 million mt per year, which corresponds to 70% of annual cassava production. The total quantity of fresh cassava tubers lost annually during transportation was 3,176,597 mt. At ₦ 10, 000 per mt, this translates into ₦ 31.7 billion.

Table 11: Monetary assessment of losses during gari processing

Food loss (gari processors)	Mean (%)	Annual prod. (mt)	Qty lost (mt)	Price per mt (₦)	Value of food loss (₦)
Loss during transportation of cassava tubers	N/A*				
Loss of finished product (gari) during processing	1.60	6,563,218	105,011	10,000	8,190,895,440
Discard of small tubers	N/A*				
Discard of woody tubers	N/A*				
Loss of gari during storage due to spoilage	1.11		72,852		5,682,433,712
Total	**2.71**		**177,863**		**13,873,329,152**

* These rows are **not applicable (N/A)** either because the loss does not occur at the farm gate or because the product that is lost is not fresh tubers but gari.

The information contained in Table 11 indicates that losses of the finished product (gari) during processing are usually due to spillage during processing and spoilage during storage. As shown in the table, the losses due to these reasons amounted to around 2.7% of the gari produced. Total annual production of gari was estimated at 6.5 million mt, which is 25% of the cassava processed into gari. Product losses at the processing phase were therefore estimated at 177, 863 mt, which corresponds to a total value of N 13.8 billion (N 78,000 per mt).

Table 12 shows the estimated losses of the finished product (gari) during marketing.

Table 12: Monetary assessment of losses of gari during marketing

Food loss (gari marketers)	Mean (%)	Annual prod. (mt)	Qty lost (mt)	Price per mt (₦)	Value of food loss (₦)
Loss of gari during transportation	2.5		164,080		12,798,275,100
Loss of gari during storage due to moisture	4.5	6,563,218	295,345	78,000	23,036,895,180
Loss of gari during storage due to rodent pests	2.5		164,080		12,798,275,100
Total	**9.5**		**623,506**		**48,633,445,380**

* These rows are not applicable (N/A) either because the loss does not occur at the farm gate or because the product that is lost is not fresh tubers but gari.

As the table shows, total losses of gari during the marketing phase were estimated at around 9.5% of the amount produced/marketed annually. This corresponds to a quantity of 623,506 mt, valued at ₦ 48.633 billion (₦ 78,000 per mt).

There are two sources of loss during the processing of starch: spillage during processing and spoilage during storage. Taken together, these two losses amounted to 11.8% of annual starch production, which itself was estimated at 900,098 mt[26]. The quantity of starch that is lost due to spillage and spoilage was estimated at 106,212 mt, with a value of ₦ 13.8 billion (₦ 130,000 per mt).

26 12% of annual cassava production goes into starch processing, while the starch content of a cassava tuber is estimated to be 20%.

Table 13: Monetary assessment of losses of cassava starch during processing and storage

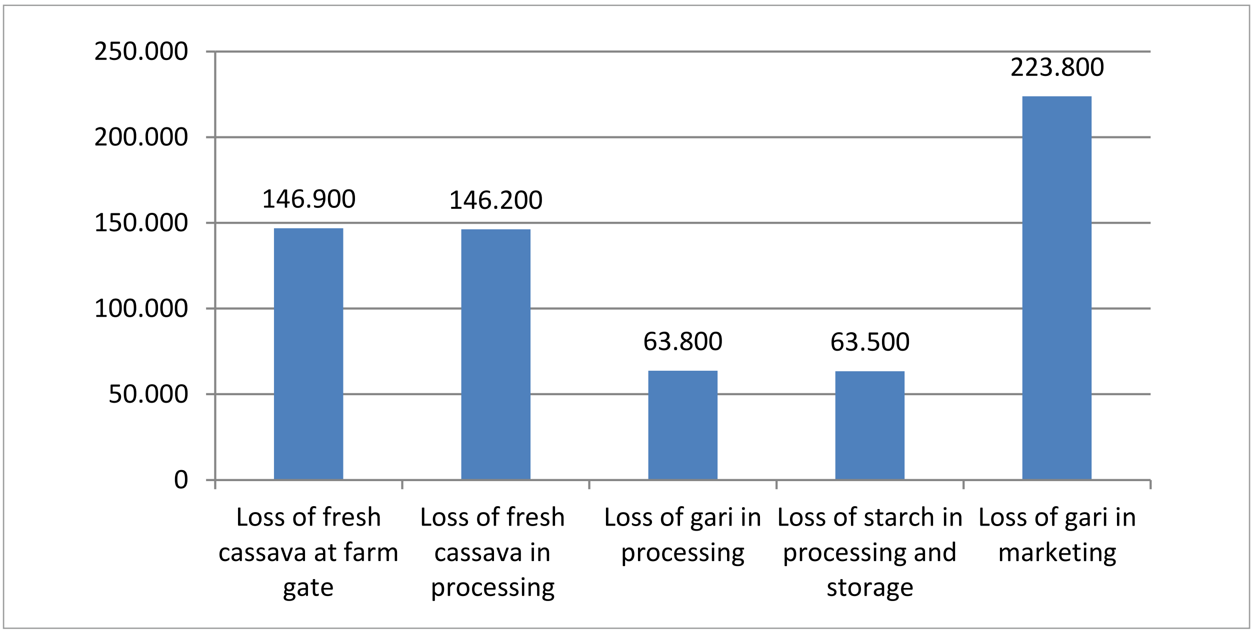
	Mean (%)	Annual prod. (mt)	Qty lost (mt)	Price per mt (₦)	Value of food loss (₦)
Loss of starch during Processing	5.5	900,098	49,505	130,000	6,435,703,560
Loss of starch during storage	6.3		56,706		7,371,805,896
Total	**11.8**		**106,212**		**13,807,509,456**

The total monetary value of losses along the cassava value chain from harvesting of cassava to marketing of gari and starch is indicated Table 14. It amounts to around ₦ 140 billion annually.

Table 14: Summary of cassava PHL monetary assessment

Quantification of losses in the cassava value chain	Value of losses (₦)	Value of losses (Mio EUR)
Loss of fresh cassava tubers at the farm gate	31,915,989,100	146,900
Loss of fresh cassava tubers at the processing phase	31,765,972,700	146,200
Loss of gari at the processing phase	13,873,329,152	63,800
Loss of cassava starch during processing and storage	13,807,509,456	63,500
Loss of gari at the marketing phase	48,633,445,380	223,800
Total	**139,996,245,788**	**644,200**

Figure 22: Distribution of cassava loss values in Mio EUR (exchange rate of 4 February 2013)

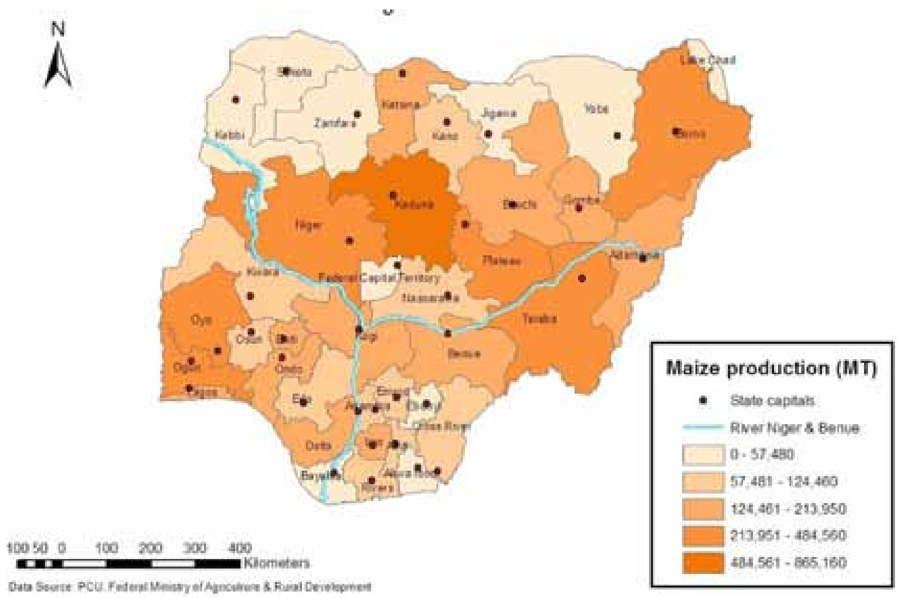


4 Maize

4.1 Maize in Nigeria

Maize is cultivated in the forest, derived savannah and southern Guinea savannah zones of Nigeria. Maize grows best on fertile, well-drained sandy loam or loamy soil. It can be planted on flat soil or on ridges or heaps. It is cultivated either as a sole or mixed crop. Most farmers practice mixed cropping, e.g. cassava/maize or cassava/maize/melon. Maize can also be cultivated with yam, guinea corn, rice, cowpeas, groundnuts and soybeans, depending on the production zone. Maize cultivation in Nigeria is spread across all states and hence all the agro-ecological zones in the country (NBS, 2007)[27]. Figure 23 indicates that the major producers are found in the Middle Belt and parts of the Southwest.

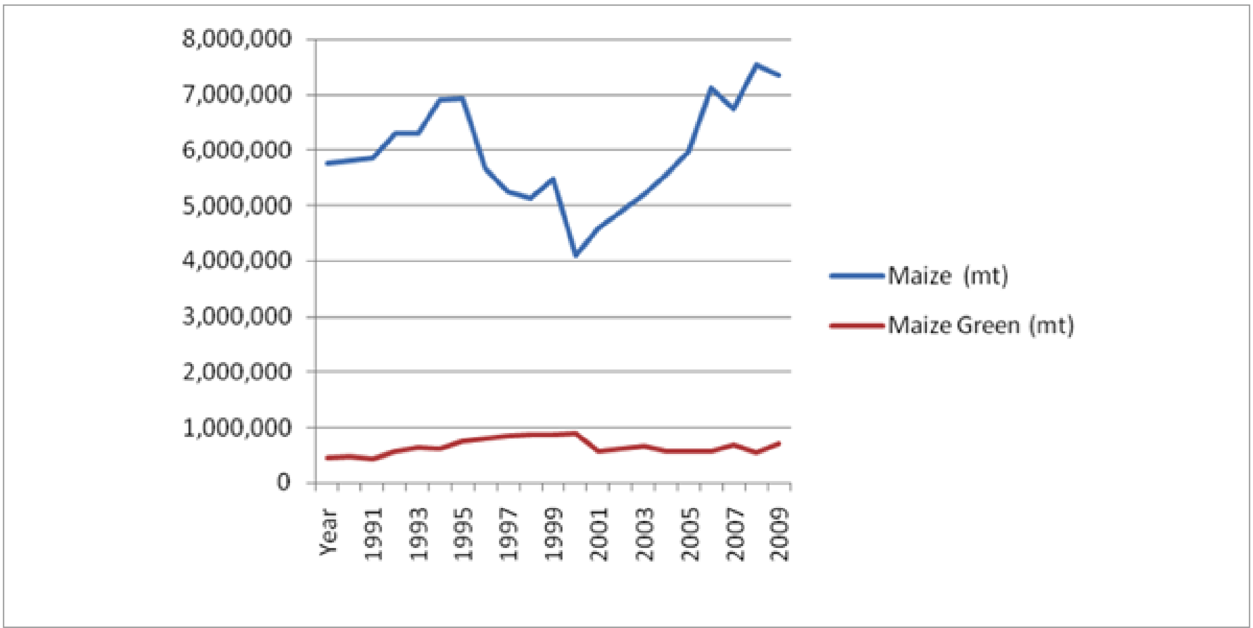
Figure 23: Maize production in Nigeria in 2005[28]



Maize produced in Nigeria is harvested either as green maize or maize grain. The green maize is consumed in season by Nigerians as a snack and as a substitute for regular food. Figure 24 presents information on the output of maize in Nigeria. It is clear that a relatively small proportion of the maize output is harvested as green maize.

27 NBS (2007) Filling the Data Gaps, National Bureau of Statistics
28 USAID MARKETS, 2010

Figure 24: Output of maize in Nigeria (1990 – 2010)[29]



The major end-users of maize are feed and flour mills. The feed mills supply the poultry and aquaculture industry while the products of the flour mills are meant for direct human consumption. As the majority of poultry farms are to be found in the southern part of Nigeria (Adene & Oguntade, 2005[30]; Hartwich et al., 2010[31]), so too are most of the feed mills.

As is the case for cassava, there are many improved maize varieties and hybrids on the market in Nigeria. In most parts of Nigeria, maize planting is carried out as soon as there is steady rainfall. Due to changes in the rainfall pattern arising from climate change, it is now difficult for farmers in certain zones of the country to adhere to specific recommended planting periods.

When planting maize as a sole crop, farmers are advised to plant one plant per stand at a spacing of 75 cm x 25 cm, which corresponds to 53,333 plants per hectare. Recommended fertiliser application is 300-400 kg/ha of 15:15:15 NPK (fertilizer consisting of Nitrogen, Phosphorus and Potassium) seven days after planting and a second application of urea at the rate of two bags/ha when plants are at knee height. Most farmers found it difficult to keep to the recommended rate because of financial restrictions.

If the crop is destined to be sold as green maize, farmers harvest when the corn is fully ripe but still green. In contrast, they allow it dry up and lose its green colour if it is to be sold as grain. Maize to be sold as grain is further sun-dried to reduce the moisture content and then shelled by hand. Shelled grain is bagged and stored until the time of sale.

29 FAOSTAT 2012
30 Adene, F. O. and Oguntade, A.E. (2005), Structure and Conduct of Nigerian Poultry Sector, FAO, Rome
31 Hartwich, F., Kormawa, P., Bisallah, I.D., Odufote, B.O. and Polycarp, I.M. (2010), Unleashing Agricultural Development in Nigeria through Value Chain Financing, UNIDO

4.2 Value chains of maize grain and green maize

The value chain map for maize is presented in Figure 25. The map indicates the stages of the value chain and the operators and products at each level. It also illustrates links between the operators across the stages. As shown in the map, the end products of maize transformation in Nigeria are green maize, breakfast cereals[32] and feed. These products emanate from both traditional and industrial sectors in the maize value chain. For the purpose of providing a detailed description of the traditional and industrial sectors, the following value chains will be considered:

i. fresh maize passing through the marketing and processing stages and reaching households as grain;

ii. fresh maize passing through the marketing and processing stages and reaching feed millers as grain.

Trade in maize grain is more significant than trade in fresh maize, with most of the grain being used in the livestock feed industry.

32 Breakfast cereals comprise cornflakes for mostly urban population and pap – a slurry liquid substance

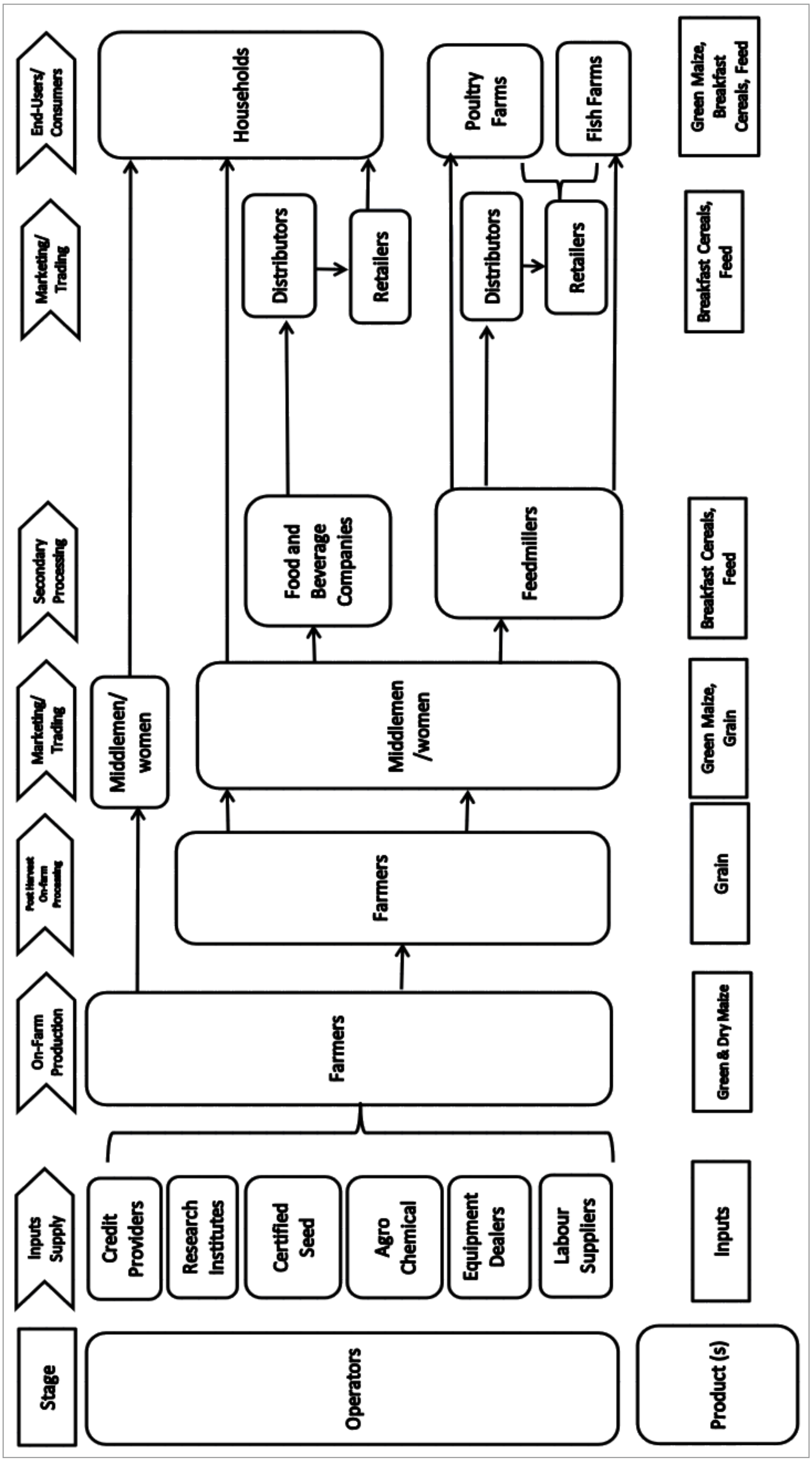


Figure 25: Maize value chain map

4.2.1 Maize production

The field survey carried out in the course of this study yielded the following information on the key variables of maize production:

Table 15: Description of key variables in maize production per average maize farm

Variable	Mean
Total size of all farms owned (ha)	2.43
Total size of all farms planted with maize in the last production season (ha)	1.59
Distance of the furthest field from the household residence (km)	3.75
Percentage of the maize planted that is normally consumed by the family (%)	31.62
Present cost per day for hired labour in the community (₦)	1,148.89
Amount paid for tractor services (₦)	28,040.00
Number of months after planting until harvesting starts	4.24
Duration of harvesting after harvesting starts (weeks)	1.78
Cobs of green (fresh) maize normally harvested per hectare	39,282.46
Cobs of dry maize normally harvested per hectare	30,241.88
After shelling, quantity of grain obtained per hectare in normal weather (kg/ha)	3,065.67
Percentage of maize produced sold as fresh maize	48.13
Distance from the farm to the market (km)	14.28
Price of fresh maize cobs sold at the farm gate (₦)	10.00
Price of fresh maize cobs sold at the market (₦)	14.00
Price of dry grain sold at the farm gate (₦/kg)	44.41
Price of dry grain sold at the market (₦/kg)	48.17
Quantity of seed per farm (kg)	17.16
Seed value per farmer (₦)	2,833.77
Fertiliser used per farmer (kg/season)	185.95
Price of fertiliser (₦/50 kg)	5,397.71
Amount of insecticides (l) used per season per farm	2.13
Price of insecticides (₦/l)	1,457.82
Amount of herbicides (l) used per season per farm	5.23
Price of herbicides (₦/l)	1,131.91

The table shows that the mean size of maize farms was 1.59 hectares while the maize yield per hectare was 39,282 cobs for green (fresh) maize and 30,241 cobs for dry maize. After shelling, the quantity of grain obtained per hectare was estimated at 3,065.67 kg per ha. 48.13% of the maize produced is sold as green maize.

4.2.2 Processing of maize into feed

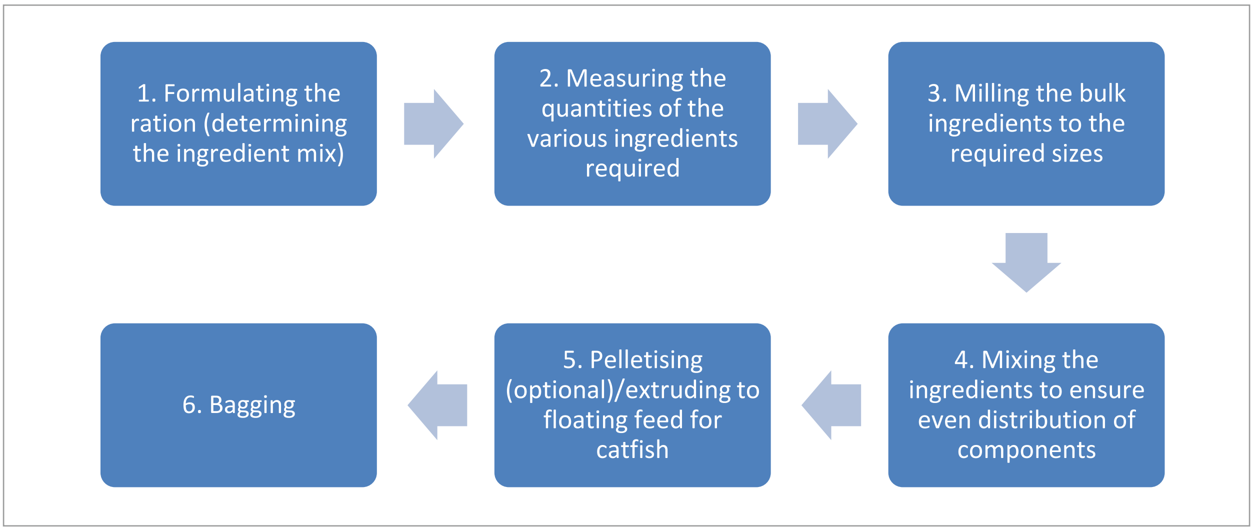
Maize is processed into feed as part of commercial livestock feed milling operations in Nigeria. The major actors in this sector are feed millers, grain merchants/buyer agents, importers of concentrates, additives and supplements, poultry shops and poultry and aquaculture farms. Three types of feed millers can be identified: custom, toll and integrated farms. The custom millers mill and market their feeds under registered trade names. The dominant trade names in the market include Amo Bym, Guinea Feed, Top Feed, and Vital Feed, among others.

The toll millers are found in locations with significant concentrations of small to medium scale poultry and aquaculture farms. The mill operators produce feed to the specification of customers (poultry and catfish farmers) and charge a fee (toll) per quantity milled. They also sell feed ingredients (including maize grain) to customers. The third category of feed millers is integrated poultry and aquaculture farms, which own feed mills and produce feed for their own use. Some of these farms sell part of their feed output to other farms.

The feed millers acquire their grain from grain merchants/buying agents who in turn buy their grain mostly from farmers. These merchants have established networks for aggregating grain from smallholder farmers.

Feed millers also require other ingredients for their rations, including fish meal, lysine methionine and soy meal. They acquire these ingredients from importers and their intermediaries. The marketing of feeds and other poultry and aquaculture inputs is generally undertaken by the feed retailers.

Figure 26: Stages of maize feed processing



4.2.3 Maize marketing

Maize is traded both as green maize and grain. Trade in green maize is carried out mostly as rural/urban and peri-urban/urban trade. Green maize is seldom moved over very long distances because it is expected to reach consumers fresh. Green maize that is kept for longer than 24 hours before consumption loses its sweetness as some of its sugar content is converted into starch.

Green maize is harvested and sold as cobs. Women traders usually buy green maize at the farm gate or at rural markets, in varying quantities. Those who purchase small amounts usually sell the green maize directly to consumers in boiled or roasted form. Those who buy large quantities transport the maize to urban centres and sell it in smaller portions to retailers. These urban retailers also sell the green maize in boiled or roasted form to consumers.

Trade in maize grain is dominated by grain merchants. These merchants have established networks for aggregating grain from smallholder farmers and have mastered the logistics of maize transportation across the country. Buying their grain mostly from the northern part of the country, they supply the wholesale markets in the urban centres as well as feed millers around the country. Retailers buy grain from the wholesale markets and sell it in small units (kongos/mudus)[33] to consumers.

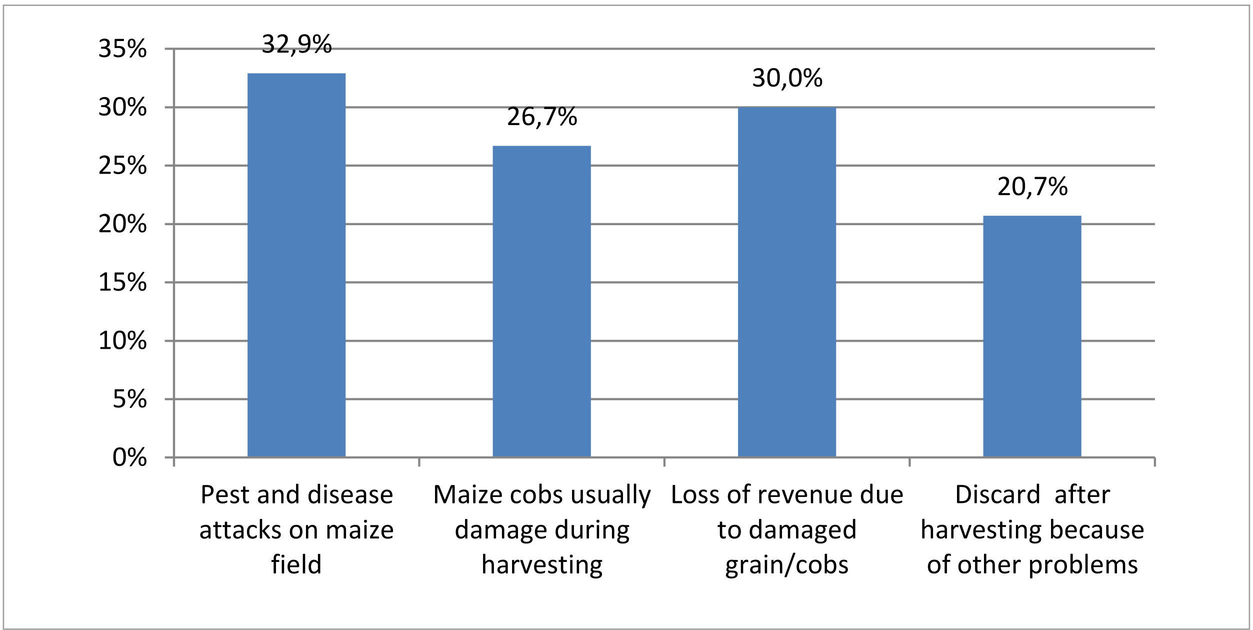
4.3 Quantitative and qualitative analysis of losses in the maize value chain

The study looked at two products in the maize value chain: green maize and feed. Loss measurement focused on quantitative losses along the value chain, as criteria for qualitative measurement are difficult to establish and communicate to operators.

4.3.1 Incidence of losses in maize value chain

The incidence of post-harvest losses among *maize farmers* was determined using a set of specific questions. The information obtained, which is presented in Figure 27, shows that only four causes of loss were identified by the farmers. The most significant of these is pests and disease attacking maize in the field.

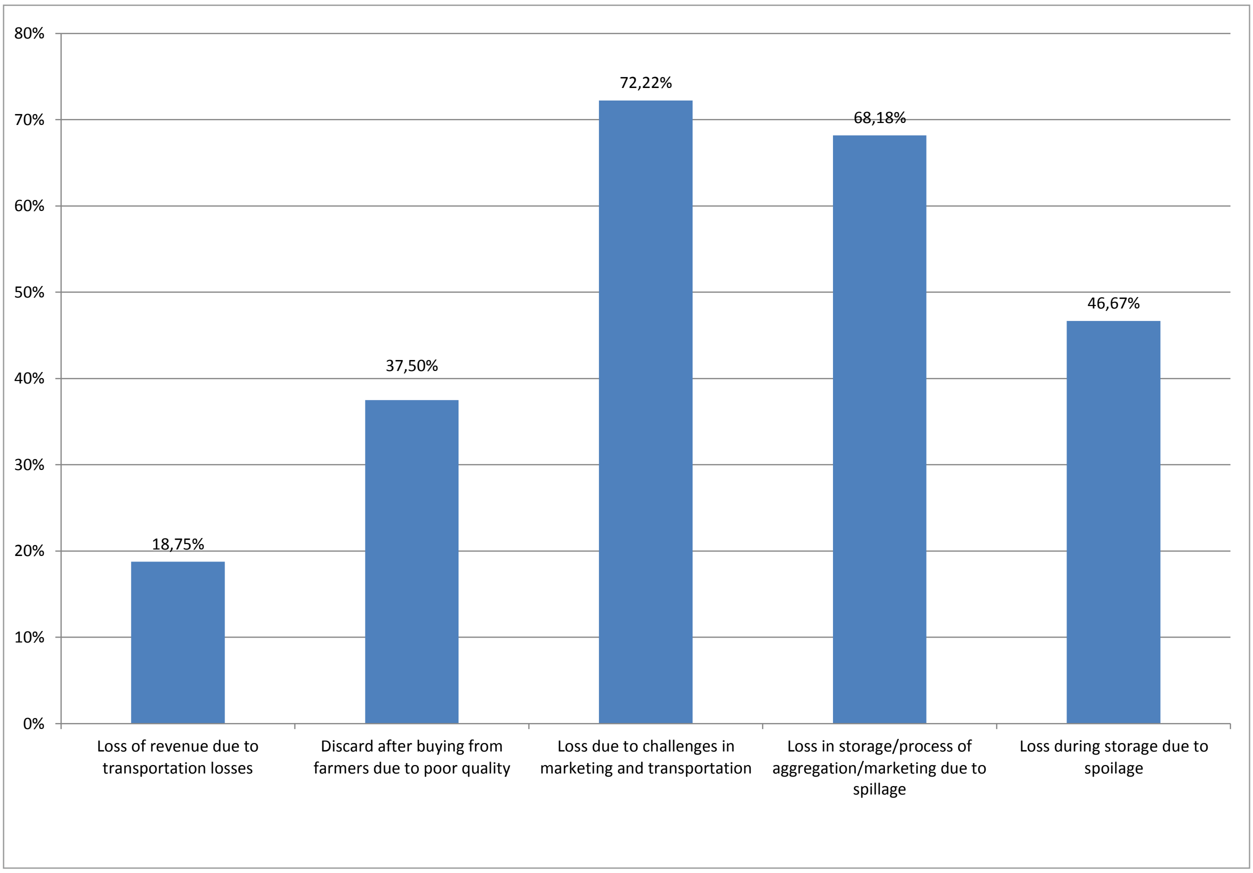
Figure 27: Losses experienced by maize farmers



33 Kongos and mudus are standard volume measures of grain, flour, etc. that are recognised by the Government. One kongo of maize grain weighs about 1.4 kg.

Analysis of the data collected on the incidence of losses among *maize marketers* yielded the information presented in Figure 28.

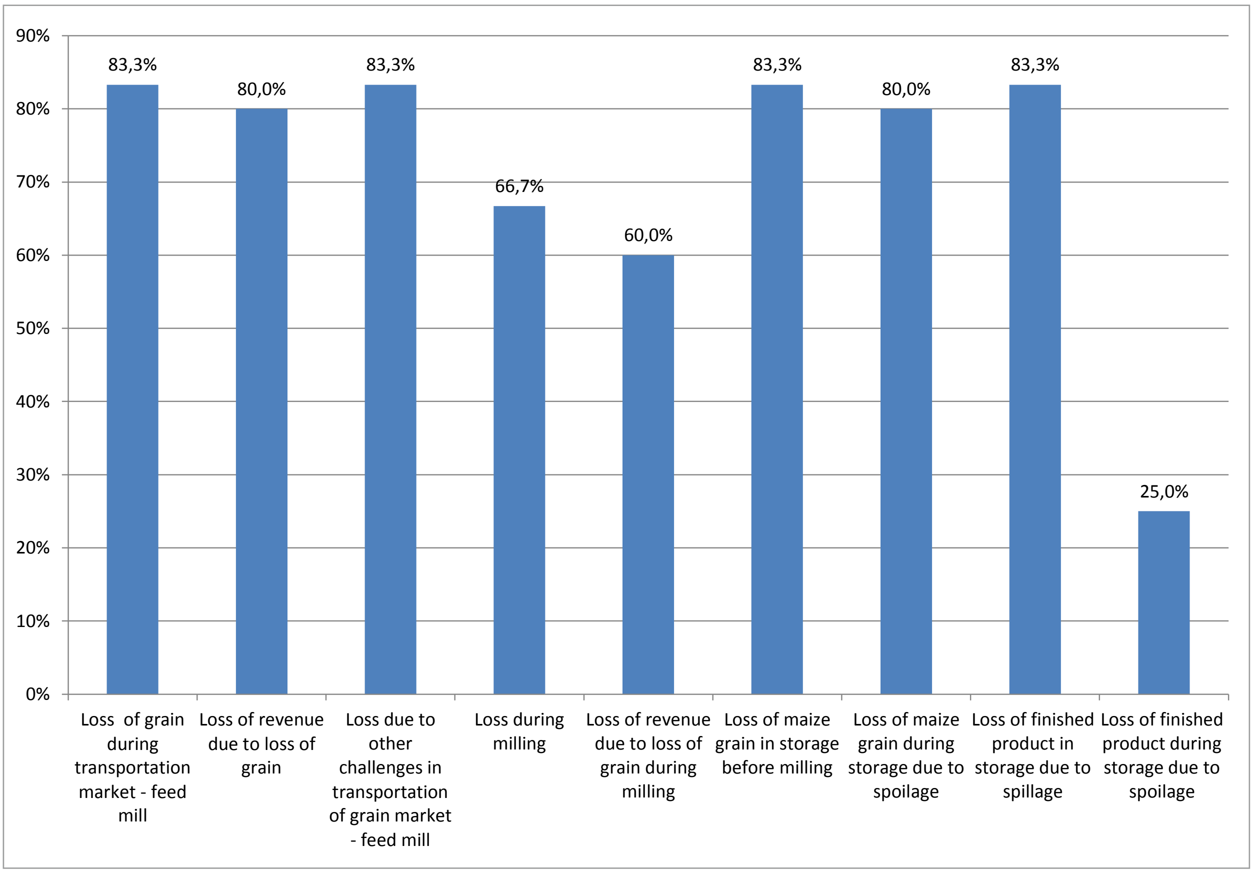
Figure 28: Losses experienced by maize marketers



The most important sources of loss among maize marketers are losses of maize grain due to challenges in marketing and transportation of maize grain (72.22 %), losses in storage during the processes of aggregation and marketing due to spillage (68.18 %) and losses of maize grain during storage due to spoilage (46.67 %) as is shown in Figure 28.

Figure 29 presents the information provided by the *feed millers* on the incidence of losses in their operations. It indicates that the most significant problems occurred during transportation of maize from the market to the feed mill (83.3%), during storage of maize grain before milling (83.3%), during storage of the finished product (spillage: 83.3%) and during storage of maize grain (spoilage: 80.0%).

Figure 29: Losses experienced by feed millers



4.3.2 Quantification of losses in maize value chain

Loss during harvesting was considered by the *farmers* to be the most significant source of loss and was estimated at 4.03% of the total harvest as shown in Table 16. This was followed by loss of dry maize cobs during storage (2.27%) and loss of dry maize grain during storage (2.00%). Loss also occurred during transportation.

Table 16: Estimates of losses in the maize value chain – farmers' assessment

Food losses (maize farmers)	Mean (%)
Loss during harvesting	4.03
Loss during shelling	1.53
Loss of fresh maize during transportation to market	1.95
Loss of dry maize grain during transportation to market	2.00
Loss of dry maize cobs during storage	2.27
Loss of dry maize grain during storage	2.00

Table 17 presents the *maize marketers'* assessment of losses in their operations. Loss of maize grain during storage due to weevils was estimated at 8.5% while loss of maize grain during storage due to rodents was 6.0%. Loss of maize grain during storage due to spillage was 5.9% while loss during transportation amounted to 3.7%. Loss due to moisture was estimated at 2.5%. Fungus infestation does not appear to be considered a source of loss. This is probably because it tends to affect quality rather than quantity.

Table 17: Estimates of losses in the maize value chain – marketers' assessment

Problems	Mean (%)
Loss during transportation	3.7
Loss of maize grain during storage due to spillage	5.9
Loss of maize grain during storage due to rodents	6.0
Loss of maize grain during storage due to weevils	8.5
Loss of maize grain during storage due to fungus	-
Loss of maize grain during storage due to excess moisture	2.5

Table 18 presents the feed millers' assessment of losses in their operations. The two most significant sources of losses are loss of the product (feed) during transportation (3.0%) and spoilage of maize grain in storage due to rodent attacks (2.8%). Commercial feed millers have to distribute their products over a wide geographical area. This requires transportation over long distances. The bags of feed may sometimes break during transportation, leading to spillage of feed. Customers are unwilling to purchase feed in broken bags because they do not want to run the risk of further spillage of feed within their own store before sale or use. Rodents are major pests wherever they have easy access to food and are consequently often found in stores in which grain and livestock feed are kept. Their presence is encouraged by the spillage of grain and feed and they can cause spillage themselves as they often cut open the bags to gain access to their contents. The ready availability of a rich diet of feed supports their rapid proliferation in these environments.

Feed millers also experienced loss of maize grain during transportation (2.0%), spoilage of maize grain in storage (2.0%) and loss of the product (feed) during storage due to spillage (2%).

Table 18: Estimates of losses in the maize value chain – feed millers' assessment

Problems	Mean (%)
Amount of maize grain lost during transportation	2.0
Amount of product (feed) lost during transportation	3.0
Amount of the maize grain spoiled in storage	2.0
Spoilage of maize grain in storage due to rodents	2.8
Spoilage of maize grain in storage due to Weevils	1.0
Amount of product (feed) lost during storage due to spillage	2.0
Amount of product (feed) lost during storage due to weevils	2.0

The mean periods of storage of maize grain before milling and before spoilage began to manifest were estimated at 8.8 weeks and 4.0 weeks respectively. The storage duration of products before spoilage started to set in was three months (Table 19).

Table 19: Duration of storage of maize grain and products (feed)

Duration of storage	Mean
Period of maize grain storage before milling (weeks)	8.8
Period of storage of maize grain before spoilage (weeks)	4.0
Period of storage of product (feed) before spoilage (months)	3.0

4.3.3 Monetary quantification of losses in the maize value chain

Maize losses at the *farm gate* comprise losses of green maize and dry cobs (Table 20) and losses of grain (Table 21). As shown in Table 20, the quantity of green maize that is lost annually was estimated at 28, 440 mt, corresponding to a value of ₦ 938.5 million (₦ 33,000 per mt). The quantity of dry maize cobs lost annually was 165,836 mt, corresponding to a value of ₦ 7.29 billion (₦ 44,000 per mt).

Table 20: Quantification of losses of maize cobs (green and dry) at the farm gate

Food loss (maize farmers)	Mean (%)	Annual prod. (mt)*	Qty lost (mt)*	Price per mt (₦)	Value of food loss (₦)
Loss during harvesting	4.03	705,700	28,440	33,000	938,510,430
Loss during shelling	N/A*				-
Loss of fresh maize during transportation to market	N/A*				
Loss of dry maize grain during transportation to market	N/A*				
Loss of dry maize cobs during storage	2.27	7,305,530	165,836	44,000	7,296,763,364
Loss of dry maize grain during storage	N/A*				-
Total	**8.51**		**194,276**		**8,235,273,794**

* These rows are **not applicable (N/A)** either because the loss did not occur at the farm gate or because only maize cobs are under consideration.
* Annual production figures were sourced from FAOSTAT, 2012.
* Current prices were obtained from field data.

The total percentage of maize grain lost during shelling and during storage was 3.53 % (see table 21). The quantity of losses occurring during these two processes was estimated at 257,885 mt, corresponding to a value of ₦ 11.3 billion (₦ 44, 000 per mt).

Table 21: Quantification of losses of maize grain at the farm gate

Food loss (maize farmers)	Mean (%)	Annual prod. (mt)*	Qty lost (mt)	Price per mt (₦)*	Value of food loss (₦)
Loss during harvesting	N/A				
Loss during shelling	1.53		111,775		4,918,082,796
Loss of fresh maize during transportation to market	N/A*				
Loss of dry maize grain during transportation to market	N/A*	7,305,530		44,000	
Loss of dry maize cobs during storage	N/A*				
Loss of dry maize grain during storage	2.00		146,111		6,428,866,400
Total	**3.53**		**257,885**		**11,346,949,196**

* These rows are **not applicable** because only maize grain is under consideration.
* Annual production figures were sourced from FAOSTAT, 2012.
* Current prices were obtained from field data.

Losses of maize grain during transportation and storage at the *marketing phase* are presented in Table 22. The total quantity of maize grain lost was 1,943,271 mt. The value of this loss was 85.5 billion.

Table 22: Quantification of losses of maize grain during marketing (storage and transportation)

Food loss (maize farmers)	Mean (%)	Annual prod. (mt)*	Qty lost (mt)	Price per mt (₦)	Value of food loss (₦)
Loss during transportation	3.7		270,305		11,893,402,840
Loss of maize grain during storage due to spillage	5.9		431,026		18,965,155,880
Loss of maize grain during storage due to rodents	6		438,332		19,286,599,200
Loss of maize grain during storage due to weevils	8.5	7,305,530	620,970	44,000	27,322,682,200
Loss of maize grain during storage due to fungus	-				
Loss of maize grain during storage due to excess moisture	2.5		182,638		8,036,083,000
Total	**26.6**		**1,943,271**		**85,503,923,120**

Losses of grain and feed at the feed milling stage of the maize value chain are presented in Table 23. It shows the quantity and value of maize grain lost annually. The total quantity of maize going into feed production each year was estimated at 1.2 million mt, while the total quantity of maize lost at this stage was 93,600 mt, corresponding to a value of ₦ 4.1 billion.

Table 23: Quantification of losses of maize grain during feed milling

Loss of maize grain during processing	Mean (%)	Maize milled (2010) (mt)[34]	Maize lost (mt)	Price per mt (₦)	Value of food loss (₦)
Amount of maize grain lost during transportation	2	1,200,000	24,000	44,000	1,056,000,000
Amount of product (feed) lost during transportation	N/A*				
Amount of maize grain spoiled in storage	2		24,000		1,056,000,000
Spoilage of maize grain in storage due to rodents	2.8		33,600		1,478,400,000
Spoilage of maize grain in storage due to weevils	1		12,000		528,000,000
Amount of product (feed) lost during storage due to spillage	N/A*				-
Amount of product (feed) lost during storage due to weevils	N/A*				-
Total	**5.8**		**93,600**		**4,118,400,000**

* These rows are **not applicable** because only maize grain is under consideration.

Table 24 shows the quantity and value of feed lost during the marketing of feed. About 140,000 mt of feed was lost due to spillage during transportation, pest attacks and spoilage during storage. This was valued at ₦ 11.2 billion (₦ 80,000 per mt).

Table 24: Quantification of losses of feed during marketing

Food loss (livestock feed)	Mean (%)	Annual prod. (mt)[35]	Qty lost (mt)	Price per mt (₦)	Value of food loss (₦)
Amount of maize grain lost during transportation	N/A*	2,000,000		80,000	
Amount of product (feed) lost during transportation	3		60,000		4,800,000,000
Amount of the maize grain spoiled in storage	N/A*				
Spoilage of maize grain in storage due to rodents	N/A*				
Spoilage of maize grain in storage due to weevils	N/A*				
Amount of product (feed) lost during storage due to spillage	2		40,000		3,200,000,000
Amount of product (feed) lost during storage due to weevils	2		40,000		3,200,000,000
Total	**7**		**140,000**		**11,200,000,000**

* These rows are **not applicable** because only livestock feed is under consideration.

34 USDA Foreign Agricultural Service, Global Agricultural Information Network, 'Nigeria Grain and Feed Annual', GAIN Report Number NI11015, 4/15/2011
35 Estimated based on the quantity of maize that was used for feed production. See footnote 36.

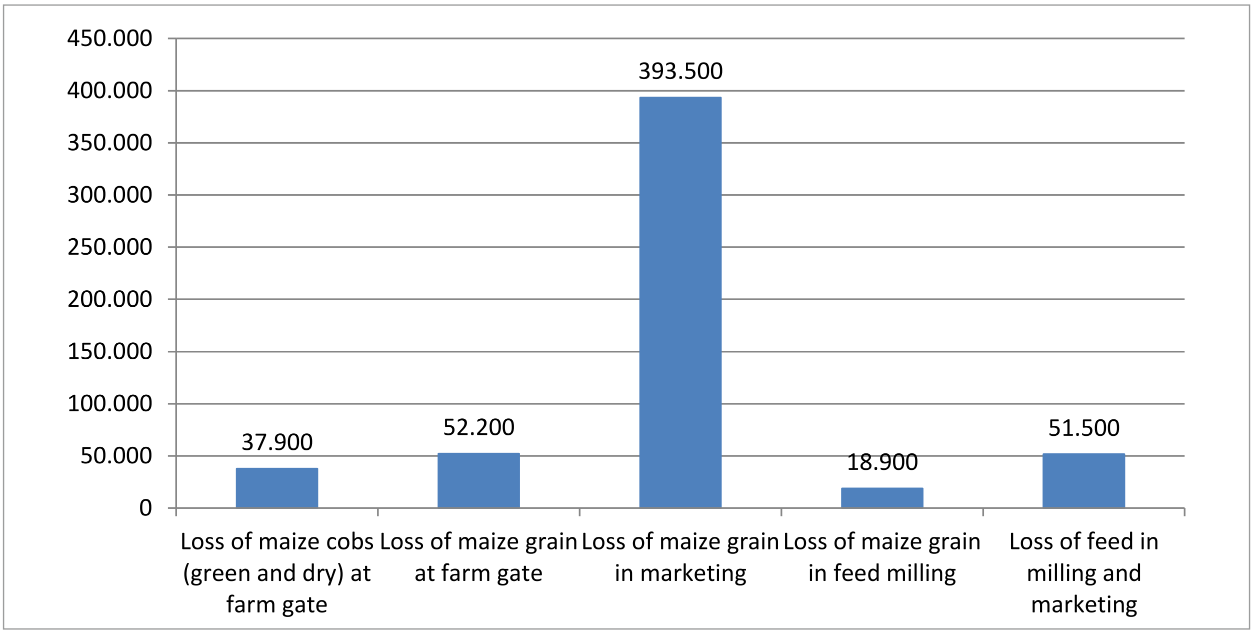
The total value of post-harvest losses along the maize value chain is shown in Table 25. The total value of maize (green and grain) and feed lost between harvest and marketing was ₦ 120.4 billion.

Table 25: Summary of quantification of maize losses

Quantification of maize losses	Value of losses (₦)	Value of losses (Mio)
Loss of maize cobs (green and dry) at the farm gate	8,235,273,794	37,900
Loss of maize grain at the farm gate	11,346,949,196	52,200
Loss of maize grain during marketing	85,503,923,120	393,500
Loss of maize grain during feed milling	4,118,400,000	18,900
Loss of feed during milling and marketing	11,200,000,000	51,500
Total Losses	**120,404,546,110**	**554,000**

* Exchange rate of 4 February 2013

Figure 30: Distribution of maize loss values in Mio EUR



4.3.4 Maize storage facilities in the study areas

Insect pests are one of the major causes of decline in quantity, quality and germination potential of maize seeds in storage. Adequate and effective storage of maize grain is therefore necessary to protect against loss during storage and limit economic damage. According to USDA GAIN (United States Department of Agriculture – Global Agricultural Information Network), about 30 percent of Nigeria's grain output is lost due to spoilage, contamination, attack by insects and rodents, and physiological deterioration in storage (Post-Harvest Losses)[36].

In most areas of Nigeria, small quantities of maize are preserved by sun-drying. Maize cobs are spread out in the sun and, when necessary, protected from the rain. After this process, the farmer or the maize marketer decides whether to store the maize as grain or as cobs. When cobs are dry enough, they can easily be shelled manually or using a shelling device.

In Nigeria, there are various means of storing maize. These include synthetic fertiliser bags, raised platforms on the farm, cribs, clay pots, rhumbu, oba, bare floor, bottles, baskets, drums, hanging cobs over the fireplace or from the ceiling, etc. In the north the most widespread means are synthetic fertiliser bags, rhumbu and storage on the bare floor, while synthetic fertiliser bags, raised platforms on the farm, baskets, and hanging over the fireplace and from the ceiling are more common in the south.

When synthetic fertiliser bags are used, the maize grain is packed in bags after shelling and the bags are tied to prevent insect attacks and spillage. Most large-scale farmers use this method because the bags can hold large quantities of grain and can be conveniently stacked in the store.

Rhumbu are traditional silos made of mud mixed with grass. The rhumbu is elevated from the ground with the aid of stones to guard against attacks by rodents, and covered with a thatched roof to protect it against rain. Rhumbu are usually built very close to residential areas to guard against theft.

Raised platforms on the farm are used to store dry maize cobs in large quantities. Platforms are constructed by tying bamboo sticks together. Stored on raised platforms the cobs are exposed to insect attacks, rainfall and humidity, which can cause deterioration and hence food loss.

Some small-scale farmers store and preserve their dry maize cobs by hanging them over the fireplace. This method uses smoke to keep the cobs dry and repel insects. However, the cobs can reabsorb moisture if the fireplace is devoid of fire for a considerable time. Maize kept in this way is prone to rodent attack. The use of ceiling storage facilities is common among smallholder farmers and is used for small quantities of cobs.

36 USDA Foreign Agricultural Service, Global Agricultural Information Network, 'Nigeria Grain and Feed Annual', GAIN Report Number NI11015, 4/15/2011

5 By-products along the maize and cassava value chain

A by-product is a useful or commercially valuable product produced incidentally in the production of other outputs. Waste products are unwanted products occurring in a value chain that are considered useless and of no commercial value. Theoretically, a waste product can become a useful by-product if a use can be found for it, or if, through the development of new technologies, it can be used as an input in other production processes.

The gari production process illustrated in Figure 17 (Flow of mass from fresh cassava tubers to gari and/or starch) generates a number of by-products. These are the fresh peel, which accounts for around 25% of the fresh cassava tuber, the fibre obtained after sieving the dewatered cassava mash, which amounts to around 2.3% of the fresh tuber, and the coarse granules which are obtained after sieving the fried gari, which amount to around 0.1% of the fresh tuber.

By-products of the starch production process include fresh cassava peel as with gari, along with the fibre arising from the sieving of cassava starch slurry from cassava mash. The by-products that currently have commercial value, albeit little, are the fresh cassava peel, the fibre and the coarse granules from the gari production process. The fibre from the starch production process has little or no value, because extraction of the starch during the sieving process removes virtually all the energy content of the fibre. From the point of view of quantity, the coarse granules that can be obtained from sieving fried cassava mash (gari) are negligible. The by-product produced in the greatest quantities is the fresh cassava peel, which can account for up to 25% of the fresh tuber. This by-product is usually sun-dried and fed to livestock. Some of the processing centres claimed that it was sometimes bought by pig farmers. The fibre that results from the sieving of dewatered cassava mash is usually milled into flour and consumed by human beings. It is prepared like ground rice and eaten with soup.

In the case of maize, two potential by-products can be identified. These are the husks and the empty cobs (cobs with the grain removed). To date these two by-products are not known to have any valuable use and must therefore be treated as waste products.

6 Options for reducing food losses recommendations for the private sector, national authorities and donors

6.1 Technology

The use of **inappropriate technology for harvesting** cassava is a major reason for losses of fresh tubers, especially during dry periods. Similarly, **lack of suitable cassava peeling technology** not only makes the work more difficult but also leads to part of the tuber itself being lost along with the outer peel. **Insufficient knowledge regarding the right time to harvest the different varieties of cassava tuber** results in woody tubers that are discarded at the time of processing, which is a further cause of losses. **The efficiency of grating/milling** can also affect the amount of loss occurring in the process of transforming cassava into gari or starch.

Many losses in the maize and cassava starch value chains occur as a result of **inappropriate bagging and packaging**, poor transportation systems and inappropriate storage technology. Weevils and rodents constitute a major source of loss of maize grain in storage.

Appropriate technologies could be developed through collaborative research projects conducted by public and private actors. The process of peeling by hand could be eliminated in the production of starch, with the tubers simply being washed and milled. This would require an affordable technology that could be deployed on a small scale to remove the particles of brown cassava peel from the slurry after milling and mixing with water. Similarly the development of an efficient and affordable cassava peeling machine could help to eliminate unnecessary work as well as addressing the problem of waste resulting from over-peeling.

6.2 Organisation of farmers and the value chain

Poverty and subsistence production limit the technological and marketing options available to the farmers. Better organisation of farmers and the whole value chain could help to overcome these obstacles to progress.

Due to the decline of farmers' organisations and cooperatives, farmers no longer have the capacity to influence the production, processing, transportation and marketing of agricultural commodities. Farmers can pool their resources and create economic incentives to improve transportation and storage facilities, thus helping to reduce food losses and enhance their own incomes. As groups and cooperatives, they will be able to receive **credit** from agricultural financial institutions or advance payments from buyers of their produce.

Farmers currently tend to keep cassava on the farm for longer than optimal periods in order to retain its value and ensure the food security of their household. They harvest/sell just enough cassava stands to meet the food and/or cash needs of the household. This can result in the fibre content of the tubers increasing significantly before they are harvested.

It would be advisable for the Department of Cooperatives at the state and federal levels to collaborate with the State Offices of the Nigerian Ministry of Agriculture and Rural Development to promote farmers' organisations. When organised into functioning cooperatives, the farmers are able to pool their resources and are more likely to invest in efficient packaging/bagging, storage, transportation and marketing with a view to minimising food losses and increasing their incomes.

Given the farm sizes, small groups of cassava farmers may find it difficult to sustain a small-scale cassava (**gari**) processing centre given the quantities of cassava that are required. This is why **toll processing centres** (usually owned by entrepreneurs) which provide services to several farmers and processors have proved successful in the case of gari production.

In the case of **starch production**, small-scale **pre-processing centres** could be established among clusters of cassava farmers and/or farming communities. Appropriate small-scale processing technology should be made available close to the farm gate for pre-processing fresh cassava into semi-finished starch which could then be transported to starch factories for processing into industrial or food-grade starch. The **semi-finished product** could be milled and dewatered cassava or wet starch. The transportation of fresh tubers to pre-processing centres that are only a short distance away would reduce the potential for loss and minimise the cost of transporting water and fibre (wastes) along with the cassava[37]. **Appropriate packaging** and transportation arrangements would have to be made for the transportation of semi-finished products to the starch factories.

Processors, public sector actors and donors should collaborate in promoting and **strengthening farmers' organisations and cooperative societies and linking them with processors** to create efficient commodity supply chains that could reduce losses in the production, processing, transportation and marketing of maize grain and cassava tubers. These supply chains would create economic incentives for appropriate transportation and storage facilities that could reduce food losses and enhance farmers' incomes.

Processors of cassava tubers should work with Agricultural Development Programmes in specific states to develop **out-grower schemes**, which could be used to provide farmers with inputs and technical guidance for efficient cassava production, while the processors undertake the harvesting, collection and transportation of fresh tubers at maturity. The out-growers should be paid at maturity and should receive the market value of the standing crops less the cost of inputs supplied to them. This would accord with the current practice of many farmers who prefer to sell their cassava tubers as standing crops and to leave the harvesting, collection and transportation to buyers.

6.3 Infrastructure

Poor transportation and storage facilities and lack of other infrastructure contribute to post-harvest losses. Fresh cassava tubers and fresh maize cobs straight from the farm can spoil in hot climates due to the lack of infrastructure for transportation, storage and marketing (Rolle, 2006[38]; Stuart, 2009[39]). This is a particular problem in Nigeria where appropriate vehicles may not be available in time to transport farm-fresh products (see annexe). The poor road network also contributes to delays in getting farm-fresh products to the end-users.

In Nigeria, the provision of vehicles for **transportation** is firmly in the hands of the private sector, while the construction and maintenance of the road network is generally accepted to be the responsibility of the government. The government is not involved to any significant extent in the provision of storage facilities. It appears that there are currently no economic incentives for private-sector operators to deploy appropriate vehicles for the transportation farm-fresh products in Nigeria. For this reason, green maize is no longer farm fresh when it arrives at the table of the final consumers in the urban centres. The poor condition of (rural) roads and the use of inappropriate vehicles lead to damage, spillage and deterioration of quality, and hence to food losses.

The establishment of **small-scale pre-processing centres among clusters of cassava farmers and/or farming communities** close to the farm gate would allow the transformation of cassava into semi-finished starch products which could then be transported to starch factories for processing into industrial or food-grade starch. This would reduce the delay in processing fresh tubers and correspondingly reduce deterioration and damage/losses in the course of transporting fresh tubers over long distances. It would also eliminate the cost of transporting water and fibre (wastes) to the starch factories.

In recent times there have been attempts in some states to improve **market infrastructure**. Within markets, sections are often created for specific agricultural products. It should therefore be easy to address the market operators for each type of agricultural product in a targeted manner. This should be particularly easy in the case of gari.

37 The starch content of cassava is 20%.
38 Rolle. 2006. Improving postharvest management and marketing in the Asia-Pacific region: issues and challenges. From: Postharvest management of fruit and vegetables in the Asia-Pacific region, APO, ISBN:92-833-7051-1
39 Stuart, T. 2009. Waste – uncovering the global food scandal. Penguin Books: London, ISBN: 978-0-141-03634-2

For industrial users of cassava tubers such as the starch factories, purchasing cassava as standing crop is not an attractive option. The preference is for suppliers to deliver cassava tubers at the factory gate where the supply can be weighed and the amount due confirmed. However, the cost of transportation is often significant and frequently makes the business transaction unprofitable for the farmers/suppliers. Greater distances from the source of supply to the starch factory mean higher transportation costs and a less profitable transaction for the farmer/supplier. It should be noted that these considerations were responsible for the lack of success and eventual demise of large-scale industrial processors of gari in Nigeria. The same considerations are affecting the industrial starch processors and making it difficult for them to get sufficient supplies of fresh cassava to feed their plants. On the other hand, small-scale gari processors and toll-operated gari processing centres have been largely successful because they are located close to the centre of cassava supply and transportation of tubers over long distances is minimised. The quantity of cassava tubers required to meet the installed capacity of the toll-operated gari processors can easily be supplied by farms in the vicinity.

6.4 Human capacity development

A comprehensive education and training policy is necessary to improve the capacity of stakeholders in production, post-harvest handling and storage, processing and marketing. As in many countries women play an important role, especially in the first part of the value chain, gender aspects are therefore crucial for the success of training and extension. Options are field days, demonstration plots, on-farm trials, storage buildings, processing plants, eventually planting, harvesting, storing and processing in groups with mutual exchange, household and kitchen visits with cooking and baking cassava and maize dishes. Appropriate advocacy measures and training can be provided to operators in the wholesale and retail sections of the market to improve the handling (especially bagging) and storage of the product with a view to maintaining quality and reducing physical losses.

The various institutions in research and training (i.e. IITA) have a lot of technical information that should be made available to those who need it.

6.5 Credit policy

It would be advisable for government and donor agencies to create an on-lending programme to promote aggregation and appropriate bagging and storage of maize grain by farmer cooperatives. This could help to ensure that relevant bagging and storage standards are followed with a view to reducing losses caused by breakages of bags, spillage and weevil and rodent attacks. Inventory credit can also enable farmers to delay the sale of some of their outputs from the time of harvest, when prices are low, to the off-season, when they can achieve higher prices.

6.6 Handling and processing policy

Standards should be established and appropriate informational materials developed to teach actors along the value chain about appropriate handling, packaging, transportation and processing techniques that will minimise losses in the value chains while ensuring cost effectiveness.

6.7 Costs and benefits of intervention options

To evaluate the feasibility of technological and institutional innovations, a proper cost-benefit analysis should be carried out. Low prices for commodities frequently restrict investment in improving post-harvest management. In many cases, accepting losses is cheaper than investing in protection. Technology transfer and training can only be successful if there is genuine economic benefit for the farmers. Whether this benefit is generated through higher market prices or, for an intermediate period, through state support and subsidies depends on the situation. Innovations often need initial support in order to become accepted and widespread, but they should be always based on sound economic analysis.

6.8 Actors and Partners with potential roles in the control of post-harvest losses

Table 26 provides examples of actors and partners (national and international) with potential to play a role in minimising post-harvest losses in cassava and maize. Some of these partners have been involved in interventions relating to either cassava, maize or both crops, but not necessarily with respect to the reduction of PHL (post-harvest losses). The table presents the names of the actors, categorised into producers, processors, research institutes, and public sector and donor agencies. It also presents information on the potential role each of these actors could play that could impact on post-harvest losses either directly or indirectly.

Table 26: Actors and partners' potential roles in post-harvest losses

Actors	Names	Potential roles in PHL
Maize seed producers	Premier Seed Nigeria Ltd., Zaria Alheri Seed Nigeria Ltd., Zaria Nagari Seed Nigeria Ltd., Zaria	As a producer of certified seeds, the company is expected to liaise with research institutes with a view to bringing high yielding and disease and pest-resistant varieties of maize onto the market. Some of the pests causing losses during storage of maize grain are in actual fact transferred from the field as eggs and larvae. Certified seed producers can help to minimise this negative transfer process by seeking from research institutions and putting onto the market varieties of maize that will be largely pest and disease-resistant, both on the field and in storage.
Farmers organisations	Cassava Growers Association of Nigeria	The association could be involved in encouraging farmers to take place in organised training events and in the implementation of other intervention activities towards the reduction of PHL. For example, the association could be useful in organising farmers into clusters for the purpose of processing cassava at a mill situated right in the centre of the cluster.
Large-scale farms	Alhaji Mustapha, Richifa Village, Soba LGA, Kaduna State (maize farmer) Alhaji Mohammed Sigan, Sigan Village, Lere LGA, Kaduna State (maize farmer)	These large-scale farmers could be persuaded to adopt appropriate technologies for shelling, bagging, and storage of maize grain. They could also serve as model farms for the surrounding small-scale farmers. They could thus help to extend these technologies to groups of small-scale farmers in their Local Government Areas.
Processors	MATNA Nigeria Ltd., Ogbese, Ondo State Peak Products, Abeokuta, Ogun State	Cassava processors could assist in reducing PHL by collaborating with international agencies and smallholder farmers to set up an efficient value added supply chain for cassava. Their collaboration with donor agencies would expose them to technologies that would enhance their operations and assist them in reducing PHL in their processing factories. Collaborating with smallholder farmers would provide a 'ready-made' market for farmers' products. This would reduce food losses, especially during a market glut.
	Durante, Ibadan (manufacturer of fish feed) FUTA Feed Mill, Akure (manufacturer of livestock feed)	The feed millers could also be involved in setting up an efficient maize supply chain in collaboration with donor agencies and maize farmers. This would be done with a view to increasing the efficiency of aggregation, transportation and storage and maximising net returns for maize farmers.

Actors	Names	Potential roles in PHL
Research Institutes	International Institute of Tropical Agriculture (IITA)	The national and international research institutes in Nigeria are responsible for carrying out field experiments and developing disease and pest-resistant, high-yielding and early-maturing varieties of planting materials. These improved maize and cassava varieties have the potential to reduce food losses on the farm and in storage.
	National Cereals Research Institute (NCRI)	
	National Root Crops Research Institute (NRCRI)	
Donors	World Bank	Donor agencies can promote interventions that aim to improve the efficiency of operations along the cassava and maize value chains, among other things with a view to reducing post-harvest losses. For example, USAID MARKETS collaborated with MATNA in developing an efficient cassava supply chain comprising the company and about 400 cassava farmers. IITA collaborated with Peak in developing and testing flash dryers for cassava processing.
	USAID MARKETS	
	International Fertiliser Development Centre (IFDC)	
Public sector	Federal Ministry of Agriculture	In partnership with donor agencies, the public sector agencies could implement interventions to reduce post-harvest losses, such as providing training to farmers, marketers and processors on how to conduct their businesses in such a way that PHL can be minimised. They could also provide loans and grants to pay for small-scale processing equipment that would increase efficiency and reduce losses during the processing of maize and cassava.

Annexe

I. SOCIO ECONOMIC DATA

Table 27: Cost of gari processing equipment and tools

Equipment and tools	Mean cost per unit
Knife	265
Bowl	600
Lister	67,500
Screw press	31,250
Sieve	1,500
Pot	2,500
Bag	60
Grater	35,000

Table 28: Description of key variables in gari processing

Amount charged/paid for processing one tonne of tubers into gari (₦)	3,645
Quantity of gari per unit of tubers (kg/mt)	250
Distance from processing centre to the market (km)	8.1
Cost of transporting gari per unit (₦/pick-up)	1384
Quantity of gari produced per annum (bags)	250.84
Price of gari at the processing centre (₦/kg)	78.06
Price of gari in the market (₦/kg)	118.30

II. DATA FROM THE FIELD SURVEY

a. Cassava

Table 29: Farmers experiencing cassava losses

Problem	Frequencies			Percentage	
	Yes	No	Total	Yes	No
Tubers usually damaged during harvesting	132	13	145	91	9
Loss of revenue due to damage	71	60	131	54.2	45.8
Discard of tubers because they are too small to peel with knife	80	51	131	61.1	38.9
Loss of tubers during storage due to spoilage	9	28	37	24.3	75.7
Discard of tubers because they are too woody to peel with knife	94	35	129	72.9	27.1
Discard of tubers after harvesting due to other problems	45	96	141	31.9	68.1
Loss of tubers while transporting them to the processing centre	27	99	126	21.4	78.6
Loss of finished product while transporting from the processing centre	16	112	128	12.5	87.5
Loss of finished product during storage due to spoilage	56	56	112	50	50

Table 30: Starch processors experiencing losses

Problem	Frequencies			Percentage	
	Yes	No	Total	Yes	No
Tubers usually damaged during transport	12	5	17	70.6	29.4
Tubers damaged during peeling	7	10	17	41.2	58.8
Loss of tubers during processing	10	5	15	66.7	33.3
Loss of revenue due to damage	11	4	15	73.3	26.7
Loss of tubers due to other problems	1	16	17	5.9	94.1
Loss due to spoilage	2	13	15	13.3	86.7

Table 31: Gari processors experiencing losses

Problem	Frequencies			Percentage	
	Yes	No	Total	Yes	No
Discard of small tubers	16	1	17	94.1	5.9
Discard of woody tubers	19	1	20	95.0	5.0
Loss of tubers during transportation	13	1	14	92.9	7.1
Loss of finished product during transportation	10	1	11	90.9	9.1
Loss of finished product during storage	11	1	12	91.7	8.3

Table 32: Gari marketers experiencing losses

Problem	Frequencies			Percentage	
	Yes	No	Total	Yes	No
Loss of gari during transportation	6	9	15	40	60
Loss of revenue	6	9	15	40	60
Loss of gari during storage	10	5	15	66.7	33.3

b. Maize

Table 33: Maize farmers experiencing losses

Problem	Frequencies			Percentage	
	Yes	No	Total	Yes	No
Pest and disease attacks on maize field	52	106	158	32.9	67.1
Maize cobs usually damaged during harvesting	43	118	161	26.7	73.3
Loss of revenue due to damaged grain/cobs	30	70	100	30	70
Discards after harvesting due to other problems	30	115	145	20.7	79.3

Table 34: Maize marketers experiencing losses

Problem	Frequencies			Percentage	
	Yes	No	Total	Yes	No
Loss of revenue due to loss of grain during transportation	3	13	16	18.75	81.25
Discard of maize grain after buying from farmers due to poor quality	3	5	8	37.50	62.50
Loss due to challenges in marketing and transportation of maize grain	13	5	18	72.22	27.78
Loss of maize grain in storage during the process of aggregation and marketing due to spillage	15	7	22	68.18	31.82
Loss of maize grain during storage due to spoilage	7	8	15	46.67	53.33

Table 35: Feed millers experiencing losses

Problem	Frequencies			Percentage	
	Yes	No	Total	Yes	No
Loss of maize grain during transportation from the market to the feed mill	5	1	6	83.3	16.7
Loss of revenue due to loss of grain	4	1	5	80.0	20.0
Loss due to other challenges in transportation of maize grain from the market to the feed mill	5	1	6	83.3	16.7
Loss during milling	4	2	6	66.7	33.3
Loss of revenue due to loss of grain during milling	3	2	5	60.0	40.0
Loss of maize grain in storage before milling	5	1	6	83.3	16.7
Loss of maize grain during storage due to spoilage	4	1	5	80.0	20.0
Loss of finished product in storage due to spillage	5	1	6	83.3	16.7
Loss of finished product during storage due to spoilage	1	3	4	25.0	75.0

III. PHOTO DOCUMENTATION

a. Means of transport

Figure 31: Pick-up van being used for cassava transportation[37]

Figure 32: Land Rover being used for cassava transportation[37]

37 Kindly provided by Dr. Adegboyega Eyitayo Oguntade

b. Tubers during processing

Figure 33: Peeled fresh cassava tubers[38]

c. Processing machines

Figure 34: Screw cassava press[39]

Figure 35: Hydraulic cassava press[39]

38 Kindly provided by Dr. Adegboyega Eyitayo Oguntade
39 Ezedinma (2006) Structure and Profitability of Cassava Enterprises in Nigeria, Paper Presented at the Root & Tuber Expansion Programme (RTEP) Training Workshop on Rural Enterprise Management and Community-Driven at ARMTI, Ilorin

Questionnaires

IV QUESTIONNAIRES

1) Survey of losses in Cassava value chain

Farmer's Questionnaire

This survey is being conducted with a view to eliciting information on losses that may be occurring between cassava farmers' field and the ultimate consumer of cassava products. This particular questionnaire is designed to collect information on losses in the quantity and quality of fresh cassava tubers and by-products on farmers' fields and homestead, etc
All information will remain anonymous and confidential and will only be used for the purposes of identifying the sources and amounts of losses in cassava production, processing, transportation and marketing.

A. IDENTIFICATION

Name of Enumerator	
Date of Interview	
State	
Local Government Area	
Village	
Name of respondent	

B. DEMOGRAPHIC DATA

1. Tribe:______________
2. Home Town (Place of Origin) :
   Town______________LGA______________State______________
3. Place of Birth:
   Town______________LGA______________State______________
5. Sex: (i) Male (ii) Female
6. Religion: (i) Christianity (ii) Islam (iii) Traditional (iv) Others
7. Age: ______________
8. Marital Status: (i) Single (ii) Married (iii) Widow/er
9. House hold size: ______________
10. Number of Wives:---------------------- (*Exact, number, please*)
11. Number of Children:

Sex	Total Number of Children	Children Still Living with You (All)	Children Still Living with You			Number Active in agriculture
			0 – 5 Yrs.	**6 – 15 Yrs.**	**16+ Yrs**	
Male						
Female						
Total						

12. Dependant Relatives:

Sex	Relative Living with You	Number Active in agriculture

	0 – 5 Yrs.	**6 – 15 Yrs.**	**16+ Yrs**	
Male				
Female				
Total				

14. Education (*Highest level only*)
    Farmer:
    (i) Primary (ii) Secondary (iii) Technical College
    (iv) Tertiary(v) Vocational (vi) Adult Education (vii) None
    Spouse:
    (i) Primary (ii) Secondary (iii) Technical College
    (iv) Tertiary(v) Vocational (vi) Adult Education (vii) None

C. PRE-PRODUCTION

1. Total size of all farms owned: …………Heaps/……….Ha
2. Total size of all farms planted with cassava last production season :…………Heaps/……….Ha
3 Distance of the farthest field from the House hold residence----------------
4 Please, list the crops you planted last production season in the order of importance
   ………
   ………
5 What percentage of the cassava planted is normally consumed by your family? ……………..%
6. Are you participating in any FG/State/NGO project that is promoting cassava production? Yes……/No……
7. If yes, please state the name of the project……………………………………………………….
8. Are government extension agents coming to provide information to you on how to grow and process cassava? Yes……/No……
9. If yes, please state how often: Twice in a month…… Once in a month…… Once in two months…… Once in three months……
10. Are you a member of a cooperative society? Yes……/No………
11. If yes, please state the type. (i) Producer………… (ii)Thrift &Credit……… (iii) Marketing……… (iv) Others, please state ……………………

D. PRODUCTION

Land tenure

1. Please complete the following table

Type of Field	Number	Size
Inherited		
Purchased		
Rented		
Pledged		
Others		

2. Did you use irrigation for cassava product last production seasons? Yes……….No……
3. If yes, what is the total size of all cassava farms irrigated last production season: …………Heaps/……….Ha
4. Please, provide an estimate of the irrigation cost. ₦…………………………

Cropping System

5. Did you plant cassava sole or mixed with other crops? Sole………. Mixed…………
6. If mixed, state the crops you mixed with cassava…………………………………………………..
……
7. In which week and month of the year do you normally prepare the land for planting cassava?
Week 1 2 3 4 Month ……………………………
8. Please, provide the following information on cassava stem cutting used for planting your field(s) last production season.

Sources	**Variety**	**Quantity**	**Value (₦)**
ADP			
MANR			
Market			
Past harvest			
Others			

9. Please, provide the following information on the fertilizer usually applied to the cassava fields planted (during the last production season).

Sources	Fertilizer type (*NPK/ Urea/ specify others*)	Quantity (50kg bags)	Price/50kg bag
ADP			
MANR			
Market			
Dealer/Agent			
Others			

10. Where do you store fertilizer?……………………………………………………….
11 Please, provide the following information on insecticide/fungicide/herbicide applied to the cassava fields planted last year.

I)

Sources	Insecticide	Quantity (pleas, specify unit)	Price/unit last year
ADP			
MANR			
Market			
Dealer/Agent			
Others			

II)

Sources	Fungicide	Quantity (pleas, specify unit)	Price/unit last year
ADP			
MANR			
Market			
Dealer/Agent			
Others			

III)

Sources	Herbicide	Quantity (pleas, specify unit)	Price/unit last year
ADP			
MANR			
Market			
Dealer/Agent			
Others			

12. Where do you store chemicals?………………………………………………………………………………
13. Did you use credit for the cassava you planted during the last production season?
Yes……….No……
13. If your answer is yes, please indicate the sources
……
14. If your answer is no, Why?
Not needed …….. Not available …… Too expensive………
15. Did you use hired labour for the cassava fields planted during the last production season?
Yes……….No……
16. If your answer is no, Why?
Not needed …….. Not available …… Too expensive………
17. If your answer is yes, how much did you pay per day for hired labour? ₦……………..
18. What is the present cost per day for hired labour in your community? ₦……………..
19. Please indicate which of the following types of family labour are being used.

Types	**Yes/No**
Head of household only	
Wife/wives	
Children	
Dependant relatives	
All Types	

20. Please, provide information on labour utilized for the cultivation of the cassava fields planted last production season

Farm Operation	**Month Done**	**Labour type**	**No. of mandays**	**Cost/manday (₦)**
Bush clearing				
Ploughing				
Heap making				
Planting				
Weeding				
Harvesting				
Others, please specify				

(i) Adult male (ii) Adult female (iii) Male children
(iv) Female children

21. Did you use mechanized equipment (tractor) to prepare the land used for cultivating the cassava planted during the last production season? Yes……….No……
22. If yes, how much did you pay for the services? ₦………………………..
23. Did any pests (insects, birds, rodents, etc) and diseases attack the cassava fields you planted last production season? Yes……….No……

24. If yes, what are the effects especially on yields; please describe and quantify.
……
……

25. What treatment did you apply and what is the cost?
……………………………………………………………………………………₦………………………

E. HARVEST AND POST-HARVEST

Harvesting

1 How many months after planting do you normally commence harvesting of your cassava? ……….months
2. Once you commence harvesting, how many months will it take for you to complete the harvesting? …………………..months
3. Who does the harvesting? Buyer……… Family labour…………… Hired labour…………
4. What are the tools used in harvesting cassava tubers?
……………………………………………………………
………
5 What month of the year do you normally harvest your cassava?
………………………………………………
6. How do you determine that your cassava is mature enough for harvesting?
……………………………
………
………
7. Are tubers usually damaged during harvesting? Yes……………….. No ………………………..
8. What percentage of each harvest is normally damaged? …………………%
9. Do you lose revenue because of the damage? Yes………………. No ………………………..
10. If you lose revenue, please explain how?
………………………………………………………………………………………………
11. What do you do with the damaged tubers? a. Throw away…. b. use as animal feed….

c. Others (please specify)
12. Are there tubers that you usually discard (throw away) after harvesting because of other problems? Yes………………. No ………………………..
13. If yes, what are the usual problems with the tubers?
………
14. Are there other challenges in harvesting cassava tubers? Yes……………….. No ………………………..
15. If yes, please describe them.
…………………………………………………………………………………………………
………
………
16. What is the yield of tubers on your cassava farm per unit area in a year with very good weather? ……………….(wheelbarrows/pickup vans/ mt/ other, specify) **per** (hectare/acre/heaps/specify)
17. What is the yield of tubers on your cassava farm per unit area in a year with normal weather? ………………(wheelbarrows/pickup vans/ mt/ other, specify) **per** (hectare/acre/heaps/specify)

Processing

18. Do you sell your cassava as fresh tubers or do you process them?
Sell as fresh tubers …………. Process …………… Both ……………

19 If both, what percentage do you sell as fresh tubers? ……………%
20. If you sell as fresh tubers, where do you sell? Farm gate ……………. On farm as standing crop …… Market ………….
21. If you sell in the market, how do you transport the tubers to the market? Please describe.
………
………
22. What containers do you use to transport the tubers from the farm to the market, house or processing centre? Baskets……….. Used rice bags…………… Others, please specify………………………
23. Are you able to sell all of the tubers that you take to the market each time? Yes …….. No ……….
24. If no, what do you do with the unsold tubers at the end of the market day?
………
25. What is the distance from your farm to the market? …………………… km
26. What is the cost of transportation per unit of tubers to the market? …₦……………/……………… (Please specify unit, e.g. wheelbarrow, pickup van, etc)
27. What price do you sell your fresh tubers at the farm gate? …₦ ……………/……………… (Please specify unit, e.g. wheelbarrow, pickup van, etc)
28. What price do you sell your fresh tubers at the market? …₦ ……………/……………… (Please specify unit, e.g. wheelbarrow, pickup van, etc)
29. What price do you sell your fresh tubers on farm as standing crop? …₦ ……………/……………… (Please specify unit, e.g. stands, acre, hectare, heaps etc)
30. If you process your tubers, what product do you process them into?
…………………………………………
31. How much do you sell this product per unit? ₦……………………/……….. (Please specify the unit)
32. If you process on-farm or at home, please, provide information on the processing of cassava in the following table

Stage	Activity (e.g. peeling)	Tools used (e.g. knife)	Cost of the tool (N/unit)	Mandays required per unit of tubers (pls specify unit)	Quantity of output per unit of tubers) (pls specify units)
1					
2					
3					
4					
5					
6					
7					

33. If you process the tubers at a commercial processing centre, please complete the following table.

Stage	Activity (e.g. peeling)	Tools or equipment used (e.g. knife)	Amount charged (N/unit of tubers) (pls specify unit)	Quantity of output per unit of tubers) (pls specify units)
1				
2				
3				
4				
5				
6				

7				

34. Do you have to discard some tubers because they are too small to peel with knife?
 Yes…… No ……
35. If yes, what percentage of the harvested tuber belongs to this category? ……..%
36. Do you have to discard some tubers because they are too woody to peel with knife?
 Yes…… No….
37. If yes, what percentage of the harvested tuber belongs to this category? ……..%
38. What do you do with the cassava peels and the discarded cassava?
 ………
39. Do you usually lose fresh tubers while transporting them to the processing centre?
 Yes………… No …………
40. If yes, please indicate the quantity that is usually lost as a percentage of the quantity transported. ………………..%
41. Do you usually lose some finished products while transporting it from the processing centre?
 Yes…… No …….
42. If yes, please indicate the quantity as that is usually lost as a percentage of the quantity transported. ………………..%

Storage

43. Do you store fresh cassava after harvesting? Yes………No ……
44. If yes, how? ……………………………………………………………………………………
45. If yes, do you lose tubers during storage due to spoilage? Yes………No ………
46. If yes, after how many days of storage do normally notice spoilage? …………………………….
47. If yes, what percentage of the tubers? ……………%
48. Do you store the finished product after processing? Yes………No ………
49. If yes, how? ……………………………………………………………………………………
50. If yes, do you lose finished product during storage due to spoilage? Yes…… No ……
51. If yes, after how many days/weeks/months of storage do normally notice spoilage?
 ……………………………. days/weeks/months
52. If yes, what percentage of the product? ……………%
53. What percentage of the finished product is reserved for home consumption? ……………%

F. IMPACT ON THE ENVIRONMENT

54. The following table is designed to collect information on the impact of cassava marketing on the environment. Please complete the table as much as it relates to your operations.

Description of Data		Crop Enterprise Combination				
		Cassava Monocrop	Cassava Mixed			
			Cassava	Crop 2	Crop 3	Crop 4
Field Size	Area					
	Unit					
Date of sowing / planting (Month/Year)						
Plant spacing						
Crops Planted Before						
Field Cleared by burning (Yes/No)						
Crops Mixed With		Not Applicable				
Percentage of each Crop in the Mixed						

Stand: Erstellt von: Seite 7

Description of Data		Crop Enterprise Combination				
		Cassava Monocrop	Cassava Mixed			
			Cassava	Crop 2	Crop 3	Crop 4
Date of harvest (month/year)						
Amount of main product harvested and taken off the field (fresh weight).wheelbarrows/pickup vans/ mt/ other, specify) per (hectare/acre/specify)						
Amount of by- product (e.g. stem cutting) harvested and taken off the field (fresh weight).wheelbarrows/pickup vans/ mt/ other, specify) per (hectare/acre/specify)						
Mineral Fertilizer Applied (Quantity in kg)	NPK					
	Urea					
	Other, specify					
Organic Manure Applied	Quantity (Bags)					
	Cost (Naira)					
	Type (Poultry/Cattle)					
Pesticide Applied	Name					
	Quantity					
	Unit					
	Name					
	Quantity					
	Unit					
	Name					
	Quantity					
	Unit					
Machinery Used	Name					
	Capacity					
	Type (Petrol/Diesel)					
	Hours of Work on Farm					
	Type of work					
	Name					
	Capacity					
	Type (Petrol/Diesel)					
	Hours of Work on Farm					
	Type of work					
	Name					
	Capacity					
	Type (Petrol/Diesel)					
	Hours of Work on Farm					
	Type of work					
Transportation (Farm to Homestead	Distance (km)					
	Type of Vehicle (e.g. Pick-up van)					

Stand: Erstellt von: Seite 8

Description of Data		Crop Enterprise Combination				
		Cassava Monocrop	Cassava Mixed			
			Cassava	Crop 2	Crop 3	Crop 4
	Number of trips carrying inputs to farm per year					
	Number of trips carrying outputs from farm per year					
Transportation (Homestead to Rural Market)	Distance (km)					
	Type of Vehicle (e.g. Pick-up van)					
	Number of trips carrying inputs to farm per year					
	Number of trips carrying outputs from farm per year					

Starch Processors' Questionnaire

This survey is being conducted with a view to eliciting information on losses that may be occurring between cassava farmers' field and the ultimate consumer of cassava products. This particular questionnaire is designed to collect information on losses in the quantity and quality of fresh cassava tubers and by-products during the *process of transformation into starch*
All information will remain anonymous and confidential and will only be used for the purposes of identifying the sources and amounts of losses in cassava production, processing, transportation and marketing.

A. IDENTIFICATION

Name of Enumerator	
Date of Interview	
State	
Local Government Area	
Village	
Name of processor	

B. PROCESSING

Cassava starch processing

1. How do you get your fresh cassava tubers?
   i. From own farm ii. Through Suppliers iii From farm gates
2. What quantity of cassava tubers do you buy annually? ……………….(wheelbarrows/pickup vans/ mt/ other, specify)
3. What is the average price of cassava tubers from farm gate? ₦ ....per (wheelbarrows/pickup vans/ mt/ other, specify)

4. What is the average price of cassava tubers from suppliers? ₦ ....per (wheelbarrows/pickup vans/ mt/ other, specify)
5. Please complete the table below:

Data Description	Data
Fresh cassava tubers (Quantity per tonne of starch) (tones)	
Quantity of water per tonne of starch (litres)	
Other ingredients (cost per ton of starch) ₦	
Total output of starch per annum (tonne)	
Selling price per tonne (₦)	
Monthly wages (₦)	
Rent on buildings (₦)	

6. Are tubers usually damaged during transportation and processing? Yes….. No …..
7. Are tubers usually damaged during peeling? Yes….. No …..
8. Do you usually have any loss during processing? Yes….. No …..
9. What percentage of total cassava is normally damaged? ………………….%
10. Do you lose revenue because of the damage? Yes…… No ……
11. If you lose revenue, please explain how? …………………………………………………………………………………
    ………
12. What do you do with the damaged tubers? a. Throw away…. b. use as animal feed….
    c. Sell d. Others (please specify)
13. How much do you realize from the damaged tubers/lost products? ₦……………………………
14. Are there tubers that you usually discard (throw away) after buying/harvesting because of other problems? Yes…… No ………
15. If yes, what are the usual problems with the tubers?
    ……….
16. Do you store the finished product after processing? Yes………………. No ……………………….
17. If yes, how? …………………………………………………………………………………………….
18. If yes, do you lose finished product during storage due to spoilage Yes…… No ………
19. If yes, after how many days/weeks/months of storage do normally notice spoilage?
    ……………………………. days/weeks/months
20. If yes, what percentage of the product? ……………%
21. What is your annual starch production? ……………………………………(please specify the unit)
22. Do you have other bye products? Yes……. No…….
23. If yes, how much do you realize from these bye products annually? ₦ ……………………….
24. What is the price per unit of the finished product? ₦ ……………………… per ……………………….. (please specify the unit)

C. IMPACT ON THE ENVIRONMENT

The following table is designed to collect information on the impact of starch processing on the environment. Please complete the table as much as it relates to your operations.

Description of Data			**Data**
Machinery Used for Processing	1	Name	
		Capacity	
		Cost(₦)	
		Use life (years)	
		Type (Petrol/Diesel/Electricity)	
		Hours of Work per day	

Description of Data			Data
		Number of Days of Work per Year	
		Type of work	
	2	Name	
		Capacity	
		Cost(₦)	
		Use life (years)	
		Type (Petrol/Diesel/Electricity)	
		Hours of Work per Day	
		Number of Days of Work per Year	
		Type of work	
	3	Name	
		Capacity	
		Cost(₦)	
		Use life (years)	
		Type (Petrol/Diesel/Electricity)	
		Hours of Work per Day	
		Number of Days of Work per Year	
		Type of work	
Transportation (Cassava farms to Processing Centre)		Distance (km)	
		Type of Vehicle (e.g. Pick-up van)	
		Number of trips carrying fresh cassava tubers from farm to processing center per year	
Transportation (Processing Centre to Distribution outlets/Market)		Distance (km)	
		Type of Vehicle (e.g. Pick-up van)	
		Number of trips carrying starch from factory to distribution outlets/market per year	

Feed Processors' Questionnaire

This survey is being conducted with a view to eliciting information on losses that may be occurring between maize farmers' field and the ultimate consumer of maize products. This particular questionnaire is designed to collect information on losses in the quantity and quality of maize grains and by-products during the *process of transformation into livestock feeds*

All information will remain anonymous and confidential and will only be used for the purposes of identifying the sources and amounts of losses in maize production, processing, transportation and marketing.

A. IDENTIFICATION

Name of Enumerator	
Date of Interview	
State	
Local Government Area	
Village	
Name of respondent	

Feed processing

1. What quantity of maize grain do you buy annually? ……………….(mt/ 50 kg-bags /other, specify)
2. How much do you pay per unit of maize grain purchased from the market? ₦ ……………………..per (mt/ 50 kg-bags /other, specify)
3. How much do you pay per unit of maize grain supplied to you at the feed mill? ₦ ……………………..per (mt/ 50 kg-bags /other, specify)
4. Do you lose maize grains during transportation from the market to your feed mill? Yes…. No …….
5. If yes, what percentage of total maize grain bought is normally spoilt / lost during transportation? …………………%
6. Please state the causes of losses of grains during transportation ……………………………………………………………………………………………………
7. Do you lose revenue because of the loss? Yes…… No ……
8. If you lose revenue, please explain how? ………………………………………………………………………… ……………………………………………………………………………………………………
9. What do you do with the spoilt maize grains?……………………………………………………………
10. Are there other challenges in transportation of maize grains from the market to your feed mill? Yes…… No …….
11. If yes, please describe them. …………………………………………………………………………………… ……………………………………………………………………………………………………
12. Please complete the following table for the different types of feed produced.

Inputs	Feed types				
	Broiler Starter	Chick Marsh	Grower	Layer	Finisher
Maize grains (Quantity per tonne of feed)					
Other ingredients (cost per ton of feed) ₦					
Total output per annum (tonne)					
Selling price per tonne (₦)					
Monthly wages (₦)					
Rent on buildings (₦)					

13. Do you usually have any loss during milling? Yes….. No …..
14. What percentage of total product is normally lost? …………………%
15. Do you lose revenue because of the loss? Yes…… No ……
16. If you lose revenue, please explain how? ………………………………………………………………………… ……………………………………………………………………………………………………
17. Do you store maize grains before milling? Yes……………….. No ………………………
18. If yes, how? …………………………………………………………………………………………………
19. If yes, do you lose maize grains during storage due to spoilage? Yes……………….. No ……………………….
20. If yes, how long on the average do you store a batch of maize grains? ……………………… weeks/months
21. If yes, after how many weeks/months of storage do you normally notice spoilage? …………………………….

22. If yes, what percentage of the maize grains is usually spoilt? ……………%
23. Which of the followings are the causes of spoilage/losses of maize grains in your store?

Rodents……. Weevils…….. Fungus……..
Moisture……. Others, specify ………………………………………………

24. What percentage of your spoilage/losses of maize grains will you attribute to:

Rodents…….% Weevils……..% Fungus……..%
Moisture…….% Others, specify ………………………………………………%

25. What do you normally do with maize grains that are spoilt due to any of the causes in (*24*)?
……
26. Do you store the finished product after processing? Yes………………… No ………………………..
27. If yes, how? ………………………………………………………………………………………………
28. If yes, do you lose finished product during storage due to spoilage Yes…… No ………
29. If yes, after how many days/weeks/months of storage do normally notice spoilage?
…………………………… days/weeks/months
30. If yes, what percentage of the product? ……………%
31. Which of the followings are the causes of spoilage/losses of finished products in your store?

Rodents……. Weevils…….. Fungus……..
Moisture……. Others, specify ………………………………………………

32. What percentage of your spoilage/losses of finished products will you attribute to:

Rodents…….% Weevils……..% Fungus……..%
Moisture…….% Others, specify ………………………………………………%

33. What do you normally do with finished products that are spoilt due to any of the causes in (32)? ……………………………………………………………………………………………………

B. IMPACT ON THE ENVIRONMENT

The following table is designed to collect information on the impact of starch processing on the environment. Please complete the table as much as it relates to your operations.

Description of Data			Data
Machinery Used for Processing	1	Name	
		Capacity	
		Cost(₦)	
		Use life (years)	
		Type (Petrol/Diesel/Electricity)	
		Hours of Work per day	
		Number of Days of Work per Year	
		Type of work	
	2	Name	
		Capacity	
		Cost(₦)	
		Use life (years)	
		Type (Petrol/Diesel/Electricity)	
		Hours of Work per Day	

Description of Data			Data
		Number of Days of Work per Year	
		Type of work	
	3	Name	
		Capacity	
		Cost(₦)	
		Use life (years)	
		Type (Petrol/Diesel/Electricity)	
		Hours of Work per Day	
		Number of Days of Work per Year	
		Type of work	
Transportation (Market to Feed mill)		Distance (km)	
		Type of Vehicle (e.g. Pick-up van)	
		Number of trips carrying inputs from market to feed mill per year	
Transportation (feed mills to distribution outlets)		Distance (km)	
		Type of Vehicle (e.g. Pick-up van)	
		Number of trips carrying outputs from feed mill to outlets per year	

Fresh Tubers Marketers' Questionnaire

This survey is being conducted with a view to eliciting information on losses that may be occurring between cassava farmers' field and the ultimate consumer of cassava products. This particular questionnaire is designed to collect information on losses in the quantity and quality of fresh cassava tubers and by-products during the process of marketing of tubers
All information will remain anonymous and confidential and will only be used for the purposes of identifying the sources and amounts of losses in cassava production, processing, transportation and marketing.

A. IDENTIFICATION

Name of Enumerator	
Date of Interview	
State	
Local Government Area	
Village	
Name of respondent	

C. CASSAVA MARKETING

1. Which months of the year do you normally buy cassava tubers? …………………….. to ……………………
2. Where do you normally buy cassava from? i. Farm gate ii. On farm as standing crop iii. Market
3. If from farm gate/market, are tubers usually damaged during transportation? Yes ….. No …..

4. If from on farm as standing crop, are tubers usually damaged during harvesting? Yes ….. No …..
5. What percentage of total cassava bought/harvested is normally damaged? ………………….%
6. Do you lose revenue because of the damage? Yes…… No ……
7. If you lose revenue, please explain how? ………………………………………………………………………… ………
8. What do you do with the damaged tubers? a. Throw away…. b. use as animal feed…. c. Others (please specify) ………………………………………………………………
9. Are there tubers that you usually discard (throw away) after buying/harvesting because of other problems? Yes…… No ………
10. If yes, what are the usual problems with the tubers? …………………………………………………… ………
11. Are there other challenges in harvesting, marketing and transportation cassava tubers? Yes…… No …….
12. If yes, please describe them. ………………………………………………………………………………… ………
13. What quantity of cassava tubers do you buy annually? ……………….(wheelbarrows/pickup vans/ mt/ other, specify)
14. What is the average price of cassava tubers from farm gate? ₦ ……………………..per (wheelbarrows/pickup vans/ mt/ other, specify)
15. What is the average price of cassava tubers from local markets? ₦ ……………………..per (wheelbarrows/pickup vans/ mt/ other, specify)
16. What is the average price of cassava tubers from on farm standing crop? ₦ ……………………..per (heaps/wheelbarrows/pickup vans/ mt/ other, specify)
17. What is the distance between the farm gate/local market and the garri processing plant/starch processing factory where you supply cassava? …….. km
18. What is the cost of transportation per unit of tubers to the garri processing plant/starch processing factory? …₦……………/……………… (Please specify unit, e.g. wheelbarrow, pickup van, etc)
19. What price do you sell your fresh tubers at the garri processing plant/starch processing factory? …₦ ……………/……………… (Please specify unit, e.g. wheelbarrow, pickup van, etc)

D. IMPACT ON THE ENVIRONMENT

The following table is designed to collect information on the impact of cassava marketing on the environment. Please complete the table as much as it relates to your operations.

Description of Data		Data
Field Size	Area	
	Unit	
Date of harvest (month/year)		
Amount of main product harvested and taken off the field (fresh weight).wheelbarrows/pickup vans/ mt/ other, specify) per (hectare/acre/specify)		
Amount of by- product (e.g. stem cutting) harvested and taken off the field (fresh weight).wheelbarrows/pickup vans/ mt/ other, specify) per (hectare/acre/specify)		
Transportation	Distance (km)	

Description of Data		Data
(Farm to Homestead	Type of Vehicle (e.g. Pick-up van)	
	Number of trips carrying inputs to farm per year	
	Number of trips carrying outputs from farm per year	
	Distance (km)	
Transportation (Homestead to Rural Market/Factory Gate/Processing Centre)	Type of Vehicle (e.g. Pick-up van)	
	Number of trips carrying inputs to farm per year	
	Number of trips carrying outputs from farm per year	

2) Survey of losses in Maize value chain

Farmer's Questionnaire

This survey is being conducted with a view to eliciting information on losses that may be occurring between maize farmers' field and the ultimate consumer of maize products. This particular questionnaire is designed to collect information on losses in the quantity and quality of fresh maize, maize (dry) grain and by-products on farmers' fields and homestead, etc

All information will remain anonymous and confidential and will only be used for the purposes of identifying the sources and amounts of losses in maize production, processing, transportation and marketing.

A. IDENTIFICATION

Name of Enumerator	
Date of Interview	
State	
Local Government Area	
Village	
Name of respondent	

B. DEMOGRAPHIC DATA

1. Tribe:______________ (optional)
2. Home Town (Place of Origin): Town______________LGA______________State___________
3. Place of Birth: Town______________LGA______________State______________
5. Sex: (i) Male (ii) Female
6. Religion: (optional) (i) Christianity (ii) Islam (iii) Traditional (iv) Others
7. Age: ______________
8. Marital Status: (i) Single (ii) Married (iii) Widow/er
9. House hold size: ______________
10. Number of Wives: _____________(*Exact, number, please*)
11. Number of Children:

Sex	Total Number of Children	Children Still Living with You (All)	Children Still Living with You			Number Active in agriculture
			0 – 5 Yrs.	6 – 15 Yrs.	16+ Yrs	
Male						
Female						
Total						

12. Dependant Relatives:

Sex	Relative Living with You			Number Active in agriculture
	0 – 5 Yrs.	6 – 15 Yrs.	16+ Yrs	
Male				
Female				
Total				

14. Education (*Highest level only*)
Farmer:
(i) Primary (ii) Secondary (iii) Technical College
(iv) Tertiary(v) Vocational (vi) Adult Education (vii) None
Spouse:
(i) Primary (ii) Secondary (iii) Technical College
(iv) Tertiary(v) Vocational (vi) Adult Education (vii) None

C. PRE-PRODUCTION

1. Total size of all farms owned: …………Heaps/……….Ha
2. Total size of all farms planted with maize last production season :…………Heaps/……….Ha
3 Distance of the farthest field from the House hold residence _____________
4 Please, list the crops you planted last production season in the order of importance…………………
………
5 What percentage of the maize planted is normally consumed by your family? ……………..%
6. Are you participating in any FG/State/NGO project that is promoting maize production? Yes……/No……
7. If yes, please state the name of the project………………………………………………………………………
8. Are government extension agents coming to provide information to you on how to grow and process maize? Yes……/No……
9. If yes, please state how often? Twice in a month…… Once in a month……
Once in two months…… Once in three months……
10. Are you a member of a cooperative society? Yes……/No………
11. If yes, please state the type. (i) Producer………… (ii)Thrift &Credit……… (iii) Marketing………
(iv) Others, please state …………………….

D. PRODUCTION

Land tenure

1. Please complete the following table

Type of Field	Number	Size
Inherited		
Purchased		
Rented		
Pledged		
Others		

2. Did you use irrigation for maize product last production seasons? Yes……….No……
3. If yes, what is the total size of all maize farms irrigated last production season: …………Heaps/……….Ha
4. Please, provide an estimate of the irrigation cost. ₦…………………………

Cropping System

5. Did you plant maize sole or mixed with other crops? Sole………. Mixed…………
6. If mixed, state the crops you mixed with maize………………………………………………………………………
7. In which week and month of the year do you normally prepare the land for planting maize?
Week 1 2 3 4 Month ……………………………
8. Please, provide the following information on maize seeds used for planting your field(s) last production season.

Sources	Variety	Type (white/Yellow)	Quantity (kg)	Value (₦)
ADP				
MANR				
Market				
Past harvest				
Others				

9. Please, provide the following information on the fertilizer applied to the maize fields planted during the last production season.

Sources	Fertilizer type (*NPK/ Urea/ specify others*)	Quantity (50kg bags)	Price/50kg bag
ADP			
MANR			
Market			
Dealer/Agent			
Others			

10. Where do you store fertilizer? ……………………………………………………….
11 Please, provide the following information on insecticide/fungicide/herbicide applied to the maize fields planted last year.

I)

Sources	Insecticide	Quantity (pleas, specify unit)	Price/unit last year
ADP			
MANR			
Market			
Dealer/Agent			
Others			

II)

Sources	Fungicide	Quantity (pleas, specify unit)	Price/unit last year
ADP			
MANR			
Market			
Dealer/Agent			
Others			

III)

Sources	Herbicide	Quantity (pleas, specify unit)	Price/unit last year
ADP			
MANR			
Market			
Dealer/Agent			
Others			

12. Where do you store chemicals?……………………………………………………………………………………
13. Did you use credit for the maize you planted during the last production season? Yes……….No……
13. If your answer is yes, please indicate the sources. …………………………………………………………………
14. If your answer is no, Why? Not needed …….. Not available…… Too expensive……
15. Did you use hired labour for the maize fields planted during the last production season? Yes……….No……
16. If your answer is no, Why? Not needed …….. Not available…… Too expensive……
17. If your answer is yes, how much did you pay per day for hired labour? ₦………………………
18. What is the present cost per day for hired labour in your community? ₦………………………
19. Please indicate which of the following types of family labour are being used.

Types	Yes/No
Head of household only	
Wife/wives	
Children	
Dependant relatives	
All Types	

20 Please, provide information on labour utilized for the cultivation of the maize fields planted last production season

Farm Operation	Month Done	Labour type	No. of mandays	Cost/manday (₦)
Bush clearing				
Ploughing				
Heap making				
Planting				
Weeding				
Harvesting				
Others, please specify				

(i) Adult male (ii) Adult female (iii) Male children (iv) Female children

21 Did you use mechanized equipment (tractor) to prepare the land used for cultivating the maize planted during the last production season? Yes……….No……
22. If yes, how much did you pay for the services? ₦……………………….
23. Did any pests (insects, birds, rodents, etc) and diseases attack the maize fields you planted last production season? Yes……….No……
24. If yes, what are the effects especially on yields; please describe and quantify. ………

26 What treatment did you apply and what is the cost? ………………………………………………………………
……………………………………………………………………………₦

E. HARVEST AND POST-HARVEST

Harvesting

1 How many months after planting do you normally commence harvesting of your maize? ……….months

2. Once you commence harvesting, how long will it take for you to complete the harvesting? …………………. weeks

3. Who does the harvesting? Buyer……… Family labour………….. Hired labour…………

4. What are the tools used in harvesting maize? ……………………………………………………………………………

5 What month of the year do you normally harvest your maize? ……………………………………………

6. How do you determine that your maize is mature enough for harvesting? ……………………………. ……………………………………………………………………………

7. Are maize cobs usually damaged during harvesting? Yes…… No …………

8. What percentage of each harvest is normally damaged? ………………….%

9. Do you lose revenue because of the damage? Yes………No …………

10. If you lose revenue, please explain how? ……………………………………………………………………………

11. What do you do with the damaged maize cobs? a. Throw away…. b. use as livestock feed…. c. Others (please specify)

12. Are there maize cobs that you usually discard (throw away) after harvesting because of other problems? Yes…… No ………

13. If yes, what are the usual problems with the maize cobs? ……………………………………………………………………………

14. Are there other challenges in harvesting maize cobs? Yes…… No ……

15. If yes, please describe them.
……………………………………………………………………………
……………………………………………………………………………

16. How many cobs of green (fresh) maize do you normally harvest from your farm per hectare? ……………

17. If you are harvesting dry maize, how many dried cobs do you normally harvest from your farm per hectare? …………..

18. After shelling, what quantity of grains do you normally obtain per hectare in a year with very good weather? ………………………… (mt/ 50 kg-bag/ other, specify)

19. After shelling, what quantity of grains do you normally obtain per hectare in a year with normal weather? ………………………… (mt/ 50 kg-bag/ other, specify)

F. PROCESSING

20. Do you sell your maize as fresh maize or do you sell them as processed dry grain?
Sell as fresh maize ………….. Processed ……………. Both ……………

21. If both, what percentage do you sell as fresh maize? ……………%

22 If you sell as fresh maize, where do you sell? Farm gate ……………. On farm as standing crop ……. Market ………….

23. If you sell in the market, how do you transport the maize to the market? Please describe.
……………………………………………………………………………
……………………………………………………………………………

24. What containers do you use to transport the maize from the farm to the market, house or processing centre? Baskets………… Used rice bags…………… Others, please specify………………………

25. Are you able to sell all of the fresh maize that you take to the market each time?
Yes ….. No …..

26. If no, what do you do with the unsold maize at the end of the market day? ……………………………………………………………………………

27. What is the distance from your farm to the market? …………………… km

28. What is the cost of transportation per unit of maize to the market? …₦……………/……………… (Please specify unit, e.g. wheelbarrow, pickup van, 50 kg bag, etc)

29. What price do you sell your fresh maize cobs at the farm gate? …₦ ……………/……………… (Please specify unit, e.g. wheelbarrow, pickup van, 50 kg bag, cobs, etc)

30. What price do you sell your fresh maize at the market? …₦ ……………/……………… (Please specify unit, e.g. wheelbarrow, pickup van, 50 kg bag, cobs, etc)

31. What price do you sell your fresh maize on farm as standing crop? …₦ ……………/……………… (Please specify unit, e.g. stands, acre, hectare, heaps etc)

32. How much do you sell dry grain per unit at farm gate? ₦……………………/…………………..(Please specify unit, e.g. wheelbarrow, pickup van, 50 kg bag, etc)

33. What price do you sell your dry grain at the market? ₦ ……………/……………… (Please specify unit, e.g. wheelbarrow, pickup van, 50 kg bag, etc)

33. If you process on-farm or at home, please, provide information on the processing of maize in the following table

Stage	Activity (e.g. shelling, winnowing, bagging)	Tools used (e.g. knife)	Cost of the tool (N/unit)	Mandays required per unit of grain (pls specify unit)	Quantity of shelled grains per unit of dry cobs) (pls specify units)
1					
2					
3					
4					

34. If you process the maize cobs at a commercial processing centre, please complete the following table.

Stage	Activity (e.g. Shelling, winnowing, bagging)	Tools or equipment used (e.g. Shelling machine)	Amount charged (N/unit of grain) (pls specify unit)	Quantity of shelled grains per unit of dry cobs) (pls specify units)
1				
2				
3				
4				

35. Do you have to discard some grains because they are spoilt (broken grain, moldy, etc) while shelling? Yes…… No …

36. If yes, what percentage of the harvested grain belongs to this category? ……..%

37. What do you do with the spoilt and discarded grains ?
……………………………………………………………………………

G. TRANSPORTATION

38. Do you usually lose fresh maize while transporting them to the market? Yes…… No ……
39. If yes, please indicate the quantity that is usually lost as a percentage of the quantity transported. ………………..%
40. Do you usually lose maize (dry) grains while transporting them to the market? Yes……………….. No ……………………
41. If yes, please indicate the quantity that is usually lost as a percentage of the quantity transported. ………………..%

H. STORAGE

42. Do you store maize (dry) cobs after harvesting? Yes……………….. No ……………………….
43. If yes, how? ……………………………………………………………………………………
44. If yes, do you lose maize (dry) cobs during storage due to spoilage? Yes………. No ………
45. If yes, after how many days of storage do you normally notice spoilage? ……………………………
46. If yes, what percentage of the maize cobs? ……………%
47. Do you store the shelled grains? Yes……………….. No ……………………….
48. If yes, how? ……………………………………………………………………………………
49. If yes, do you lose maize grains during storage due to spoilage? Yes…… No …….
50. If yes, after how many days/weeks/months of storage do normally notice spoilage? …………………………… days/weeks/months
51. If yes, what percentage of maize grains is usually spoilt? ……………%
52. Which of the followings are the causes of spoilage/losses of maize grains in your store?
    Rodents……. Weevils…….. Fungus……..
    Moisture……. Others, specify ……………………………………………
53. What percentage of your spoilage/losses of maize grains will you attribute to:
    Rodents…….% Weevils……..% Fungus……..%
    Moisture…….% Others, specify ……………………………………………%
54. What do you normally do with maize grains that are spoilt due to any of the causes in (*53*)?
    …………………………………………………………………………………………………
55. What percentage of the finished product is reserved for home consumption? ……………%

I IMPACT ON THE ENVIRONMENT

56. The following table is designed to collect information on the impact of maize production on the environment. Please complete the table as much as it relates to your operations.

Description of Data		Crop Enterprise Combination				
		Maize Monocrop	Maize Mixed			
			Maize	Crop 2	Crop 3	Crop 4
Field Size	Area					
	Unit					
Date of sowing / planting (Month/Year)						
Plant spacing						
Crops Planted Before						
Field Cleared by burning (Yes/No)						
Crops Mixed With		Not Applicable				
Percentage of each Crop in the Mixed						
Date of harvest (month/year)						
Amount of green (fresh) maize harvested and						

Description of Data		Crop Enterprise Combination				
		Maize Monocrop	Maize Mixed			
			Maize	Crop 2	Crop 3	Crop 4
taken off the field (fresh weight).wheelbarrows/pickup vans/ mt/ cobs, other, specify) per (hectare/acre/specify)						
Amount of dry maize harvested and taken off the field (fresh weight).wheelbarrows/pickup vans/ mt/ cobs, other, specify) per (hectare/acre/specify)						
Mineral Fertilizer Applied (Quantity in kg)	NPK					
	Urea					
	Other, specify					
Organic Manure Applied	Quantity (Bags)					
	Cost (Naira)					
	Type (Poultry/Cattle)					
Pesticide Applied	Name					
	Quantity					
	Unit					
	Name					
	Quantity					
	Unit					
	Name					
	Quantity					
	Unit					
Please state the method of preservation in storage of maize grains			Not Applicable			
Agrochemical used for preservation of Maize grain	Name		Not Applicable			
	Quantity per annum		Not Applicable			
	Cost per unit		Not Applicable			
Machinery Used	Name					
	Capacity					
	Type (Petrol/Diesel)					
	Hours of Work on Farm					
	Type of work					
	Name					
	Capacity					
	Type (Petrol/Diesel)					
	Hours of Work on Farm					
	Type of work					
	Name					
	Capacity					
	Type (Petrol/Diesel)					
	Hours of Work on Farm					
	Type of work					
Transportation	Distance (km)					

Description of Data		Crop Enterprise Combination				
		Maize Monocrop	Maize Mixed			
			Maize	Crop 2	Crop 3	Crop 4
(Farm to Homestead	Type of Vehicle (e.g. Pick-up van)					
	Number of trips carrying inputs to farm per year					
	Number of trips carrying outputs from farm per year					
Transportation (Homestead to Rural Market)	Distance (km)					
	Type of Vehicle (e.g. Pick-up van)					
	Number of trips carrying inputs to farm per year					
	Number of trips carrying outputs from farm per year					

Maize Marketers' Questionnaire

This survey is being conducted with a view to eliciting information on losses that may be occurring between maize farmers' field and the ultimate consumer of maize products. This particular questionnaire is designed to collect information on losses in the quantity and quality of maize grains and by-products during the process of marketing of maize grains

All information will remain anonymous and confidential and will only be used for the purposes of identifying the sources and amounts of losses in maize production, processing, transportation and marketing.

A IDENTIFICATION

Name of Enumerator	
Date of Interview	
State	
Local Government Area	
Village	
Name of respondent	

B. MARKETING

20. Which months of the year do you normally buy maize grains? ……………………. to ……………………
21. Where do you normally buy maize grain from? i. Farm gate ii. Market
22. If from farm gate/market, are grains usually destroyed / lost during transportation? Yes ….. No …..
23. What percentage of total maize grain bought is normally spoilt / lost during transportation? …………………%
24. Please state the causes of losses of grains during transportation ………………………………………………………………………………………………

25. Do you lose revenue because of the loss? Yes…… No ……
26. If you lose revenue, please explain how? ………………………………………………………………………………… ……
27. What do you do with the spoilt maize grains? a. Throw away…. b. use as animal feed…. c. Others (please specify)
28. Are there maize grains that you usually discard (throw away) after buying because of other problems? Yes…… No ………
29. If yes, what are the usual problems with the maize grains? ……
30. Are there other challenges in marketing and transportation of maize grains? Yes…… No …….
31. If yes, please describe them. ………………………………………………………………………………………………… ……
32. What quantity of maize grains do you buy annually? ……………….(pickup vans/ mt/ 50 kg-bags /other, specify)
33. How much do you buy maize grain maize grains from farm gate/rural market? ₦ ……………………. per (pickup vans/ mt/ other, specify)
34. What is the distance between the farm gate/rural market and the final market/destination where you supply maize grains? ……….. km
35. What is the cost of transportation per unit of maize grains from farm gate/rural market and the final market/destination where you supply maize grains? ₦……………………… /……………… (Please specify unit, e.g. wheelbarrow, pickup van, etc)
36. What price do you sell your maize grains at the final market/destination where you supply maize grain ₦ ………………………../……………… (Please specify unit, e.g. wheelbarrow, pickup van, etc)
37. Do you store maize grains during the process of aggregation and marketing? Yes………………. No ……………………….
38. If yes, how? ………
39. If yes, do you lose maize grains during storage due to spoilage? Yes……………….. No ………………………..
40. If yes, how long on the average do you store a batch of maize grains? ……………………… weeks/months
41. If yes, after how many weeks/months of storage do you normally notice spoilage? …………………………….
42. If yes, what percentage of the maize grains is usually spoilt? ……………%
43. Which of the followings are the causes of spoilage/losses of maize grains in your store? Rodents……. Weevils…….. Fungus…….. Moisture……. Others, specify ………………………………………………
44. What percentage of your spoilage/losses of maize grains will you attribute to: Rodents…….% Weevils……..% Fungus……..% Moisture…….% Others, specify ………………………………………………%
45. What do you normally do with maize grains that are spoilt due to any of the causes in (*25*)? ……

C. IMPACT ON THE ENVIRONMENT

The following table is designed to collect information on the impact of maize grain marketing on the environment. Please complete the table as much as it relates to your operations.

Description of Data	Data
Amount of maize grain bought per annum (pickup vans /wheelbarrows/ mt/ 50 kg-bags other, specify)	

Description of Data		Data
Please state the method of preservation in storage of maize grains		
Agrochemical used for preservation	Name	
	Quantity per annum	
	Cost per unit	
Transportation (Farm gate/ rural market to Homestead/store)	Distance (km)	
	Type of Vehicle (e.g. Pick-up van)	
	Number of round trips per year	
Transportation (Homestead /store to Urban Market/Factory Gate/feed mill)	Distance (km)	
	Type of Vehicle (e.g. Pick-up van)	
	Number of round trips per year	

Sample size and budget estimate for questionnaire administration

To collect this data and others from the farmers, appropriate questionnaire will be developed. The questionnaire will be used as interview guide by trained enumerators to elicit information from the farmers since most of the farmers may not be able to read and complete the questionnaire on their own. A multistage sampling technique will be adopted to select the farmers that will constitute the sample. In the first stage two states, one in the north and the other in the south, which are high producers of cassava and maize will purposively selected. The states being contemplated are Ondo State in the south and Kaduna State in the north. In each of the two states, two local governments which are high producers of cassava and maize will be selected. Thus four local governments will be selected for the study. For the local governments selected, the lists of cassava and maize farmers will be obtained from the Agricultural Development Programme (ADP) from which random samples of respondents will taken.
A total of 100 cassava farmers will be randomly selected in each local government, making a total of 400 cassava farmers. Similarly, 100 maize farmers will be randomly selected also making a total of 400 maize farmers.

Cassava and Maize Farmers

States	LGAs	No of Maize farmers	No of Cassava Farmers	Total No of Farmers
Ondo		100	100	200
		100	100	200
Kaduna		100	100	200
		100	100	200
Total		400	400	800

Garri Processors

States	LGAs	No of Garri Processors
Ondo		10
		10
Kaduna		5
		5
Total		30

Grain Marketers

States	LGAs	No Grain Marketers
Ondo		2
		2
Kaduna		10
		10
Total		22

Fresh Cassava Tuber Marketers

States	LGAs	No of Cassava Marketers
Ondo		10
		10
Kaduna	Saminaka	5
		5
Total		30

Feed Millers

States	No of Feed Millers
Ondo and others	6

Cassava Starch Processor

States	No of Starch Processors
Ondo and others	15

SUMMARY

State	**Ondo**		**Kaduna**		**Total**
Local Government Area	TBD	TBD	TBD	TBD	
Maize farmers	100	100	100	100	400
Cassava Farmers	100	100	100	100	400
Gaari Processors	10	10	5	5	30
Maize Grain Marketers	2	2	10	10	22
Fresh Cassava Tuber Marketers	10	10	5	5	30
Feed Millers	6				6
Cassava Starch Processors	15				15
TOTAL					903

TBD - To be determined in consultation with State Agric Development Programme

Estimate of the number of pages of questionnaires to be reproduced

State	**Total**	Number of pages per Questionnaire	Number of pages to be photocopied
Local Government Area			
Maize farmers	400	14	5600
Cassava Farmers	400	14	5600
Gaari Processors	30	4	120
Maize Grain Marketers	22	4	88
Fresh Cassava Tuber Marketers	30	4	120
Feed Millers	6	4	24
Cassava Starch Processors	15	4	60
TOTAL	903		11,612

Budget Estimate for Questionnaire Administration

Item of Expenses	State		Total
	Ondo	Kaduna	
Stipend for Enumerators @ N3,000 per enumerator for 25 enumerators per state	75,000	75,000	150,000
Transportation for enumerators @ N3,000 per enumerator for 25 enumerators per state	75,000	75,000	150,000
Stipend for Supervisors @ N5,000 per supervisor for 2 supervisors per state	10,000	10,000	20,000
Transportation for supervisors @ N3,000 per supervisors for 2 supervisors per state	6,000	6,000	12,000
Training of enumerators on the questionnaires before field work			-
Rent of venue	5,000	5,000	10,000
Tea Break @ N500 per participants for 30 participants per state	15,000	15,000	30,000
Lunch Break @ N1000 per participants for 30 participants per state	30,000	30,000	60,000
Reproduction of questionnaires - 11,612 pages for all questionnaires and all respondents in the two states @ N10.00 per page			116,120
Data Entry - Lump Sum			100,000
TOTAL			648,120

Notes

Published by
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn,
Germany

Sector project Sustainable Agriculture
Dag-Hammarskjöld-Weg 1-5
65760 Eschborn
Germany
Tel. +49 (0) 6196 79 - 0
Fax +49 (0) 6196 79 - 1115

naren@giz.de
www.giz.de/nachhaltige-landwirtschaft

Author
Dr. Adegboyega Eyitayo Oguntade, Department of Agricultural & Resource Economics,
Federal University of Technology, Akure, Nigeria.

Design and layout
Jeanette Geppert, Frankfurt

Printed by
Top Kopie GmbH, Frankfurt
Printed on FSC-certified paper

Photo credits
Front page © Alida Vanni, istockphoto
Other photos © Dr. Adegboyega Eyitayo Oguntade

As at
June 2013

GIZ is responsible for the content of this publication.

On behalf of
German Federal Ministry for Economic Cooperation
and Development (BMZ);
Division Rural Development, Agriculture and Food Security

Addresses of the BMZ offices
BMZ Bonn
Dahlmannstraße 4
53113 Bonn
Germany
Tel. +49 (0) 228 99 535 - 0
Fax +49 (0) 228 99 535 - 3500

BMZ Berlin
Stresemannstraße 94
10963 Berlin
Germany
Tel. +49 (0) 30 18 535 - 0
Fax +49 (0) 30 18 535 - 2501

poststelle@bmz.bund.de
www.bmz.de