

BEYOND GRAIN: THE POTENTIAL OF COWPEA IN LOCAL MARKETS OF MALI

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Summary

In addition to being well adapted to the climatic conditions of Mali, cowpea has the potential to meet the needs of consumers who are looking for food products that are nutritious, diverse and easy to prepare. Despite its potential, little research or policy has focused on cowpea and, in particular, its processing and commercialization components. The purpose of this study is to assess the development potential of cowpea beyond grain in local markets in Mali, including: (1) identifying different types of vendors and different types of cowpea products sold; (2) examining the roles of different types of cowpea vendors and their relationships; (3) quantifying the profit margins of different vendors; and (4) discussing constraints and opportunities to develop the cowpea value chain in Mali. To do this, information on cowpea products was collected from 487 vendors in 26 local markets. Our results show that the cowpea value chain in Mali includes several types of vendors in local markets, such as processed product retailers, fresh leaf retailers and fodder retailers in addition to wholesalers, grain collectors and retailers. Women are clearly at the heart of grain processing activities and the marketing of processed products as well as fresh leaves. The marketing of cooked cowpeas offers retailers higher margin rates compared to beignets (fritters) and pancakes. Grain sellers, mostly men, have lower margins, but sell larger quantities. Their activities are therefore more profitable than those of retailers of processed products. Given the great potential of cowpea processing and marketing in Mali, this study recommends that policy makers include cowpea in their policy to support agricultural diversification.

1. Introduction

Demographic and socio-economic changes are transforming agro-food systems in West Africa, including Mali. Population growth is reflected in a growing demand for food products. Urbanization is progressing and bringing with it changes in eating habits. In urban areas, demand for food products that are easy to prepare and consume is on the rise. As incomes grow, consumers are looking for a more diverse and varied diet. Traditional staple foods such as millet and sorghum are gradually being replaced by more expensive and processed products (Smale et al., 2020). In addition to being nutritious and well adapted to the climatic conditions of Mali, cowpea is a food that has the potential to respond well to these socio-economic changes. For example, from 1980-85 to 2005-09, per capita consumption of pulses, including cowpeas, went up by 113% in Mali, indicating that both poor and non-poor households increased their consumption of pulses with as their incomes rose (Hollinger and Staatz, 2015). Despite its potential, cowpea is a food that has received little attention from policy makers and researchers.

The development of the cowpea value chain in Mali could be beneficial to all of its stakeholders, including consumers who are looking for nutritious, affordable and diverse products. The market is the main place of food transactions and at the heart of the cowpea value chain development. Cowpea products sold on markets include grain, fresh leaves and fodder, and processed products derived from cowpea. Despite this, market studies on cowpea in Mali are few and far between. To date, most socio-economic studies on cowpea in Mali have focused on the adoption and dissemination of new technologies, such as improved seed varieties (Kergna and Kébé, 2001; Langyintuo and Lowenberg-DeBoer, 2006; Doumbia et al., 2019) and enhanced storage bags¹ (Dabat et al., 2010; Moussa et al., 2011). Few studies have been carried out on the links in the cowpea value chain beyond production, although any effort to improve productivity is insufficient if processing and marketing are not taken into account (Allen and Heinrigs, 2016). Without the latter, agricultural productivity gains will lead to temporary increases in production and prices that will not benefit producers, thus not allowing for sustained growth (Haggblade & Hazell, 2010).

Previous work on post-production links has included work on consumer preferences for different varieties of cowpea (Langyintuo et al. 2004; Mishili et al., 2009), the determinants and impacts of market information systems on the farm incomes of cowpea producers (Ngom,

¹ For example, the storage bags known as Purdue Improved Cowpea Storage.

2018) and the transmission of prices at the sub-region market level (Sadiq et al., 2018), as well as the characterization of the supply and demand of cowpea in various countries of West Africa: see Témé et al. (1986) and Cissé (2012) for Mali; Wade and Dia (2011) for Senegal; Robinson and al. (2014) for Nigeria. Cowpea grain was the focus of these studies. Studies focused on processed cowpea products are rare. For example, Ibro et al. (2006) examined the factors that influence the success of women entrepreneurs in the sale of beignets (Accras) in Niger. The study found that the experience of these women was a key determinant of their success. Idrissa (2013) also studied the market characteristics of processed cowpea products in several regions of Niger. According to the author, cowpea processing units are poorly equipped, processors do not yet have control over marketing channels and institutions consume a very significant share of processed cowpea products in the regions studied.

Unlike previous work, most of which is more than a decade old and focuses primarily on the grain market, we take a holistic perspective of the processing and marketing links of the cowpea value chain in Mali. This perspective leads us to examine the role of women in the trade of processed products, fresh leaves and fodder.

The aim of this research is to assess the development potential of cowpea, beyond grain, in the local markets of Mali. To achieve this, we: (1) identify the different types of vendors and different types of cowpea products sold on local markets; (2) examine the roles of different types of cowpea vendors and their relationships; (3) quantify the profit margins of different vendors in local markets; and (4), discuss existing constraints and opportunities to development of the cowpea value chain in Mali. Information on cowpea products was collected from 487 sellers in 26 local markets in Mali, including 6 urban or semi-urban markets. They are the sellers of processed products, the sellers of grain, the sellers of fresh leaves and the sellers of fodder.

This study therefore contributes to a limited literature that addresses the processing and marketing of nutritious local products, such as cowpea, which are often overlooked by research and policy makers compared to staple grains. Findings are useful for the development and strengthening of policies and strategies to enhance the value of cowpea production and marketing in Mali, beyond grain.

2. Overview of Cowpea Supply and Demand

With a cowpea cultivated area of over 450,000 hectares, Mali comes in 4th position as a world cowpea grower after Niger, Nigeria, and Burkina Faso (FAOSTAT, 2021). Cowpea is

one of the few cash crops in Mali that is grown almost everywhere in the country. During the decade 2008-2018, the production of cowpeas expanded. From about 120,000 tonnes in 2008, domestic production rose to nearly 260,000 tonnes in 2018, an increase of more than 115% over that decade (FAOSTAT, 2021). However, cowpea production remains marginal in Mali. Mali’s agriculture is dominated by the cultivation of cereals such as rice, millet, sorghum and maize, with an estimated cereal production of nearly 10 million tonnes in 2018; 38 times more than cowpea (FAOSTAT, 2021).

Traditionally, three large cowpea production basins in Mali have been divided among the regions of Ségou, Mopti and Koulikoro. Although the Ségou region is historically known as the largest cowpea production area in Mali, the Koulikoro region took the lead in 2018, with an estimated production of 118,880 tonnes compared to 88,436 tonnes for Ségou. Other regions are far behind with 16,720 tonnes for Kayes, 14,894 tonnes for Sikasso, 13,755 tonnes for Mopti and 5,006 tonnes for other parts of the country.

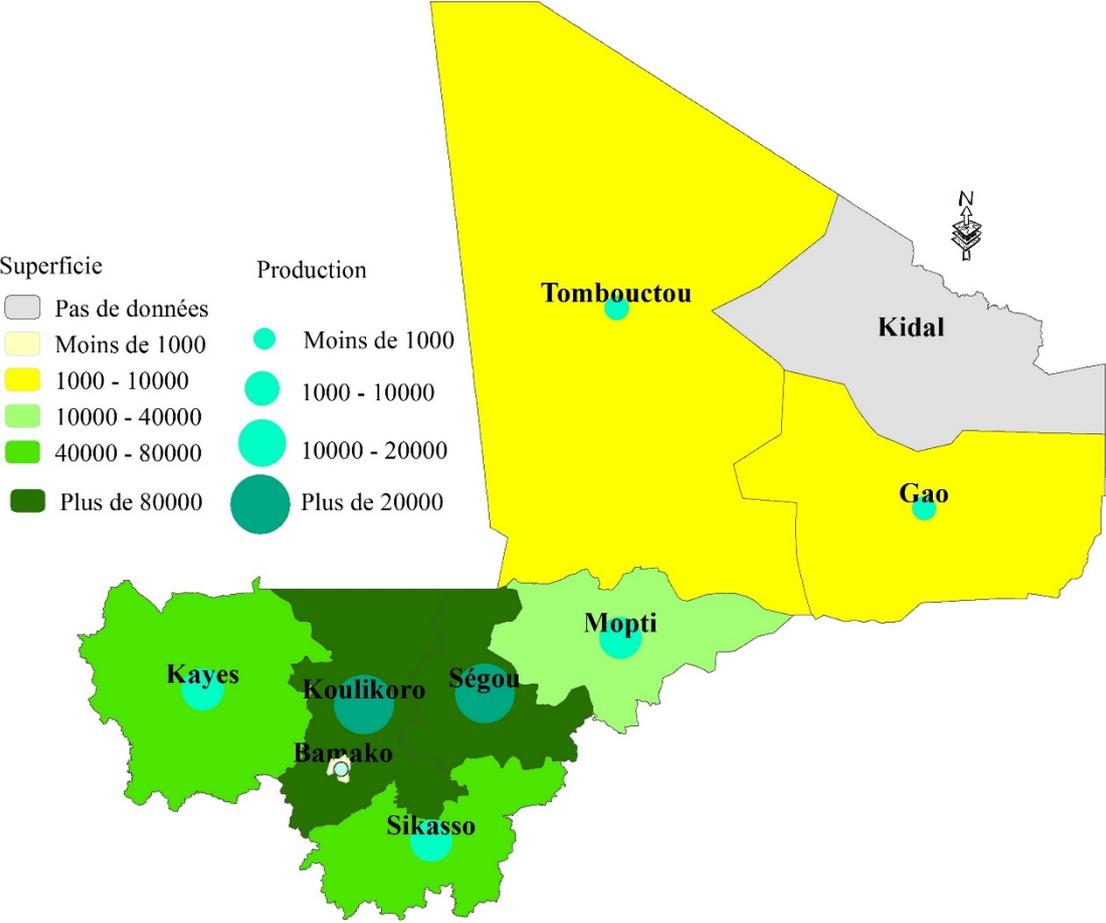


Figure 1. Location of area and production of cowpea in 2018 (map by AK Traoré)

The loss of production in some regions, including the Mopti region, can be explained by the insecurity resulting from armed conflict that significantly disrupted agricultural activities in Mali (FAO, 2020). Farming families lost means of production because of abandoned or inaccessible fields.

Data on cowpea consumption, including grains, processed products, fresh leaves and fodder, are virtually non-existent. As in other West African countries, cowpea is reported to be consumed primarily as grain in Mali (Langyintuo et al., 2003; Mishili et al., 2009) and to have a low level of consumption (Langyintuo et al., 2003; Gómez, 2004; Monyo et al., 2013). Langyintuo et al. (2003) indicated that the average annual consumption of cowpeas (all regions combined) per capita in Mali is 1.5 kg (an estimate for the period 1990-1999). This is quite low compared to more recent estimates in other West African countries, where consumption is reported to be as high as 13 kg/capita/year (CNFA, 2016; Cruz et al., 2019). The consumption of cowpea in Mali also seems insignificant compared to the consumption of the staple cereals such as millet, sorghum and rice, whose average consumption in 2009 per capita is estimated at 114.9 kg, 61.2 kg and 57 kg respectively (Mas Aparisi et al., 2013; Coulibaly and Ouologuem, 2014).

3. The importance of cowpea

In terms of food and nutrition, cowpea is an important staple commodity, particularly during the lean season, as it matures while most major food crops in Mali are in the growing phase (Ferroni and Gabathuler, 2011). Harvested cowpeas can be consumed by households and/or sold to obtain cash for food, agricultural inputs and/or other necessities. Producers place their hopes on cowpea in the event of low rainfall or a late crop year because it generally manages to complete its production cycle under these conditions (Idrissa, 2013). Cowpea also provides quality fodder for livestock feed during the “lean” season preceding the harvest, which coincides with the period of intensive field work and the scarcity of other fodder (Sanogo et al., 2019).

Cowpea is widely recognized as rich in proteins, vitamins and minerals (Walker and Kochhar, 1982) and can play an important role in the diversification of diets in Mali. Its grains, leaves and fresh pods are a valuable source of nutrition for poor populations (Dugje et al., 2009). Given the difficult access of poor consumers to animal proteins, the use of plant-based proteins based on cowpea would contribute to improving nutrition for vulnerable populations

in Mali. For example, cowpea has often been called the “Meat of the Poor” because it is a real substitute for animal meat (Ferroni and Gabathuler, 2011).

In addition to its nutritional content for consumers, from an economic point of view, cowpea occupies a particularly important place in the diversification of income sources of the most vulnerable strata. Dembélé (2015) has shown that the production and marketing of cowpea fodder is a profitable activity that allows women in the village of Sala to diversify their sources of income.

In its agro-climatic dimension, one of the main characteristics of cowpea is its ability to adapt to drought, thanks to its deep roots that can grow far to extract water from the soil. This allows small producers to reduce the effects of rainfall variability and build resilience to climate change. Cowpea is also known for its ability to bind nitrogen to the soil, thus improving soil fertility (Dabat et al., 2012). This reduces the need for mineral fertilizers, which are not affordable for most small producers in Mali. For all these reasons, cowpea is grown most often in association with cereals, and specifically millet and sorghum, in Mali.

Culturally, cowpea is a plant whose consumption brings more “blessing” to the actions of individuals. As a result, prepared cowpea grains are part of the usual household consumption and meal preparation during social ceremonies (baptisms, weddings, funerals, etc.). Despite being consumed by almost all ethnic groups, no group wants to claim it ancestrally because it is associated with poverty. In this context, cowpea appears as an important pillar of “cousinage” (norms of kinship) and a contributor to social cohesion and sense of community.

4. Methods

Cowpea data were collected from a total of 487 cowpea vendors in 26 markets, including 6 urban markets in four regions of Mali (Kayes, Koulikoro, Ségou and Sikasso) and in Bamako, the capital. Figure 2 below shows the markets surveyed and the fair days. The purpose of the field data collection was to acquire information on the characteristics of the markets and those of the sellers and their products.

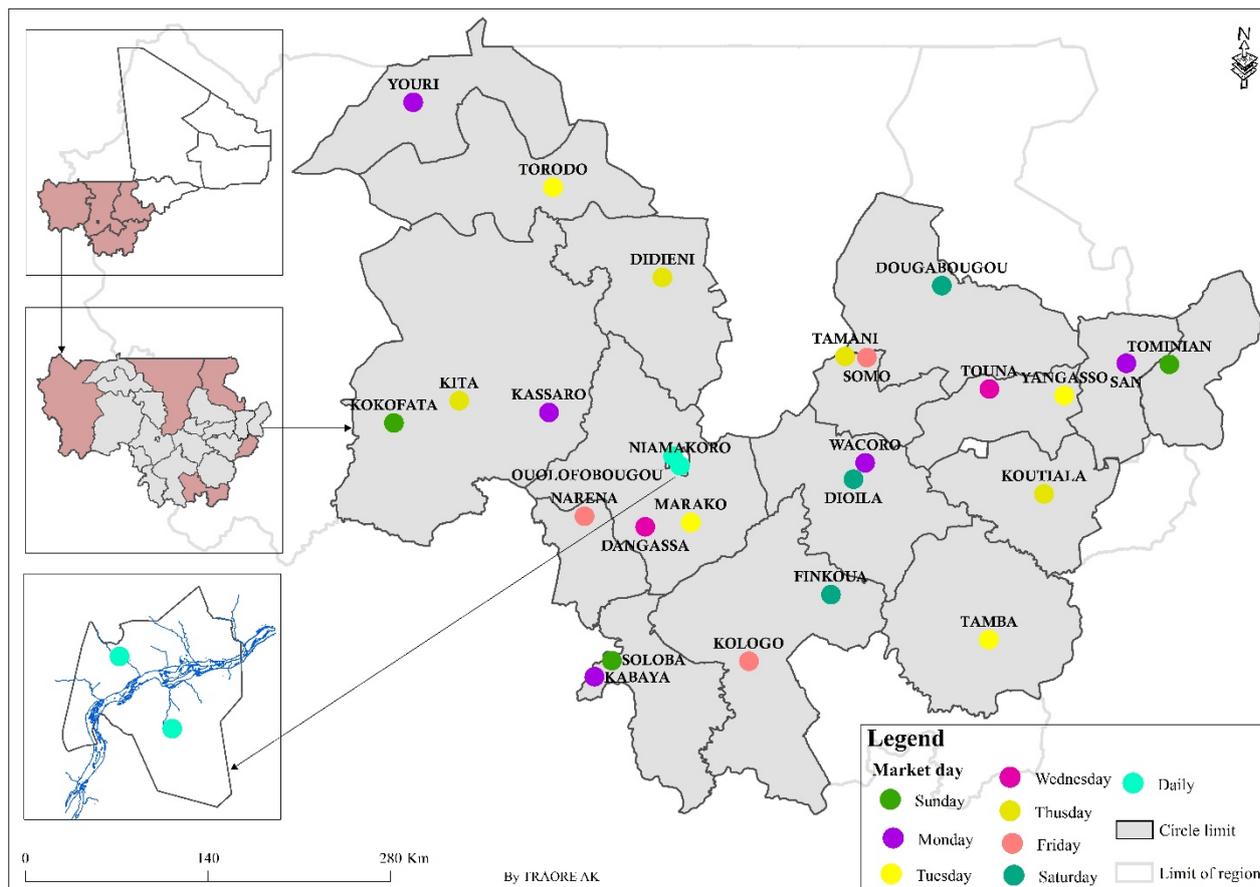


Figure 2. Location of the markets surveyed with their fair day

Questionnaires developed on tablets were pre-tested and revised, and the surveys were conducted primarily in the Bambara language. Questionnaires were administered to sellers in the cowpea value chain, including vendors of processed products, grains, fresh leaves and fodders. Field surveys were conducted during the dry season, between February and March 2021, from 10:00 am to 4:00 pm.

The surveyed markets were selected based on existing secondary data on cowpea production areas in Mali (i.e., CPS-SDR, INSTAT and OMA) and in collaboration with local informants, including Agriculture Services Officers and Chambers of Agriculture. These experts provided information on market presence, the presence of cowpea products, the fair day, and the security situation. A list of markets located in the regions of Kayes, Koulikoro, Sikasso, Segou and the district of Bamako was compiled. Rural markets were selected from the resulting list at random, systematically, and proportionally according to three levels of cowpea production in the administrative circles where they are located: low, medium and high. A total of 21 markets were retained, including 7 in each stratum. Six urban and semi-

urban markets were selected with the help of experts. In Bamako, the markets were chosen based on advice from OMA. During collection, one market was eliminated for security reasons.

This study uses the value chain approach to identify cowpea vendors and better understand their role and relationship. The value chain approach is important for the development of economies (Porter, 1985), particularly in fragile countries in sub-Saharan Africa (Haggblade et al., 2012). A value chain can be defined as the set of activities required to bring a product or service to end consumers. In the agro-food sector, these activities generally take place in a number of functions or phases, including production, processing, marketing and consumption (Hellin and Meijer, 2006). The value chain actors that interact with each other and the product include input suppliers, producers, processors, transporters, wholesalers, collectors, retailers and end consumers. The value chain approach plays an important role in the development of these activities and the links between these actors, which have a common interest for the final product, as any change in the final market affects them both simultaneously and collectively (Kumar et al., 2012).

A central tool in value chain analysis, mapping is used to show the relationships between the different actors as well as the flows of transactions, including quantities, prices, costs and profit margins. Our map was developed by a working group during a workshop on the cowpea value chain held in Mali (see Annex 3).

We estimate the performance of each player in the value chain by calculating profit margins. An actor's profit margin refers to the difference between sales revenue and expenses (purchase price and other costs) for a product. Based on Acharya and Agarwal (2004), profit margins and margin rates for a player i are given by the following equations:

$$MB_i = PV_i - (PA_i + CC_{ij}) \quad (1)$$

$$TxMB_i = \frac{PV_i - (PA_i + CC_{ij})}{PV_i} * 100 \quad (2)$$

Where PV_i is the unit selling price of the gross or processed product, PA_i is the unit purchase price of the gross or processed product, and CC_{ij} is the cost incurred for marketing and processing per unit of gross product purchased. MB_i is the sales profit margin of the product per unit of gross or processed product sold, and $TxMB_i$ is the profit margin rate.

5. Results and discussion

5.1 Main cowpea products and their vendors

The results below present the characteristics of the main players who are directly involved in cowpea value chain activities in local markets. Through the value chain map, we can visualize the roles and relationships among the actors for each product as well as the associated volume of cowpea flows.

Historically, grain producers, collectors, wholesalers and retailers have been considered the main actors of cowpea in Mali (Témé et al., 1986; Langyintuo et al., 2003; Mishili et al., 2009; Cissé, 2012; CNFA, 2016). The results of our study show that the value chain for cowpea grain and cowpea-derived products includes other players and other products.

The relationships between the different actors as well as the flows of transactions are represented in the map of the cowpea value chain below (Figure 3). The quantities supplied are in terms of cowpea grains.

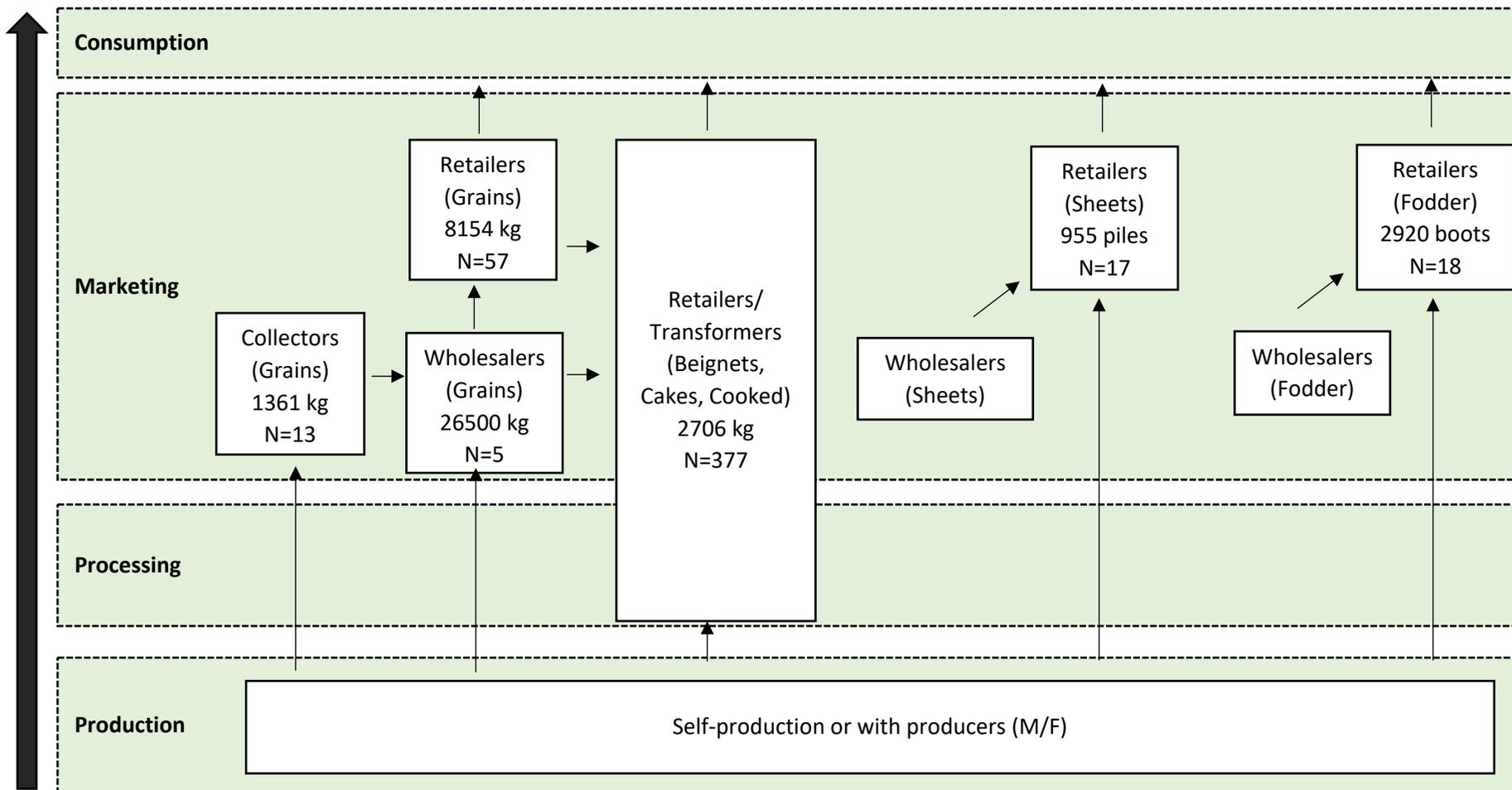


Figure 3. Cowpea Products Value Chain in the Study Area

5.1.1 Processed products

Retailers

In the market for processed cowpea products, the number of actors in the value chain is still limited. This seems to reflect the weak development of processing activities in Mali. Actors perform both the processing and retail marketing functions.

Our investigation has highlighted the presence of five processed products traded in local markets. These foods serve as snacks for a clientele that is generally very poor. As shown in Table 1, the dominant product is Sho-froufrou, where the number of vendors is highest (268). On the other hand, only one Sho-boulettes vendor could be identified in the markets.

Table 1. Major cowpea products identified in traditional processing markets

Processed products	Description	N	%
SHO-FROUFROU (BEIGNETS)	Fritters prepared from the dough of the cowpea flour.	268	71
ACCRAS (BEIGNETS)	Fritters made with paste of crushed cowpea grains, fried.	15	4
SHO-BOULETTES (BEIGNETS)	Dumplings made from the dough of cowpea and wheat flour, fried. These may be served with a tomato sauce.	1	0.3
FARI (PANCAKES)	Pancakes prepared with cowpea paste steamed. They are served with an onion sauce and oil.	41	10.9
COOKED COWPEA	Cowpeas boiled in water until cooked through, eaten with oil and vegetables, such as tomatoes, onions, or cucumbers, etc.	52	13.8
Total		377	100

Traditionally, Sho-froufrou is made from dough made from cowpea flour while Accras is prepared from a paste that is obtained by grinding the drenched cowpea grains. Thus, the difference between Accras and Sho-froufrou lies mainly in the texture of the dough and the processing technique (see also IFDC, 2016; Grdr, 2019). For the Sho-boulettes, the dough is obtained by combining cowpea and wheat flour. These dumplings are similar in shape to beignets. The different doughs can be seasoned with onion, garlic, salt and chili. For the

preparation of these products, the retailers themselves first process the grains into flour or directly grind the grains into a dough as in the case of Accras.

In their activities, retailers of processed products are not completely independent in the value chain because they depend on grain vendors and millers for the milling of grains into flour. Vendors and millers are generally installed in villages near rather than inside markets. They have small, motorized mills and are rare in villages (1 or 2 per village, and sometimes none at all). The type of processing carried out by these retailers can be considered traditional due to the processes and equipment used. The mortar and pestle, grindstone, small, motorized mill and utensils (stove, mixer, calabash, etc.) remain the primary equipment used in the processing of cowpeas in Mali. Our results show that 93% of retailers of beignet and pancake products use the motorized grinder, compared to 7% who use their own grinder. All practice grain husking using a mortar and pestle.

In Mali, it is estimated that around 45% of cowpea production is marketed, 45% is reserved for home consumption and 10% is lost (CONTEXT, 2014). Of the 45% of production intended for marketing, only 9% is processed. Our results are consistent the national figure, showing a processing rate of cowpea grains of 8% on local markets we surveyed. Taking seasonality into account, we find that 4% of cowpea grains are processed during the harvest season compared to 7% in the dry season and 13% in the rainy season. Findings indicate an inverse relationship between the volume of cowpea grains in the markets and the rate of processing of cowpeas. Overall, we can see that the processing rate of cowpea remains low in Mali. Opportunities therefore exist to further develop market niches for the processing and sale of processed cowpea products.

Our results show that retailers of processed products in local markets buy what they need for processing from a variety of sources, day to day, during the weekly fair. They most often process and market only 7 kg of grain per market day. This average processed amount of cowpea appears to be relatively stable regardless of the season in the year. In the village of Cinzana, in the Ségou region, Cissé (2012) found even lower quantities of cowpea beignets produced and marketed on average, 3 kg per vendor per day of the fair.

The data show that of the 377 processed retailers, 303 obtained their cowpea grain from grain retailers. This can be explained by the availability of grain with these sellers and their credit facility. In discussions with the sellers of processed products, it turned out that many take their grain on credit, hoping to repay it at the next weekly fair. In addition, it must be

recognized that in some localities, cowpea was beginning to become less available at the time of the survey due to time from harvest, so it was more difficult for these vendors to obtain it directly with producers.

Some 16 processed retailers are also small-volume grain producers, using a total of 95 kg of grain per market day. Another 16 retailers stated that they source directly from grain producers, for a total of 109 kg of grain purchased per market day. In addition, 15 retailers interviewed told us that they buy their grain stock with wholesalers and use it as they go along on several market days, for a total quantity of grain purchased of 104 kg per market day. In fact, these retailers, especially those who do not find cowpea grain in their communities, revealed that they can buy 50 to 100 kg of cowpeas with wholesalers if necessary.

5.1.2 Grain

Wholesalers, collectors, and retailers are the main sellers of cowpea grains in the local markets surveyed.

Wholesalers

Wholesalers buy and sell large quantities of cowpea grain, and transport the cowpea they collect in villages and rural markets to urban markets (cities of administrative units called “cercles,” regions and in the district of Bamako) where they are mostly located. They operate actively during the harvest period (between September and December). We met with very few wholesalers during our survey, which took place outside the harvest period and focused mainly on processed products.

Of the 5 wholesalers surveyed, 4 source cowpea grains directly from producers and have 25,500 kg per market day. The last wholesaler had 1000 kg of grain, purchased from the collectors. No wholesaler sells exclusively cowpea.

Collectors

Cowpea grain collectors are actors who operate independently or on behalf of wholesalers. They usually live in production areas and use several weekly markets around their village of residence. Collectors go to the edge of the fields or use their social networks to acquire part of producers' production. Some also have a point of purchase and sale.

All 13 sampled collectors acquired their cowpea grain from producers. The total quantity of cowpea grain available from these collectors was 1361 kg per market day.

Retailers

Cowpea grain retailers are the closest actors to cowpea grain users. They are found in both rural and urban markets. Like processed retailers, grain retailers obtain their products from a variety of sources. They source with wholesalers and sometimes directly from producers or even through certain collectors, to resell directly to final consumers and processors. Some of the retailers are also cowpea producers. The quantities sold vary greatly from one retailer to another: from less than 40 kg/day to more than 6000 kg/day.

It is important to note that there are some grain retailers (41 out of 57) that market in kg and others (16) that sell in local units of measure and in very small quantities. The latter are mainly those who source with producers, or market their own production. The local measuring units encountered are the *bol*, the *moud* and the *pani* (see Annex 2).

5.1.3 Fresh leaves

Retailers

Retailers of fresh cowpea leaves are vendors who detail their product to fresh leaf users. The unit commonly used by these retailers is the *tas* (heap or pile). This product is generally available in the morning in small quantities in markets, especially urban. Fresh cowpea leaves are generally used in the preparation of sauces for households and restaurants.

Of the 17 fresh leaf retailers surveyed 14 obtain their product directly from small market gardeners, for a total purchase of 922 piles per market day. Some market gardeners produce cowpea leaves and are established in certain parts of large cities and around cities. In rural areas, cowpea leaves most often originate from small plots where women usually produce them for their own family meals but also sell them in markets.

Two retailers claim to acquire their stockpiles (3 in total per market day), with wholesalers. Only one retailer was also a producer and had 30 *tas* per market day. However, there is a large disparity in the number of piles sold per retailer between communities. This number can reach sometimes 100 on average in some areas, compared to 4 in others.

As for cowpea pods, although they are consumed in several countries in West Africa, such as Senegal (Cissé, 2016), in Mali they have not yet really entered into the food habits of consumers and have not been identified in any of the markets we surveyed. However, it should be noted that leaves, with fresh pods, can play a crucial role in feeding populations

during the lean season in Mali and throughout the rest of the Sahel (Ferroni and Gabathuler, 2011).

5.1.4 Fodder

Retailers

Fodder retailers market feed bundles to livestock feed users. In addition to grains, the fodder market is one of the main markets for cowpea products in West Africa (Dugje et al., 2009). Cowpea fodder plays a particularly important role in the quality feed for livestock in Mali (Traoré et al., 2010; Sanogo et al., 2019). Livestock feeding remains an activity that provides fodder vendors with significant income throughout the year, especially in cities (Diallo et al., 2019).

Our results show that 16 of the 18 fodder retailers sourced directly from producers and had 2,590 cowpea fodder bundles per market day. The two remaining retailers had 330 cowpea fodder bundles per market day from a few rare fodder wholesalers. According to our interviews, some fodder producers are located in rural areas close to cities and sell to urban and peri-urban markets. Peri-urban areas are areas where milk production is intensifying in Mali. On the other hand, it appears that in rural areas a large part of the fodder is used directly by producers for their own livestock (if any), and the remainder is sold to local producers. In this sector, the sale of fodder to collectors or wholesalers is almost non-existent. It must be recognized that production of cowpea fodder is crucial for strengthening the integration of agriculture/livestock on farms and can be used as a substitute for cotton meal in the dry season (Coulibaly et al., 2007; Coulibaly et al., 2017).

5.2 Socio-economic characteristics of vendors

The socio-economic characteristics of vendors are presented in Table 2. Of the 487 vendors, 434 were women (89%). The processing and marketing of processed products is a women's business. Of the 377 retailers of processed products found in local markets, 373 were women, selling mainly beignets and fritters. The remaining 4 retailers were men, who marketed baked cowpea beans. Most of the processing process (grain husking up to the production of flour) takes place at home. Dough preparation and baking are usually done in markets. Most retailers of processed cowpea products (199 of 377) make only cowpea products.

Table 2. Descriptive results of socio-economic characteristics of vendors

Description of the actors	Processed products	Beans			Fresh leaves	Fodder	Together
		Retailer	Wholesaler	Collector	Retailer	Retailer	
Men	4	5	12	21		11	53
Women	373		1	36	17	7	434
Age	40	49	45	48	41	51	42
Married	326	5	13	43	13	18	418
Schooled	104	2	5	16	6	2	135
Specialized	199	0	1	3	1	0	204
N	377	5	13	57	17	18	487

For cowpea grain vendors, our results show that women operate primarily as retailers, 36 of whom are women out of 57 retailers surveyed. It should be noted that the grain retailers that sell in units of measurement are almost all women. As underlined by Langyintuo et al. (2003), women sell their products to collectors, who come to solicit them in the villages, because they still don't have the time or the means to go to the market. When they have access to the rural market, they are the ones who generally market cowpea in detail to users, in small quantities, to support their family needs (Cissé, 2012).

For fresh leaves, the 17 retailers surveyed are exclusively women. On the other hand, our results show that men and women operate in the sale of fodder (11 men and 7 women). It was also revealed to us that in addition to selling at fodder outlets, women sell from door-to-door in urban areas.

The average age of vendors is 42. The oldest are among grain retailers (57 years old) who use local units of measure, followed by fodder vendors (51 years old). Retailers of processed products appear to be the youngest, with an average age of 40 years. The vast majority of vendors are married (418 out of 487) and did not attend school (135 out of 487). However, education is an important factor in improving processing practices and enhancing the value of cowpea products.

The results also show that the marketing of fresh fodder and leaves is rare in rural markets, especially in the dry season.

5.4 Analysis of profit margins

After discussing the actors in the value chain and their relationship, it is now up to us to analyze the marketing costs and profit margins for the main products identified.

5.4.1 Processed products

Table 3 presents the marketing costs and profit margins of retailers of processed cowpea products. For the main processed products - beignets, pancakes and baked cowpeas - the table shows that the processing costs for one kilogram of cowpeas are 532, 746 and 477 FCFA, respectively. This shows that the production costs of pancakes are significantly higher than those of other processed products. Regardless of the type of product processed, we see that it is the expenses related to the purchase of oil or fat that dominate, followed by far by the costs of packaging, seasoning and fuel. Furthermore, labor, transportation and market costs are almost rarely considered by retailers of processed products.

Table 3. Marketing costs and profit margins of processed products of cowpea

Processed products (KG/FCFA)	Beignets	Cakes	Baked Cowpea	Together
Sellers	retailers	retailers	retailers	retailers
Marketing costs				
Milling costs	38	50.9	0	34.2
Fuel costs	39.4	105.5	68.3	50.6
Fresh oil or fat costs	353.5	320.7	238.7	334.1
Seasoning costs	35.3	160.3	93.3	56.9
Labor costs	4.0	1.2	14.2	5.1
Transportation costs	2.6	6.5	1.2	2.8
Packaging costs	56.3	99.6	59.8	61.5
Market taxes	2.9	1.2	1.6	2.5
Total costs	532	746	477	548
Purchase price	395	429	411	401
Selling price	1536	1959	1688	1603
Profit margin	609	784	800	654
Margin rate (%)	40	40	47	41

Profit margins vary between 600 and 800 FCFA per kilogram of processed grain, with a profit margin rate of between 40 and 47%. We note that it is the marketing of baked cowpea that offers retailers the highest margin rate, 47%, against 40% for beignets and pancakes.

However, it should be noted that the sale of baked cowpea depends on the markets and the type of clientele. It is often sold in dense markets and/or on roads. Targeted consumers appear to be vendors in markets and motor carriers.

5.4.2 Grain

On average, sellers of cowpea grain spend 15 FCFA per kilogram of grain sold, as shown in Table 4. The most reported costs are those related to the transport and purchase of packaging. This is rather understandable when we know that most of these vendors buy from producers, who are often far away and who still do not have adequate packaging for transport. Regarding storage and preservation of cowpea grains in stores, our observations show that polyethylene and woven polypropylene bags are generally used rather than improved PICS bags.

The results also show that, on average, grain vendors obtain profit margins of 66 FCFA per kilogram of grain sold, with a margin rate of 15%. With these results, we find that grain vendors have lower margins, but sell larger quantities (thus making more profits), unlike retailers of processed products. Margins are generally low. Moreover, in a 2014 study by the University of Purdue (cited by CNFA, 2016), wholesalers of cowpea grains in West Africa earn a gross margin rate of about 2%, 4% for intermediaries and 10% for retailers.

Table 4. Marketing costs and profit margins of cowpea grain

Products	Grains (KG/FCFA)			
	Vendors	Wholesalers	Collectors	Retailers
Marketing costs				
Labor costs	0.4	0.6	0.2	0.3
Transportation costs	1	2.2	9.5	7.7
Packaging costs	0.3	4.7	6	5.4
Market taxes	0	0.8	0.4	0.5
Storage costs	0.2	0	0.9	0.7
Preservation costs	0.5	1.3	0.4	0.5
Total costs	2	10	18	15
Purchasing price	320	327	354	347
Selling price	390	390	440	428
Profit margin	68	54	68	66
Margin rate (%)	17	14	16	15

5.4.3 Fresh leaves

For fresh leaf retailers, transport and packaging costs are also the main costs incurred. These vendors earn on average profit margins of 130 FCFA per *tas* (250 FCFA) of fresh leaves sold and record a margin rate of 44%.

Table 5. Marketing costs and profit margins of fresh cowpea leaves

Products	Fresh Leaf (PILE/FCFA)
Sellers	Retailers
Marketing costs	
Seasoning costs	0
Transportation costs	5.6
Packaging costs	35.1
Market taxes	1.5
Storage costs	0
Preservation costs	0
Total costs	42
Purchasing price	122
Selling price	295
Profit margin	130
Margin rate (%)	44

5.4.4 Fodder

In the same vein as before, at fodder retailers, the dominant costs remain those dedicated to transport and packaging. Table 6 also shows that they have 66 FCFA profit margins per bundle of cowpea fodder and their margin rate is 23%.

Table 6. Marketing costs and profit margins of cowpea fodder

Products	Fodder (BUNDLE/FCFA)
Vendors	Retailers
Marketing costs	
Seasoning costs	0.3
Transportation costs	7.7
Packaging costs	2.4
Market taxes	0.1
Storage costs	0
Preservation costs	0

Total costs	11
Purchasing price	210
Selling price	286
Profit margin	66
Margin rate (%)	23

Ultimately, retailers of processed products and fresh leaves obtain the highest margin rates (in turns of 40%) as opposed to retailers of fodder (23%) and vendors of grain (15%). Thus, processed products and fresh leaves appear to bring greater value to the cowpea value chain. However, retailers of processed products and fresh leaves sell small quantities, while fodder retailers and grain vendors market larger quantities and subsequently make more profits.

5.5 Analysis of constraints and opportunities

5.5.1 Supply Difficulties

Vendors in the cowpea value chain, whether they are retailers of processed products, grains, fresh leaves, or fodder, face multiple supply challenges. About 61.4% of vendors surveyed reported these difficulties. The latter usually live in cowpea production areas or store a certain quantity of cowpea or supply themselves directly in the cities.

Among the retailers of processed products who say they have difficulties supplying grain from cowpea (their raw materials), the lack of grain (80%), its high price (12%), the lack of working capital (5%), the poor quality of grain (2%) are the most cited difficulties. A number of retailers have told us that they stop processing and marketing several times a year because of lack of grain and the high price of grain in markets.



Figure 4. Supply difficulties for retailers of processed products

The poor quality of cowpea products is often related to insect damage. The lack of working capital for retailers of processed products means insufficient financial resources to acquire their usual raw materials, increase their production capacity, or build up their stock in order to compensate for any shortages of raw materials. For these retailers, having working capital is also a way out of the credit cycle with their suppliers.

According to grain vendors (wholesalers, collectors and retailers), the main obstacles to supply are the lack of grains (84%), followed by far by the high price (7%) of grain. Similarly, retailers of fresh leaves and fodder who face supply problems have all spoken exclusively of the lack of fresh leaves and fodder, respectively.

It should be noted that for grains and fodder, scarcity begins in the dry season and intensifies during the growing season. This is reflected in the prices shown in Annex 1. For fresh cowpea leaves, retailers reported the difficulty of sourcing at the start of the rainy season and during the harvest period because many producers are busy with field work on other crops. For example, there is a decrease in the size of fresh leaf *tas* during these periods, while the size of *tas* increases during the winter and after the harvest period during the dry season. On the other hand, the price of fresh leaves seems to be on average stable depending on the season (Annex 1). Other supply difficulties mentioned relate more to the difficulties linked to storage problems, to the state of the roads for access to markets, the length of distances traveled to obtain supplies, and the COVID-19 pandemic or insecurity in the country.

5.5.2 Other constraints

Beyond the supply difficulties (which represent 24% of the constraints), retailers of processed products highlighted other constraints including the heat of the cooking fire² (19%), the high price of oil (18%), sluggishness (16%) and the difficulty of processing (12%). This corroborates Cruz et al. (2019), who state that the actors of the transformation can be hampered in their development mainly because of the lack of accessible processing equipment that is adapted to their needs.

Particularly among grain vendors, we also find constraints related to storage of cowpea grains (11%).

²The heat released from wood or charcoal fires is generally unbearable for processors.

Table 7. Constraints linked to the activities of cowpea sellers

Constraints related to the activities of vendors	Processed products	Grains	Fresh leaves	Fodder
	Retailers	Wholesalers / Collectors / Retailers	Retailers	Retailers
Supply difficulties	89 (24%)	32 (43%)	4 (24%)	11 (61%)
Heat of fire	70 (19%)			
Oil price	67 (18%)			
Weak sales	60 (16%)	22 (29%)	9 (53%)	3 (17%)
Painful transformation	46 (12%)			
Preservation difficulty		8 (11%)		
Others	45 (12%)	13 (17%)	4 (24%)	4 (22%)
N	377 (100%)	75 (100%)	17 (100%)	18 (100%)

Weak sales are also reported among all vendors of cowpea products. Although there are supply difficulties, paradoxically the slump is on everyone's lips. This phenomenon is usually the result of leaving the market without achieving the usual sales targets per market day. It occurs very occasionally and usually during the rainy season (except for fresh leaves). In fact, the retailers of processed products indicate that during the rainy season, customers in the markets are rarer because of rain or because of departures from the field. In this case, they try to sell unsold goods on credit, consume them or donate them.

For grain, weak sales may be related to informational malfunction in the cowpea market or excessive price increases. For fresh leaves, it is thought to be due to a drop in demand during the dry season, which seems to be linked to changes in consumer eating habits. The demand for cowpea fodder seems to be also low during the rainy season when livestock producers find other, free or cheaper alternatives.

5.5.3 Opportunities

Our results show that supporting women and enhancing the value of processed cowpea products will also develop the cowpea value chain in Mali, because of its high added value. Several opportunities must be seized to achieve this objective.

Traditional know-how

In Mali, the presence of small women's businesses that retail processed products proves that the processing and marketing of cowpea products is a women's enterprise. This enterprise generates value in the local markets of urban and rural areas.

Culturally rooted in their businesses, these women, seated on the ground behind their products, play a crucial role in providing low-cost food with high nutritional content to poorer consumers and in safeguarding traditional Malian cuisine. They maintain know-how they have acquired in the family, in the village, and from generation to generation.

Women retailers of processed cowpea products are not included in national statistics of most West African countries (CNFA, 2016). Women entrepreneurs manage their small businesses in the informal sector and seem to attract very little attention from policy makers or development projects. As economic actors, they are nevertheless a significant group in the creation of national wealth, although they are among the most vulnerable citizens. Certainly the sale of processed products generates low but permanent income for them. The presence of women at the heart of cowpea transformation should be an opportunity for decision-makers and donors to boost the development of the cowpea value chain in Mali. If nothing is done to accompany them, there is a real threat that these women will stop their activities, because they struggle to resist the multiple constraints.

The professionalization of cowpea actors

While the role played by retailers of processed cowpea products is important in local markets, the professionalization and modernization of cowpea processing activities are essential to the development of the cowpea value chain in Mali.

For some time, semi-industrial units for processing agricultural food products have been run by professional female processors as individuals or in cooperatives. Most have received training and advice from the LTA (the Laboratory of Food Technology of the Institute of Rural Economics - IER) and/or development projects. New products derived from cowpea have been proposed, including pure flour, infant flour, and couscous. These processing units are located outside the markets. None were identified in our field surveys.

Packaged and labelled in bags, these products can be kept longer and usually require preparation before consumption. For example, cowpea flour could be used directly in the preparation and marketing of cowpea beignets and pancakes. More importantly, processing

cowpea flour at the time of harvest could be an alternative to grain loss during storage. This could partially solve the supply difficulties faced by traditional processors during the year. According to Cruz et al. (2019), the transformation of cowpea into dry granules, obtained from flour, is also a better way to keep cowpea for several years while the grains are very rapidly infected by insect pests.

Only a small part of the processing of cowpea grains is carried out by the few processing units in Mali. There is no permanent market for these cowpea products. Processing units usually start production according to market opportunities. Often, an institutional clientele such as the WFP solicits them for the production of infant flour for pregnant women and infants. It is noteworthy that we have not identified any actors of this modern transformation process in local markets. Only a few actors have been found, and these operate at home in cities and in a very embryonic way.

Despite this modern know-how in the processing of cowpea products, it is necessary to recognize the low penetration of these products on the market and in the food habits of households. These products seem to be unaffordable for many consumers. By working in the formal sector, new actors have the advantage of being able to conclude supply contracts with customers such as supermarkets and NGOs. They can better negotiate commodity prices by buying large quantities and have easy access to agricultural and banking services.

Innovation as an opportunity

The LTA conducts research and development on the processing of agricultural food products, including cowpea. According AFD (2011), in West Africa, knowledge about processed products, processing methods (including artisanal) and adapted equipment is still poorly known by actors in the value chain. The aim of the LTA is to provide innovative solutions to the problems encountered by those involved in transformation (women's groups, private companies, individuals, etc.). LTA is responsible for the development of new cowpea-based products and building the capacity the actors concerned through training on aspects of manufacturing processes, hygiene and food regulations, packaging, and preservation of products. In addition, the laboratory is involved in the design of equipment for the processing of cowpea products.

In addition to pure flour, infant flour or couscous, the LTA has developed a number of improved food technologies based on cowpea such as vermicelli, meatballs, soup, and cookies. Despite the range of cowpea products offered, the majority of these products are not

on the market and are not known to the general public. Moreover, we should continue to value products traditionally consumed by households, which are disappearing from areas of origin.

In addition, through the efforts of the IER, ICRISAT and other partners, several agricultural technologies are available or under development to enhance the economic value of cowpea, including new varieties of cowpea fodder and PICS bags to conserve insect pests.

Therefore, policy makers and development agencies should continue to seek strategies to support innovation, entrepreneurship, and market access for processed cowpea products in Mali, whether these are made from grain, leaves, or pods.

6. Conclusion

Our study of the cowpea value chain in Mali has revealed the multidimensional character of the cowpea plant, which goes far beyond its grain. We have demonstrated that the cowpea value chain in Mali is composed actors other than those trading grain, including retailers of processed products, fresh leaves and fodder. This study highlights the relationships among these actors, but also the connection between processing and marketing.

Data collected have enabled us to calculate the profit margins made by the various actors when selling their products. Retailers of processed products and fresh leaf retailers report the highest margin rates. With a processing rate of only 8% for grains and almost zero for fresh leaves, findings suggest that business opportunities remain untapped. All players in the cowpea value chain in Mali would benefit from further development of processing channels for cowpea products.

Women are at the heart of these value-creating, transformation activities. It is therefore important that their expertise be recognized, that their needs be considered by research and that they be included in any action to professionalize the processing of agricultural products. In addition, through our results we believe that the processing of cowpea grains into flour could partly resolve the constraints faced by processors, including grain supply difficulties after the harvest period.

Cowpea is recognized today as an important source of income diversification for women, while contributing to job creation, food and nutrition security, in both urban and rural areas. This is especially the case in the context of climate change, conflict and health crises. Thus, given the challenges surrounding the processing and marketing of cowpea in Mali, the

authorities must include strategies that will support stakeholders in the cowpea value chain as part of a policy of agricultural diversification. It is also imperative to support research and innovation in cowpea food processing, and to promote nutritious cowpea-based meals at the national level.

The transfer of food technologies, equipment and the dissemination of knowledge must be encouraged between the countries of the sub-region because some seem more advanced in cowpea transformation, such as Burkina Faso, Niger and Nigeria (Soule, 2002; Idrissa, 2013). Finally, future work should formulate of effective strategies to develop the commercialization of processed cowpea products in Mali. Researchers might also explore future preferences of cowpea consumers in Mali, beyond grain.

References

- AFD (2011). Les cultures vivrières pluviales en Afrique de l'Ouest et du Centre. Ouvrage Collectif AFD - CIRAD – FIDA. Agence Française de Développement (AFD). Paris, France.
- Allen, T., Heinrigs, P. (2016). Les nouvelles opportunités de l'économie alimentaire ouest africaine, Notes ouest-africaines, N°01, Éditions OCDE, Paris.
- Cissé, N. (2016). La culture traditionnelle du niébé au Sénégal. Revue sur Agriculture durable à faibles apports externes - *AGRIDAPE*, 32(2) - Juin 2016.
- Cissé, Y. (2012). Etude d'Opportunité de Marché Relatif à la Filière Niébé au Mali. Rapport préparé pour le Global Mechanism of the UN Convention to Combat Desertification. Bamako, Mali.
- CONTEXT (2014). Multi crop value chain phase II: Burkina Faso/Mali cowpea. (<https://doi.org/10.21955/gatesopenres.1115075.1>)
- Coulibaly, D., Ba, A., Dembele, B., Sissoko, F. (2017). Développement des systèmes de production innovants d'association maïs/légumineuses dans la zone subhumide du Mali. *Agronomie Africaine*, 29 (1), 1-10.
- Coulibaly, D., Moulin, C., Chapuis, R.P., Morin, G., Sidibé, S., Corniaux, C. (2007). Evolution des stratégies d'alimentation des élevages bovins dans le bassin d'approvisionnement en lait de la ville de Sikasso au Mali. *Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux*, 60, 103-111.
- Coulibaly, Y., Ouologuem, A. (2014). Etude sur les chaînes de valeur riz au Mali. Rapport final, Octobre 2014, Bamako, Mali.
- Cruz J.F., Hounhouigan D.J. Havard M., Ferré T. (2019). La transformation des grains. Collection Agricultures tropicales en Poche, Quæ, Presses agronomiques de Gembloux, CTA, Versailles, Gembloux, Wageningen. 182 p.
- Cultivating New Frontiers in Agriculture (CNFA). (2016). Resilience and Economic Growth in the Sahel Accelerated Growth (REGIS-Project Value Chain and End Market Assessment – Cowpea. USAID Contract #AID-625-C-14-00001.
- Dabat, M.H., Drabo, I., Lançon, F., Baas, W. (2010). Innover pour développer les marchés : le cas de la conservation du niébé au Burkina Faso. Communication à l'Atelier système post-récolte, valorisation technologique et qualité des ressources alimentaires africaines, 20-25 septembre, MAEE, Cotonou, Bénin.
- Dabat, M.H., Lahmar, R., Guissou, R. (2012). La culture du niébé au Burkina Faso : Une voie d'adaptation de la petite agriculture à son environnement? *Autrepart*, 95–114.
- Dembélé, R. (2015). Diversification des sources de revenu des femmes de Sala. Mémoire de Fin de Cycle. IPR/IFRA, Katibougou, Mali.
- Diallo, H., Diallo, S., Maiga, Y. (2019). Etude de la filière fourrages ligneux dans le district de Bamako. *Global scientific journal*: 7(9).

Doumbia, I.Z., Boukar, O., Touré, M., Tamò, M., Tignegre, J. B. De La Salle, Fatokun, C., et al. (2019). Evaluation of cowpea accessions for resistance to flower bud thrips (*Megalurothrips sjostedti*) in Mali. *Journal of Genetics, Genomics & Plant Breeding* 3(2) 15-30.

Dugje, I.Y., L.O. Omoigui, F Ekeleme, A.Y. Kamara, H. Ajeigbe. 2009 Production du niébé en Afrique de l'Ouest: Guide du paysan. IITA, Ibadan, Nigeria. 20 pages.

FAO (2020). Mali Réponse conjointe - Soutenir les activités agricoles et pastorales des ménages touchés par la crise dans les régions de Kayes et de Mopti. FAO, Rome, Italy

FAOSTAT. (2021). Cowpeas, dry. Accessed on August 8, 2021.
<http://www.fao.org/faostat/en/#data/QC>.

Ferroni, S., Gabathuler, E. (2011). Quand les greniers se remplissent. Les bénéfices du partenariat entre la recherche agronomique, la vulgarisation agricole et des organisations paysannes du Mali. University of Berne, Suisse. Editeur: Fondation Syngenta pour un Agriculture Durable.

Gómez, C. (2004). Cowpea: Post-harvest Operations. In: Mejia (Ed.) Postharvest Compendium, AGST, FAO. Rome, Italy.

Grdr (2019). Préserver le patrimoine semencier du bassin du fleuve Sénégal : Mali, Mauritanie, Sénégal. Livret Méthodologique. Grdr - Migration-Citoyenneté-Développement. Montreuil, France.

Haggblade, S., Hazell, P.B.R. (2010). *Successes in African agriculture: Lessons for the future*. Baltimore: The Johns Hopkins University Press.

Haggblade, S., Theriault, V., Staatz, J., Dembele, N., Diallo, B. (2012). A Conceptual Framework for Promoting Inclusive Agricultural Value Chains. Prepared for the International Fund for Agricultural Development (IFAD) under Grant # G-I-R-1352-MSU

Hellin, J., Meijer, M. (2006). Guidelines for value chain analysis. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Hollinger, F., Staatz, J.M. (2015). *Agricultural Growth in West Africa. Market and policy drivers*. FAO, African Development Bank, ECOWAS.

Ibro, G., Fulton, J., Lowenberg-DeBoer, J. (2006). Factors Affecting Success for Women Entrepreneurs in West Africa: The Case of Kossai, a Value-Added Cowpea Product. Selected Paper prepared for presentation at 2006 American Agricultural Economics Association Annual Meeting, Long Beach, California, July 23-26, 2006.

Idrissa, A. (2013). Etude de marche des produits de la transformation du niébé. Document préparé pour SNV. 70 p.

IFDC (2016). Formation sur la transformation des produits agricoles alimentaires - Manuel de formation innovant genre sensible sur les technologies post récolte.

Kergna, A.O., Kebe, D. (2001). Evaluation économique de l'impact de la recherche sur le niébé au Mali. Programme Economie des Filières, Rapport. 2001.

- Kumar, R., Alam, K., Krishna, V.V., Srinivas, K. (2012). Value Chain Analysis of Maize Seed Delivery System in Public and Private Sectors in Bihar. *Agricultural Economics Research Review*, 25(conf), 387-398.
- Langyintuo, A., Lowenberg-DeBoer, J., Faye, M., Lambert, D., Ibro, G., Moussa, B., Kergna, A., Kushwaha, S., Ntougam, G. (2003). Cowpea supply and demand in West Africa. *Field Crops Research* 82: 215-231.
- Langyintuo, A., Lowenberg-DeBoer, J. (2006). Potential regional trade implications of adopting Bt cowpea in West and Central Africa. *The Journal of Agro Biotechnology Management and Economics*, 9:111-120.
- Langyintuo, A., Ntougam, G., Murdock, L., Lowenberg-DeBoer, J., D. Miller. (2004). Consumer preferences for cowpea in Cameroon and Ghana. *Agricultural Economics* 30: 203-213.
- Mas Aparisi A., Diallo F., Balié J., (2013). Analyse des incitations et pénalisations pour le mil et le sorgho au Mali. Série notes techniques, SPAAA, FAO, Rome.
- Mishili, F.J., Fulton, J., Shehu, M., Kushwaha, S., Marfo, K., Jamal, M., Kergna, A., Lowenberg-DeBoer, J. (2009). Consumer preferences for quality characteristics along the cowpea value chain in Nigeria, Ghana, and Mali. *Agribusiness: An International Journal*, 25(1), 16-35.
- Monyo, E., Boukar, O., Ntare, B. (2013). Bulletin of Tropical Legumes. N° Janvier 2013. ICRISAT, IAT et IITA.
- Moussa, B., Lowenberg-DeBoer, J., Fulton, J., Boys, K. (2011). The economic impact of cowpea research in West and Central Africa: A regional impact assessment of improved cowpea storage technologies. *Journal of Stored Products Research*, 47, 147-156.
- Ngom, M. (2018). Déterminants et impact des systèmes d'information de marché sur les revenus agricoles des producteurs de niébé du bassin arachidier sénégalais. Thèse de Doctorat, Université Cheikh Anta Diop de Dakar.
- Robinson, E., Nwuneli, N., Henson, S., Humphrey, J. (2014). Mapping Value Chains for Nutrient-Dense Foods in Nigeria, Evidence Report 65, Brighton: IDS.
- Sadiq, M.S., Singh, I.P., Yusuf, T.L., Sani, T.P., Lawal, M. (2018). Cowpea Trade in West Africa Region. *Journal of Forestry, Environment and Sustainable Development*, 4(1): 91-105.
- Sanogo, O.M., Doumbia, S., Descheemaeker, K. (2019). Complémentation des bovins laitiers pour l'amélioration de la production de lait et du fumier en milieu paysan dans le cercle de koutiala. Vol. 0 No 22 (2019): Revue Malienne de Science et de Technologie Série A.
- Smale, M., Theriault, V., Vroegindewey, R. (2020). Nutritional implications of dietary patterns in Mali. *African Journal of Agricultural and Resource Economics* 15(3):177-193.
- Soule, B.G. (2002). Le marché du niébé dans les pays du Golfe de Guinée : Côte d'Ivoire, Ghana, Togo, Bénin et Nigeria. Laboratoire d'Analyse Régionale et d'Expertise Sociale. Cotonou, Benin.

Témé, B., Coulibaly, O.N., Koné N.D. (1986). Etude sur le marché du niébé du Mali. Préparé pour le projet Fonds de Développement Villageois de Ségou. Bamako, Mali.

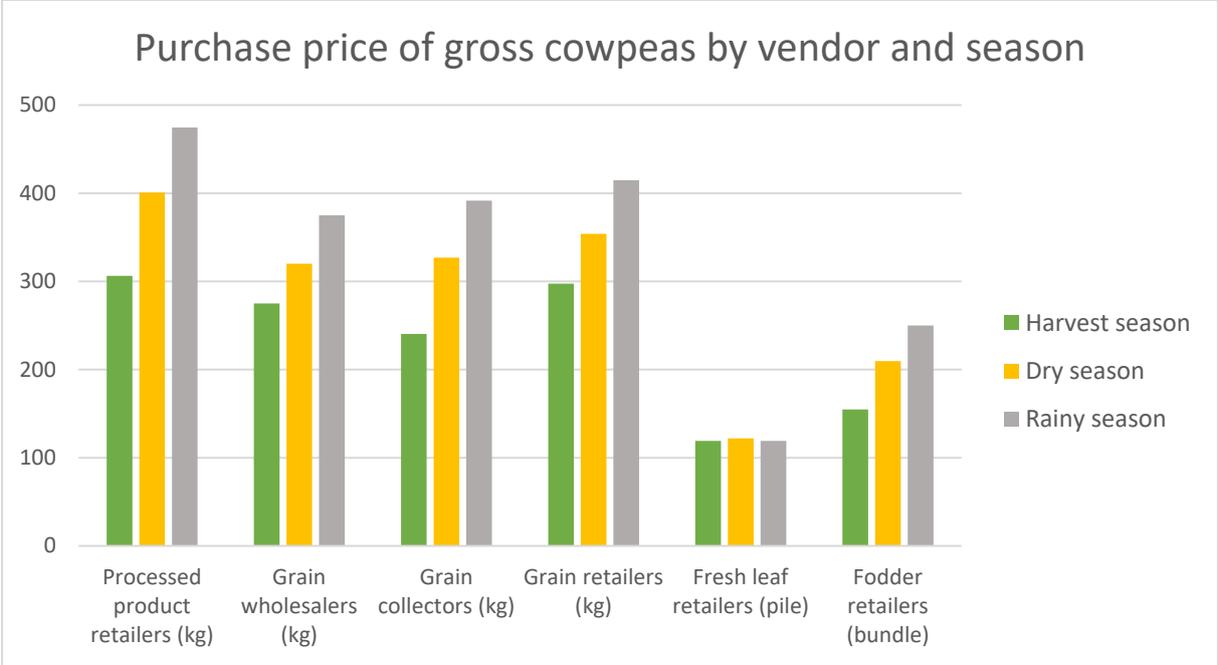
Traoré, C.O., Aune, J.B., Sidibé, M.M. (2010). Projet Ecoferme au Mali. Rapport No. 57, Groupe de coordination des zones arides. Oslo, Norvège.

Wade, I., Dia, D. (2011). Analyse Approfondie de la Filière Niébé. Rapport Provisoire. Projet d'Appui aux Filières Agricoles. Dakar, Sénégal.

Walker, A.F., Kochhar, N. (1982). Effect of processing including domestic cooking on nutritional quality of legumes. *Proceedings of the Nutrition Society*, 41(1), 41-51.

Annexes

Annex 1. Price changes during the year³ by sellers and products



³ The dry season is considered to be a period that covers the end of the current crop year until the start of the new crop year rains. This period can be between February and May, depending on the year.

The rainy season is usually between June and September.

The harvest period generally takes place between October and January.

Annex 2. Grain local units of measure



Pani



Bol



Moud

Annex 3. Map of the cowpea value chain in Mali

