# Diagnosis of practices and equipment used in the transformation of cassava into attiéké in Banfora, Bobo Dioulasso and Ouagadougou


## ABSTRACT

Cassava is a perishable commodity with a shelf life of less than 3 days after harvest. The general objective of our study is to take stock of the practices and equipment used in the processing of cassava into attiéké. This will subsequently allow us to optimize the operating energy of a mechanized cassava into attiéké processing unit. To do this, a diagnosis was made through a field survey of local processing companies(add total number) in the cities of Banfora, Bobo Dioulasso and Ouagadougou.
The results made it possible to list the equipment used at each stage of processing and their methods of use (manual or mechanized). It appears that in most companies, processing equipment(list the main equipment)is mainly manual. The inventory of equipment used in cassava processing units in Banfora, Bobo Dioulasso and Ouagadougou showed that graters/crushers are the only motorized equipment used in these units. It is therefore essential to mechanize cassava processing equipment into attiéké as far as possible in order to reduce the arduousness of the work.



*Keywords: diagnosis, equipment, processing, cassava, attiéké.*


## 1. INTRODUCTION

According to the Food and Agriculture Organization of the United Nations (FAO), Africa is the continent hardest hit by food insecurity. Indeed, one in five people in Africa, or 20.2% of the population was suffering from hunger in 2021 [1].
Burkina Faso, a Sahelian and essentially agricultural country, faces the permanent challenge of sustainable food security for its population. Agriculture employs nearly 86% of the population. In other words, the vast majority of its population derives most of its income from agriculture, which represents 40% of the Gross Domestic Product (GDP). The interventions of the Burkinabe Government in the agricultural sector have made it possible to record progress, in particular, an average increase in cereal production of 2% per year over the period 2011-2015 and a reduction in the incidence of poverty in rural areas which fell from 52.8% in 2009 to 47.5% in 2014 [2].
Cassava is a perishable commodity with a shelf life of less than 3 days after harvest. Processing is an alternative and a way to obtain products with a long shelf life, thus reducing post-harvest losses. Flours made from cassava tubers are widely consumed in West Africa. Thus, several dishes such as (foutou, attiéké, placali, gari, flour, bread and starch) have been developed based on these tubers [3].People in some West Africa countrieshave quickly realized the need of transforming cassava in its derivate byproducts whose value added is generally higher than the fresh roots [4]. Fortified with cereal flours, they are used in the complementary feeding of infants over six months and malnourished children [5].
However, the processing of tubers such as cassava is carried out in the traditional way using knives, machetes, mortars and other tools.
The importance of post-harvest mechanization in the sector is essential because it helps to reduce the burden on women. Processing involves many difficulties in terms of the arduousness of the work and the lack of optimized and standardized equipment [6].
The objective of this work is to take stock of the practices and equipment used in cassava processing units into attiéké in three cities in Burkina Faso, namely Banfora, Bobo Dioulasso and Ouagadougou.

## 2. MATERIAL AND METHODS

### 2.1. Study areas

The study was conducted in the cities of Banfora, Bobo Dioulasso and Ouagadougou. The first two cities have a strong potential in the production and processing of cassava [7]. Ouagadougou is a developing city in the field of cassava processing. The aim of this study was to take stock of the practices and equipment used in cassava processing units into attiéké. It was mainly a question of knowing the equipment used as well as their technical characteristics, the breakdowns related to their use and the processing diagrams.

Our study focused on 20 processing units selected on the basis of the products manufactured and their geographical area. Figure 1 shows the mapping of the study areas.

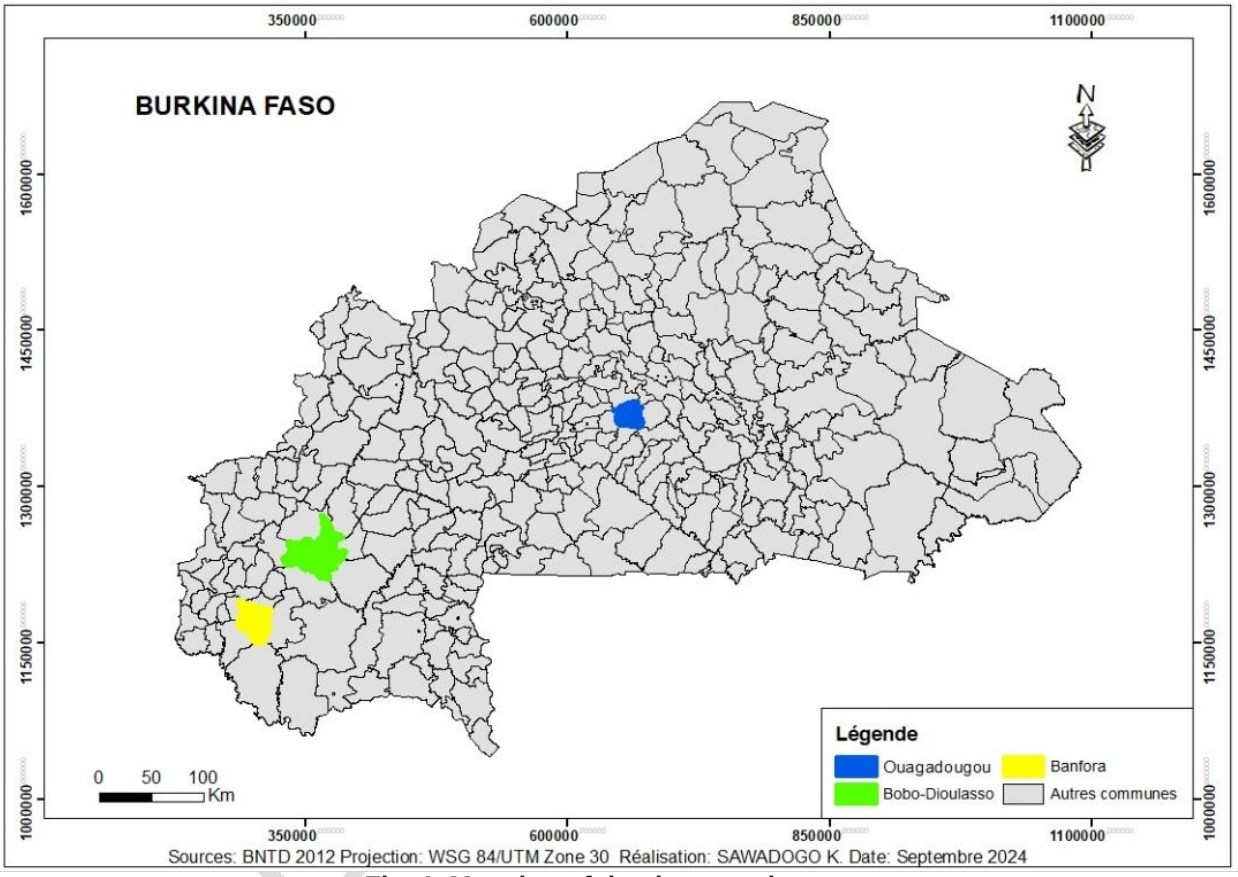


**Fig. 1. Mapping of the three study areas**

Table 1 shows the processing units surveyed by city.

**Table 1. List of units surveyed by city**

| Code | Name of the structure | City | Year of creation |
|---|---|---|---|
| 1 | Sababougnouma | Banfora | 2005 |
| 2 | Moussodjigui | Banfora | 2006 |
| 3 | Christ Mar | Banfora | anonymity |
| 4 | Allah Kan Dêmê | Banfora | 2013 |
| 5 | Hope group | Bobo Dioulasso | 2020 |
| 6 | anonymity | Bobo Dioulasso | 2015 |
| 7 | anonymity | Bobo Dioulasso | 2021 |

| | | | |
|---|---|---|---|
| 8 | anonymity | Bobo Dioulasso | 2022 |
| 9 | anonymity | Bobo Dioulasso | 2003 |
| 10 | anonymity | Bobo Dioulasso | 2009 |
| 11 | anonymity | Bobo Dioulasso | 2018 |
| 12 | Attiéké of the future | Ouagadougou | 2008 |
| 13 | WendPanga | Ouagadougou | 2009 |
| 14 | Faso Attiéké | Ouagadougou | 2010 |
| 15 | WendKonta | Ouagadougou | 2008 |
| 16 | Agro-fishprocessing unit | Ouagadougou | 2019 |
| 17 | WendPanga | Ouagadougou | 2022 |
| 18 | anonymity | Ouagadougou | 2011 |
| 19 | NanAlim | Ouagadougou | 2004 |
| 20 | Faso unity | Ouagadougou | 2007 |

### 2.2. Data collection

For data collection we developed a survey sheet comprising 87 questions divided into 14 parameters which are:

Presentation of the cassava processing unit;
- peeling ;
- washing ;
- grinding/grating ;
- fermentation;
- pressing ;
- seing;
- drying;
- cooking;
- energy availability;
- mass yield;
- economiccost;
- frequency of breakdowns;
- the nature of the breakdowns.

The questions are either closed or open depending on the objective. Data collection was done through exchanges in French, Moré or Dioula. some questions didn't get answersbecause of their confidentialy nature, insufficient information or difficulty in someparameter'squantification.

The survey was conducted between the 8$^{th}$ and 14$^{th}$of May 2023. Data processing was carried out using Sphinx Plus V5 and Excel software, which made it possible to produce descriptive statistics for the study sample.

## 3. RESULTS AND DISCUSSION

### 3.1. Information on the 20 transformation units

- 11 units are individual and 09 are groups;
- 15 units are traditional and 05 are semi-industrial;
- 05 units have a production/transformation diagram ;
- 09 units have a staff of more than 10;
- 11 units have a daily attiéké production of more than 50 kg.

Table 2 shows the literacy levels of staff in each unit.

**Table 2. Literacy level of staff in each unit**

| **Literacy level** | **Weak** | **Average** | **high** |
|---|---|---|---|
| **Number of units** | 10 | 6 | 3 |

Table 2 shows that more than half of the units have staff with low literacy levels. One processing unit did not provide a response to this question.

Table 3 presents cassava-derived products by number of processing units.

**Table 3. Cassava-derived products by number of processing units**

| **Derivatives** | **Attiéké** | **Gari** | **Tapioca** | **Placali** | **Starch** | **Flour** |
|---|---|---|---|---|---|---|
| **Number of units** | 20 | 6 | 6 | 8 | 10 | 7 |

Among the food substances, cassava root (Manihot esculenta Crantz) is one of the most important food products by the volume of its production and its consumption in Africa, Europe and Asia[8]. Cassava root is shortly preserved after harvesting due to its tanning and rapid physiological decomposition [9].It is also employed for animal feed. Several derived products of cassava are marketed, of which the most known are: “gari”, “Attiéké”, “cossette”, starch, “tapioca”, “fufu”, rough flour, cassava pulp [10]. In West Africa, cassava root is used mainly in human food in various artisanal and industrial forms. It is also used for livestock feed. Several cassava-derived products (see Table 3) are marketed in Burkina Faso. Table 3 clearly shows that all processing companies produce attiéké.
Table 4 shows the number of processing units by type of attiéké produced.

**Table 4. Types of attiéké produced in the processing units**

| Types of attiéké | Abodjama | Garba | Normal |
|---|---|---|---|
| Number of units | 18 | 13 | 14 |

Table 4 shows that Abodjama attiéké is the most produced by almost all processing units, i.e. 18 out of 20 units.
Figure 2 shows the Abodjama attiéké produced in a processing unit in Ouagadougou.

**Fig. 2. Abodjama Attiéké produced in a processing unit in Ouagadougou**

In Figure 2, each ball of attiéké has a mass of 1 kilogram and costs 1000 CFA francs on the market in Ouagadougou.
Referring to the country of origin of attiéké production which is Ivory Coast, three varieties are generally produced. These are abodjama, garba and normal attiéké.

- Abodjama (high-quality attiéké) is prepared by calibrating the grains through increasingly fine-mesh sieves to produce batches with grains of uniform diameter: abodjama small grain, medium grain, or large grain. These sieving steps allow residual fibers to be eliminated again. Cooking takes longer than for the other two varieties.
- Garba is considered a lower quality attiéké which, not having been sieved before cooking, retains more of the central fibers of the root.
- Normal attiéké is the product of a series of unit operations based on standard production steps.

According to one author, the most requested attiéké is the abodjama type at 48%, the normal type at 37% and the garba type at 15% [11].

### 3.2. Attiéké production diagrams in the units

The diagnosis made it possible to determine the production diagrams of attiéké on the one hand from cassava roots (figure 3) and on the other hand from cassava paste (figure 4). These diagrams summarize the stages of attiéké production in all the units surveyed.

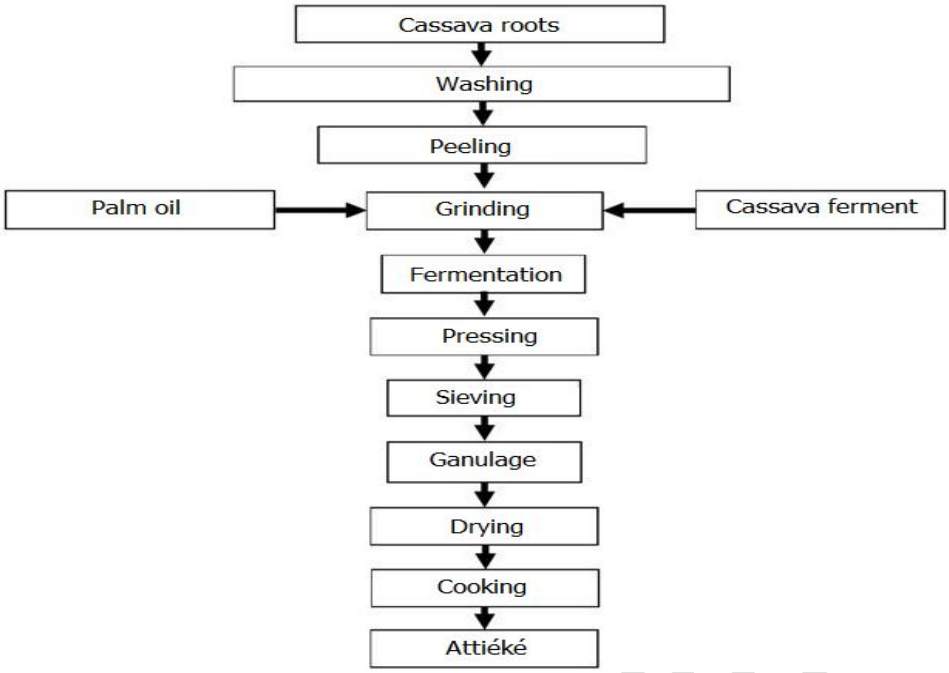


**Fig. 3. Production diagram of attiéké from cassava roots**

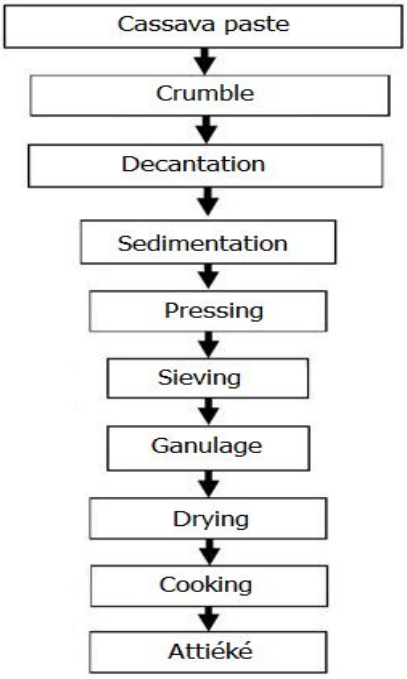


**Fig. 4. Production diagram of attiéké from cassava paste**

These production diagrams of the diagnosed transformation units are in agreement with those in the literature [6].

### 3.3. Peeling

In all processing units, peeling is done manually using knives. There is no mechanized equipment for this activity. Out of all 20 units, we note that seven (07) units peel more than 100 kg of cassava per day. Peeling consists of removing the outer shell of the cassava tuber. This outer shell, yellow, brown or reddish, thin, of a corky nature, is rejected because of its higher content of cyanogenic glucosides and fibers.

### 3.4. Washing

Almost all units use plastic and metal basins for washing. Nine (09) units wash more than 100 kg of cassava per day. Figure 5 shows basins and buckets used for washing cassava roots in a processing unit in Banfora.

**Fig. 5. Basins and buckets used for washing cassava roots at Banfora**

Fresh peeled cassava roots are washed several times. During this step, producers remove all visible impurities from the peeled root to preserve the color of the finished product.

### 3.5. Grinding

The inventory of equipment used in cassava processing units in Banfora, Bobo Dioulasso and Ouagadougou shows that graters/crushers are the only motorized equipment. We have listed five (05) of them whose technical characteristics are given in Table 5.

**Table 5. Technical characteristics of the graters/grinders used**

| City | Name of the structure | Type of equipment | Type of engine used | Driving power (kW) | productivity (tons/hour) |
|---|---|---|---|---|---|
| **Banfora** | Sababou gnouma | graters / grinders | thermal | 8.5 | 0.5 |
| **Banfora** | Moussodjigui | graters / grinders | thermal | 8.5 | 0.5 |
| **Banfora** | Christ Mar | graters / grinders | thermal | 9.5 | 0.25 |
| **Banfora** | Allah Kan Dêmê | graters / grinders | thermal | 7.35 | 0.5 |
| **Ouagadougou** | Faso Attiéké | graters / grinders | thermal | 7 | 2 |

The processing units that do not have graters/grinders proceed by subcontracting to carry out this activity. We also noted that 10 units carry out grinding of more than 500 kg of cassava for 2 hours per day.

The analysis of the results of the technical characteristics of the graters/grinders in Table 5 allowed us to obtain Figure 6.

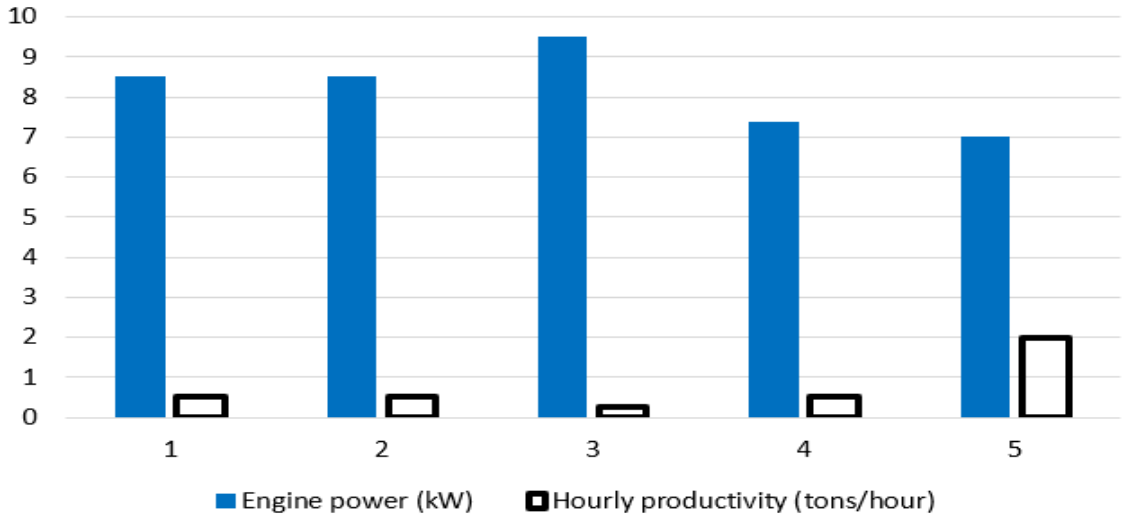


**Fig. 6. evolution of productivity as a function of engine power**

Figure 6 shows the disproportions between the driving powers and the hourly productivities of the graters/grinders. It appears that there are graters/grinders with low driving powers that have their hourly productivity greater than or equal to that of graters/grinders with high powers. This therefore leads to high production costs and losses linked to the oversizing of this equipment.

### 3.6. Fermentation

Fermentation equipment is basically done in basins and bags.The fermentation time of the dough varies from one producer to another and is 12 to 15 hours on average. The producer estimates the quality of this fermentation by touch and can then decide to stop this step to move on to pressing. According to the producers unanimously, the ferment makes the dough light, making it suitable for transformation into grains. The fermentation technique does not differ according to the types of attiéké. This step is carried out in a large, well-covered basin or in well-closed bags. Fermentation is a process that takes place in an anaerobic environment and therefore does not require oxygen.

### 3.7. Pressing

Fifteen (15) units have manual hydraulic presses and (05) units have screw presses. Half of the units count more than 500 kg of pressed pastes per day. Pressing the fermented paste contained in a nylon bag eliminates excess water and facilitates granulation. Producers, with experience, know the appropriate humidity level. In this case too, producers decide by checking by touch if the pressing is correct. Figure 7 shows manual presses (screw and hydraulic) used in processing units in Banfora and Ouagadougou.

a. Screw press (Banfora) b. Hydraulic press (Ouagadougou)

**Fig. 7. Presses used in processing units in Banfora and Ouagadougou**

The difference between these two presses is in the hydraulic jack. The latter creates pressure by circulating oil in two cylinders via the pump piston. With a hydraulic press, the operator exerts less effort to press the dough.

Depending on the daily quantities of cassava roots used by the producers, the pressing time varies from one hour to three hours. This step also depends on the cassava variety. To save time, some producers combine the fermentation (after about two to eight hours of fermentation) and pressing stages. During this pressing stage, the water that is eliminated drains with it all the soluble residues (excess starch, cyanide, mineral substances, etc.).

### 3.8. Sieving

Almost all units have wooden and stainless-steel sieves of all sizes (small, medium and large mesh). Eight (08) units process more than 500 kg of sieved pasta per day. Figure 8 shows examples of sieves used in the processing units in Ouagadougou.

a. Large mesh sieve b. Small mesh sieve

**Fig. 8. Sieves used in processing units in Ouagadougou**

After pressing, the fermented dough is taken into a ball and then passed through a first sieve to eliminate the first impurities and obtain the semolina (lumping) which will be used to make the grains. This sieve has the largest meshes (4

to 5 mm). Then a second sieve with smaller meshes (1.5 to 2 mm) is used to have a cleaner and finer flour. With different sieves, the producer obtains the size of the grains she wants.

### 3.9. Drying

Seventeen (17) units use tarpaulins, mats and trays. Four (04) units use solar and gas dryers. Five (05) units have fans (for example in Ouagadougou, Faso Attiéké and NanAlim use fans for 5 hours per day). Figure 9 shows examples of dryers used in a processing unit in Ouagadougou.

a. Hybrid dryer (solar and gas)

b. Air drying on a stepped table

**Fig. 9.Dryers used in processing units in Ouagadougou**

The hybrid dryer is made of glazing allowing solar drying of cassava flour during the day. During the night, the process can continue thanks to the butane gas supply. Drying serves to harden the grain and reduce the amount of water so as to maintain a certain humidity in the finished product after cooking. The grains are dried in the sun on large plastic sheets (or more frequent tarpaulins). The quality of drying is assessed by eye. Depending on the intensity of the solar radiation, the grains remain on average 30 minutes in the sun.

The drying supports are varied (table or stool) to comply with hygiene measures.

### 3.10. Cooking

Table 6 shows the types of hearthsused for cooking attiéké.

**Table 6. Types of cooking hearthused**

| **Types of cooking hearth** | Wood burning hearth (three feet) | Wood burning hearth (improved) | Charcoal hearth | Gas hearth |
|---|---|---|---|---|
| **Number of units** | 8 | 3 | 3 | 15 |

Seven (07) units produce more than 500 kg of attiéké per day. Butane gas is much more widely used due to its affordable cost, ease of use and its influence on the quality of attiéké. Figure 10 shows an example of a gas stove used for cooking in a processing unit in Ouagadougou.

a. Connectinggasbottles

b. Hearth connected to a gas bottle

**Fig. 10.** Butane gas stoves used for cooking attiéké in Ouagadougou

Cooking is done by steaming in stainless steel equipment such as a couscoussier. The producer regularly turns or stirs the attiéké using a wooden or stainless-steel spatula in order to expose all the grains to the steam. Cooking lasts about 15 to 30 minutes, the cooked grains are cohesive and take on a slightly translucent appearance. A pleasant slightly fermented odor is released. This odor is quite characteristic of attiéké. However, after cooking over a wood fire, it is observed that the finished product reveals a slight aroma of charcoal. The color (cream, light yellow or beige or off-white) of the attiéké stands out perfectly depending on the variety of cassava and the oil [12].

### 3.11. Nature of breakdowns

The continuous use of mechanical equipment for operations leads to breakdowns when there is no proper maintenance plan. Table 7 presents the breakdowns frequently encountered during the use of equipment.

**Table 7. Nature of breakdowns or faults related to the use of equipment**

| Equipment | Nature of breakdowns or defects |
|---|---|
| Peelers | Brokenknives, dullknives |
| Crushers | Nuts coming out, jamming, bearing breakage, carburetor damage, engine stopping |
| Presses | Broken screws, broken brackets, lack of lubricating oil |
| Sieve | Tears in the mesh, wear on the wood |
| Dryers | Ripping tarpaulins, breaking wood, shedding loads |
| Homes | Unavailability of wood and butane gas, wear and tear on fireplaces, gas leaks |

Producers point out that these breakdowns are frequent. It is therefore necessary to integrate maintenance techniques into the use of processing equipment. This will make it possible toreduce the frequency of breakdowns and consolidate the competitiveness of companies by improving their productivity [13].

There is very little discussion of the results.

**Discussion (insert discussion section)**

- Present the practices and equipment used in processing cassava into attiéké and compare them with those in the literature, then explain the differences or similarities.
- Highlight the specific practices and equipment used in each of the Banfora, Bobodioulasso and Ouagadoudgou regions, showing the advantages and disadvantages;
- Make recommendations for improving practices and equipment used in the processing of cassava into attiéké.

## 4. CONCLUSION

This work allowed us to understand the process of transforming cassava into attiéké. The processing methods are almost identical regardless of the study areas, namely Banfora, Bobo Dioulasso and Ouagadougou. The production diagrams used in the units are in agreement with those in the literature. The results of the diagnosis carried out show the difficulty of this attiéké production activity because all the operations are almost manual. We noted, however, that the only motorized equipment in the units is the grater/grinder. Hence the need to mechanize other processing equipment such as washers, peelers, presses, sieves and dryers.

## CONSENT (WHEREEVER APPLICABLE)

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

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