APPLICATION OF HACCP-BASED SYSTEM TO SHEANUT/UNREFINED BUTTER PRODUCTION IN NIGERIA

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Abstract

Poor practices in the production of Shea nuts / butter as well as presence of free fatty acids and aflatoxins have been responsible for its low quality and trade exports from Nigeria. Excessive human contacts with the product, minimal intervention by the government regulatory bodies and lack of documentation of the process further exacerbate the problems. With the assistance of WTO-STDF, a national Sanitary and Phytosanitary (SPS) project was initiated and A HACCP-based study was conducted in the project which was used to examine the extant practices, identify the hazards, critical control points and limits, monitoring and corrective measures and proffer intervention recommendations. Altogether there are sixteen recommended intervention steps with seven in the kernel (Shea nuts) processing and nine in the Shea butter processing stage. The interventions are basically in the areas of good hygiene, good manufacturing practices and process control; there are also some, bordering on good agricultural practices. While machines were introduced to minimise human contact with the product other interventions are based on adoption of improved practices over the existing methods of production.

Keywords: Sanitary and Phytosanitary (SPS), Shea nuts / butter, HACCP, Aflatoxins, Nigeria

Abbreviations:

HACCP - Hazard Analysis Critical Control Point, **FAO/WHO-** Food and Agricultural Organisation/World Health Organisation, **WTO –** World Trade Organisation, **STDF –** Standards and Trade Development Facility, **PAH –** Polycyclic Aromatic Hydrocarbon, **GAP** – Good Agricultural Practice, **GMP –** Good Manufacturing Practices – **SOP –** Standard Operating Procedure, **CCP –** Critical Control Point, **FFA –** Free Fatty Acid

1. INTRODUCTION

Products of Shea tree [*Vitellaira paradoxa*] such as Shea kernels and butter have been used for a long time as food and cosmetics items and articles of trade. In some areas of Nigeria, use of Shea butter as food item goes beyond common usage as vegetable oil but as accompaniments. Lumps of Shea butter are tucked into cereal-flour meals and breakfast cereals for full culinary and health benefits[2]. However, the numerous culinary and health benefits derivable from Shea butter are only known to a few; especially to those residents in the areas of production, which cut across the savannah breadth of the country and known as Shea belt.

While the Nigerians may be losing in the acclaimed benefits of Shea products, the economy is definitely deprived of derivable benefits of Shea products. This is due to massive illegal across-the-border trade in the border towns for example Shaki to neighbouring Republic of Benin.

To counter this challenge, efforts were made to strengthen the national capacity to produce consistently high quality and volume of unrefined Shea butter that meet international standards. Towards this end, a HACCP based approach was employed in studying the value chain of Shea butter production in Nigeria to address challenges of safety and quality of the product for the purpose of trade promotion in the international market and creating more awareness on safe practices internally. This study spans a period of two to three years and involves collaboration with various groups, stakeholders, layers of government and regulatory bodies. It also demands a paradigm shift from existing way of doing things; encouraging formation of strong rural association of women producers, buyers and local end users; and focussing attention of inspectors to safety and quality issues. The study was a sub-component part of WTO-STDF sponsored project – SPS Project 172.

HACCP is one of the food safety management systems, which has its origin in the US space programme but has been adopted into the management of hazards in the high risk food categories, most especially. However, for its adoption into various segments of food production because of its proven usefulness and to prevent neglect due to high cost of implementation and cumbersomeness, the FAO/WHO Joint Food Standards Programme has recommended and encouraged the adoption of HACCP-based approaches to non high-risk food components by government[3].

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[2] Report on Fact Finding Trip to Iluwa-Shaki on Existing Practices for the Production of Shea nuts /Butter: A Part of the Activities in the Execution of Component 2 in the WTO-STDF SPS Project 172 by Adegboye A.O., Akinsanya A. J. and Tumo O.O.

[3] *FAO Food and Nutrition Paper 86: FAO/WHO Guidance to Governments on the Application of HACCP in Small and/or Less-developed Food Businesses*

2. JUSTIFICATION

Arising from the study there were technical and procedural interventions that will ensure that the goals of the project were met. Moreover in order to ensure adoption and taking over ownership of the interventions, it is imperative that the various players in the value chain who had been involved from the inception stages of the project should be guided by series of training. This paper formed the basis for the training of a portion of some of the operators in the Project Intervention Areas. This group of Trainees is made up of Traders, Exporters and Standards Enforcement Officers.

3. METHODS

The HACCP Team[4] comprised of regulatory officers, food establishment inspectors, food scientists and technologists, produce inspection officers, microbiologists, investment advisor and chemists. The team described the Shea kernel and butter and intended uses of the products. Thereafter field trip was carried out to ascertain existing production practices by witnessing production and interviewing the operators. A flowchart was thereafter constructed for the purposes of hazard analysis.

The findings were presented and recommended interventions were made periodically to the HACCP Team for scrutiny and reviewing. HACCP-based flowchart incorporating newly introduced equipment and improved units operation steps was drawn after consultation with equipment manufacturers and extension workers and approval by the HACCP Team. Shortly after installation at Pilot Plants in Selected Production Areas and test running, training was carried out to introduce the areas of project intervention to the selected group.

3.1. Flow Diagrams for Shea kernel /Butter Production

Two sets each of flow diagrams depicting the Shea kernel and butter production processes were developed – a set showing the Shea kernel production before the STDF Project Intervention Figures 1 and 2; and those depicting the production steps incorporating the STDF project’s intervention steps in Figures 3 and 4 for Shea kernel and unrefined Shea butter respectively.

[4] Appendix List of HACCP Team

Fig 1: Shea Kernel Production before the STDF Project Intervention

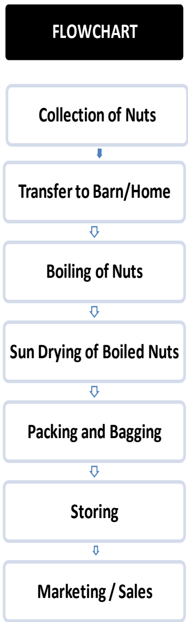
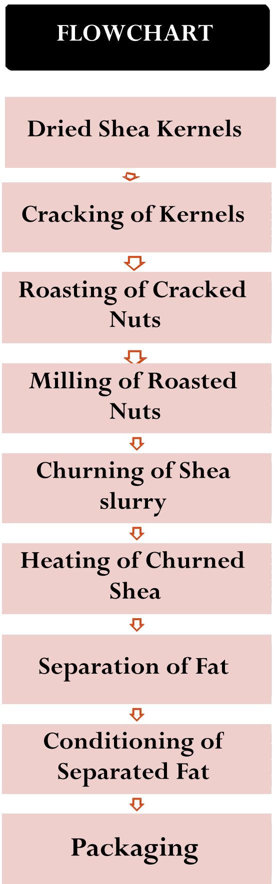


Fig. 2: Shea Butter Production before the STDF Project Intervention



3.2. Hazard Analysis

3.2.1. Shea Kernel:

The Shea tree is known to grow wildly, it is not planted and the task of fruit collection and processing is left to the women by the men folk. Therefore the hazards identified with the processing of Sheanut/butter are somehow related to the two aforementioned factors. The hazards include physical, biological and chemical hazards.

The wild cultivation of Shea tree resulted in the non ownership of the tree and the resulting lack of care. Thus its surrounding is expectedly untended and bushy. The fruits attract both man and animals especially snakes that are attracted by its flavour. This poses a problem at the point of picking by the collectors who stands the risk of snake bites[5]. Apart from this physical hazard there could be biological hazard introduced by handlers and these could include the natural flora on the human body and others from poor personal hygiene and unsafe water sources.

Furthermore for each of the Unit process identified in Figure 1 and those recommended from the project intervention in Figure 3, the identified hazards with their sources of contamination and issues of concerns are enumerated in Figure 4. Identified possible physical hazards apart from snake venoms include contamination with animal dropping and virus from wild rodents. Also it may include contamination from the environment during drying which may be dusts, tree twigs, etc. Chemical hazards may include aflatoxins as metabolites of fungi, residues of pesticides and fertilizers from used bags, polycyclic aromatic hydrocarbons (PAHs) arising from smoke deposition and possible presence of high levels of heavy metals from inherent chemical properties of the kernel.

[5] Overview of the Intervention of PROMER in Shea Sector in the Department de Kedougou, Senegal Amadou Souare

Fig. 3: Project's Intervention Flowchart for Shea Kernel Production

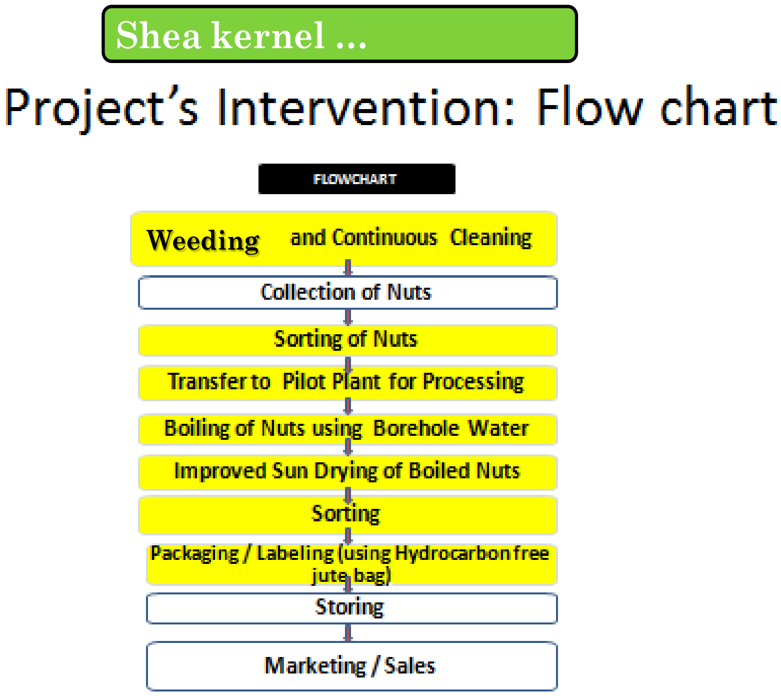


Fig. 4: Tabulated Hazard Analysis for Shea kernel

Hazard Analysis for Shea kernel

FLOWCHART	TYPE OF HAZARD	SOURCE	ISSUE OF CONCERN	CONTROL
LAND CLEARING AND CONTINUOUS CLEANING	Physical, Biological	Snakes, Rodents, Games	Contamination with Snake venom, droppings and Virus	GAP
COLLECTION OF NUTS	Biological, Chemical	Handlers	Contamination with Mould; Mycotoxins	GAP/GHP
SORTING OF NUTS	Biological, Chemical	Handlers	Contamination with moulds (Survival upon Multiplication)	GHP/GMP
TRANSFER TO PILOT PLANT & IMMEDIATE PROCESSING	Biological, Chemical	Chemicals residues in Bags	chemicals	GHP/GMP
BOILING OF NUTS	Biological, Chemical	Water, Smoke	Survival of Moulds ; PAHs	Process Control
IMPROVED SUN DRYING	Physical	Environment and Equipment	Iron chippings	GMP
SORTING	Biological Chemical	Handlers	Recontamination by Mould	GMP
PACKAGING INCLUDING LABELLING	Physical Chemical Biological	Handlers, Chemical residues in bags,	Dirts, Odours	GMP
STORING	Biological Chemical	Environment	Moisture, Rodents, Sun and Heat, Pests; PAHs	GMP
MARKETING / SALES				

3.2.2. Unrefined Shea butter:

While the dried nuts if properly processed have been known to store for up to 3 years, the processing of Shea kernels to unrefined Shea butter also comes with its own hazards. The identified hazards based on the production flowchart Fig 2 and the Project’s Intervention Flowchart for Shea butter (Fig 5) are shown in Fig 6.

The identified hazards are similar to that of kernel especially in the biological hazards. The possible chemical hazards are now more pronounced because of processing by machines and depositon of PAHs through contaminations by smoking, rancidity from greater surface areas exposure of butter to air and sunlight from poor storage. While some of these might not be safety issues, they play a vital role in the final quality of the product; and are considered since safety and quality are the focus areas of the STDF Project.

Fig. 5 Project's Intervention Flowchart for Shea butter

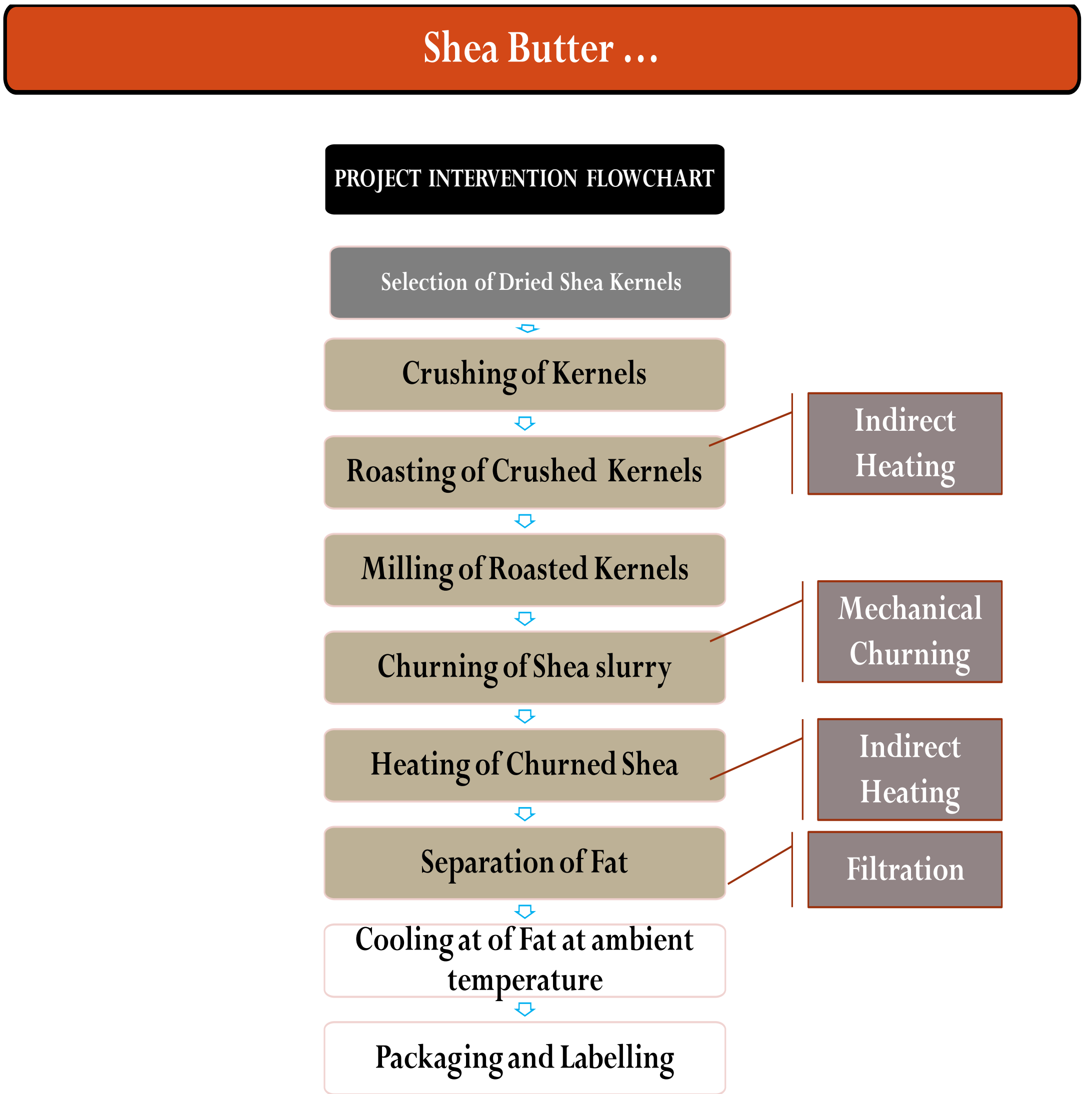


Fig. 6: Tabulated Hazard Analysis for Shea butter

Hazard Analysis for Shea butter

FLOWCHART	TYPE OF HAZARD	SOURCE	ISSUE OF CONCERN	CONTROL POINT
Selection of Dried Kernels	Physical, Biological	Handlers	Contamination with microbes	GHP
Crushing of Kernels	Biological, Mechanical	Crushing Machine and Handlers	Contamination with Fungi; lubricants, metals	GHP & GMP
Roasting at 120°C for 1h 45min	Chemical	Heat	Contamination with metals, PAH	Process Control
Milling of Roasted Kernels	Biological, Physical	Milling machine	Contamination with left over, metals, oils	GHP & GMP
Churning powdered shea into Slurry	Biological, Chemical	Handlers, Water	Contamination with microbes, sweat, chemicals	GHP & GMP
Heating of slurry at 105°C for 1h	Physical, Chemical and Biological	Heat	Contamination with PAH	Process Control
Separation & Filtration of Fat	Physical & Biological	Filter, Handlers, Container	Odour, Colour, Contamination with Chemicals, Microbes	GHP & Process Control
Cooling of Fat at ambient temperature to form fat	Physical, Biological	Handlers, Environment	Sweat, Dirt, Contamination with Chemicals, Microbes	GHP
Packaging and Labelling	Biological, Chemical	Handlers, Environment, packaging material	Moisture, rancidity, pesticide, infestation	GMP

Notes on Intervention Steps

Altogether there are sixteen recommended intervention steps with seven in the kernel processing and nine in the butter processing stage. The interventions are basically in the areas of good hygiene, good manufacturing practices and process control; while some border on good agricultural practices. Machines were introduced to minimise human contact with the product and other interventions were based on adoption of improved practices over the existing methods of production. Listed in the table below (Fig. 7) are the intervention steps, justification and recommended medium.

Figure 7: Justifications for Recommended Project Intervention Steps

s/n	Product	Unit Process	Project Intervention	Justification	Medium of Intervention
1	Shea Kernel	Farming	Weeding and Continuous Clearing	Need to minimise risk of snake bites and microbial contamination	Farmers Guide
2		Sorting	Introduction of Sorting of Fruits	Non existence	Guide or SOP
3		Transfer for Processing	Timely Transfer	To prevent /minimise biochemical changes leading to FFA	Farmers Guide or SOP
4		Boiling	Use of Clean Water for Processing	To minimise microbial contamination	Sinking of Borehole
5		Sun drying	Introduction of Improved Sun dryer	To improve rate of drying, prevent contamination and re wetting	Provision of Improved Sun Dryer
6		Sorting	Introduction of Sorting of Dried Kernels	To introduce grading and remove infested kernels	SOP
7		Packaging and Labelling	Introduction of Jute bags for packaging and Introduction of Labels	To prevent infestation, promote aeration and improve traceability	SOP
8	Shea butter	Selection	Raw Material Specification and Check	To ensure consistency in high quality production	SOP
9		Crushing	Introduction of Stainless steel plated crusher	To reduce incidences of heavy metal introduction and heat generation	Provision of equipment

s/n	Product	Unit Process	Project Intervention	Justification	Medium of Intervention
10		Roasting	Introduction of Indirect Heating	To reduce incidences of smoke deposition	Provision of Roaster
11		Milling	Introduction of Stainless Steel plated Milling machine	To reduce incidences of heavy metal introduction and heat generation	Provision of Equipment
12		Churning	Introduction of Stainless steel plated Churner	To reduce microbial contamination by eliminating human contact	Provision of Equipment
13		Heating	Introduction of stainless steel plated indirect Heater	To remove all non butter impurities.	Provision of equipment
14		Separation	Introduction of series of machines	To separate, clarify and dehydrate the butter	Provision of clarifier, butter washing machine and dehydrator
15		Cooling	Conditioned environment for cooling	To prevent odour absorption and encourage rapid smooth solidification of butter	SOP
16		Packaging and Labelling	Use of regulatory approved packaging materials and mandatory labelling information	To ensure consistent production of high quality product.	SOP

3.3. Identified Critical Control Points, Establishing Limits, Monitoring Systems and Corrective Actions

Critical Control Point is defined as a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level. Strictly, identifying critical control points is a function of ensuring safety in process control. Four and three of such points were identified for Shea kernel and Shea butter value chains respectively. For Shea kernels the critical control points as shown in figure 8, include the following: Sorting of Nuts, Boiling, Sun drying and Sorting of Dried nuts; and for Shea butter the points include Roasting, Heating and, Extraction and Filtration (Figure 9). While some of these identified points may be addressed by good hygienic and/or manufacturing practices but since the focus of the project is both safety and quality they are all considered.

Critical Limit is the maximum and/or minimum value to which a biological, chemical or physical parameter must be controlled at a CCP to prevent, eliminate or reduce to an acceptable level the occurrence of a food safety hazard. The tolerance for moldy nuts is 2% with adequate drying; good handling maintain low moisture content at later stages ensures 4% (max) aflatoxin content[6] ; records for parboiling reflects that the best quality both in appearance and low free fatty acid is obtained with constant stirring during parboiling for 20 to 30 minutes[7]. The average temperature of 35^{o}C for sun drying at elevated position for 11 days has been found to give best drying. Sorting of dried kernel at this stage is very critical to prevent or minimize consequent aflatoxins development from moldy kernels.

[6] African Standard for Shea Kernel

[7] The effect of Traditional Primary Processing of the Shea Fruit in the Kernel Butter Yield and Quality. P.C. Aculey, S.T. Lowor, W.O. Kumi and M. K. Assuah

Fig. 8: Critical Control Points, Limits and Corrective Actions for Dried Shea kernel Production

CRITICAL CONTROL POINTS, CRITICAL LIMITS, MONITORING SYSTEMS AND CORRECTIVE ACTIONS

FLOWCHART	CRITICAL CONTROL POINT	ESTABLISH CRITICAL LIMITS	MONITORING SYSTEMS	CORRECTIVE ACTION
LAND CLEARING AND CONTINUOUS CLEANING				
COLLECTION OF NUTS				
SORTING OF NUTS	Sorting of Nuts	% Mouldy Nuts	Visual Sighting	Reject and Destroy Mouldy Nuts
TRANSFER TO PILOT PLANT & IMMEDIATE PROCESSING				
BOILING OF NUTS	Boiling of Nuts	T°C; Boiling Time	Temperature, Duration	Reduce or Increase Temp and/or Time
IMPROVED SUN DRYING	Improved Sun Drying	Ambient Temp T°C; Air Current, Drying Time	Temperature, Duration	Control the Exposure to Sun heat/Air current/Time
SORTING	Sorting	% Mouldy Nuts	Visual Sighting	Reject and Destroy Mouldy Nuts
PACKAGING INCLUDING LABELLING				
STORING				
MARKETING / SALES				

The identified three critical control points for unrefined butter namely roasting, heating and separation of fat by filtrations have the critical limits shown in Figure 9 under the critical limits column. For roasting, a temperature of 120°C for a duration of 1 hour and 45minutes; for heating a temperature of 105°C for I hour were identified. Proper separation of fats and dehydrating the resultant butter is important to reducing moisture and probability of recontamination and rancidity.

The various monitoring systems and required corrective measures include: carrying out on batch basis, visual examination for percentage mould and rejecting the batches that fail; for boiling, monitoring the temperature and the duration which could be corrected by either reducing or increasing the heat and /or duration; sun drying will require monitoring of ambient temperature, air current and the corrective measure will be reduction/increase of time or degree of exposure; for roasting and heating systems measures used for controlling boiling will also suffice; while for separation and filtration, recording flow time and clogging of filter materials will serve for monitoring and replacement or cleaning of filter for corrective measures.

Fig. 9: Critical Control Points, Limits and Corrective Actions for Sheabutter Production

Critical control points, Critical limits, Monitoring systems and Corrective actions

FLOWCHART	CRITICAL CONTROL POINT	ESTABLISHED CRITICAL LIMITS	MONITORING SYSTEMS	CORRECTIVE ACTIONS
Selection of Dried Kernels				
Crushing of Kernels				
Roasting	Roasting	At $120^{\circ}C$ for 1h 45min	Temperature Recordings at Intervals	Reduce Temperature and / or Time
Milling of Roasted Kernels				
Churning powdered shea into Slurry				
Heating of slurry	Heating	At $105^{\circ}C$ for 1h	Temperature Recording at Intervals	Reduce Temperature and/or Time
Separation & Filtration of Fat	Extraction and Filtration	Portable Water and Right Pore sized Muslin	Water Quality Tests / Rate of Filteration	Use Portable Water/ Clean or Replace Filter
Cooling of Fat at ambient temperature to form fat				
Packaging and Labelling				

3.4. Verification and Documentation:

The production system will be verified by constant inspection and applying necessary modifications until the processing lines stabilize. At each of the unit processing step, required documentation have been identified and they include: % mouldy rejects; record of receipt – name, source, date, quantity, etc; ^{O}T and Time in minutes, hours or days; quantity released to store and also laboratory results on samples of production in respect of moisture content, heavy metals, aflatoxins and FFAs .

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