

**CONSTRAINTS RELATED TO THE MANGO (*Mangifera indica* L.) SECTOR IN THE TCHOLOGO AND PORO REGIONS (NORTHERN CÔTE D'IVOIRE)**

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<https://doi.org/10.35410/IJAEB.2022.5754>

**ABSTRACT**

This study aims to diagnose the constraints in the value chain of the mango sector in the regions of Poro and Tchologo in order to adapt the scientific research action to the real problems of the sector. A survey covered the production, processing, export and marketing sectors. The data was recorded from 344 actors. The results revealed that Kent (100.0%), Keitt (23.0%) and Amélie (28.0%) mango varieties were the most exported and generally known on the market. Also, mango prices vary in the market and the shelf life of dried mangoes differs in several processing plants. However, the losses recorded at the level of producers (64.1%), processors (76.0%), exporters (52.0%) and traders (77.0%) are enormous. They are mainly due to microbial diseases such as anthracnose, bacteriosis and fly and cochineal bites, technical breakdowns in machinery, ripening and rotting of mangoes. Finally, the mango actors revealed several difficulties, mainly the lack of funds to support the sector, the seasonality of production, the high cost of transport and the lack of organization at the level of the sector.

**Keywords:** Mango sector; Value chain ; Poro and Tchologo regions ; Côte d'Ivoire.

**1. INTRODUCTION**

Since the 1960s, the economy of Côte d'Ivoire has been based on agriculture. Indeed, the country has natural assets favorable to agriculture. Thus, it adopted a policy of diversification of export crops, including mango (Minagri, 2012). The cultivation of this fruit is dominated by a large orchard of traditional varieties and a few varieties of the modern type. The main production zone is mainly concentrated in the north of the country, particularly in the regions of Poro and Tchologo with an area of 2000 hectares, Bagoué (Boundiali) with an area of 200 hectares and Kabadougou (Odienné) with an area of 150 hectares. These regions mainly produce hybrid varieties suitable for export (Kent, Keitt, Amélie, Palmer, Zill, etc.). As for the Gboklè region, with about 1500 hectares, it produces traditional varieties known under the vernacular names of "Tchrele-tchrele, Séguéla and Mango" according to (Kouassi, 2012). Thus, mango cultivation currently remains one of the main sources of income in the northern region of the country after cotton (FIRCA, 2014), with more than 1.5 million people being directly or indirectly involved in the sector. Côte d'Ivoire produces about 100,000 tons of mangoes per year, the exported fraction being around 10,000 to 15,000 tons. This represents only a small part of its production. The rest being consumed or rotting during storage. In addition, the sector generates more than 7 billion FCFA in revenue. It provides producers with approximately 1 billion FCFA annually (Kouassi, 2012).

However, the sector faces many problems. The small planters, ensuring nearly 90% of production encounter difficulties in cultivation practices. Also, at the level of processing, we note the absence of a policy to supply the international market. Consequently, each year, tens of tons of mangoes rot in the orchards (Touré, 2012), resulting in huge losses of financial gains for the actors. Post-harvest losses, estimated at about 40% of total production in 2014, corresponded to a loss of earnings of more than six billion FCFA for actors in the sector (FIRCA, 2014). This study was therefore undertaken in order to make a diagnosis of the constraints in the value chain of the mango sector in the regions of Tchologo and Poro.

## 2. MATERIAL AND METHODS

### 2.1 Study area

This study was conducted in the Tchologo and Poro regions in the northern part of Côte d'Ivoire (Figure 1). The climate there is of the transitional sub-Saharan type with two seasons. The rainy season extends from April-May to the end of October and the dry season from October to May (Perraud, 1971). The annual averages of temperature and rainfall vary between 27°C and 28°C and between 900 mm and 1400 mm, respectively (Yao et al., 2018). The vegetation, formerly dominated by a grassy savannah (Ouattara, 2015), is nowadays replaced by plantations of perennial and food crops (Talnan, 2009) adapted to the physical properties of the soil (Perraud, 1971).

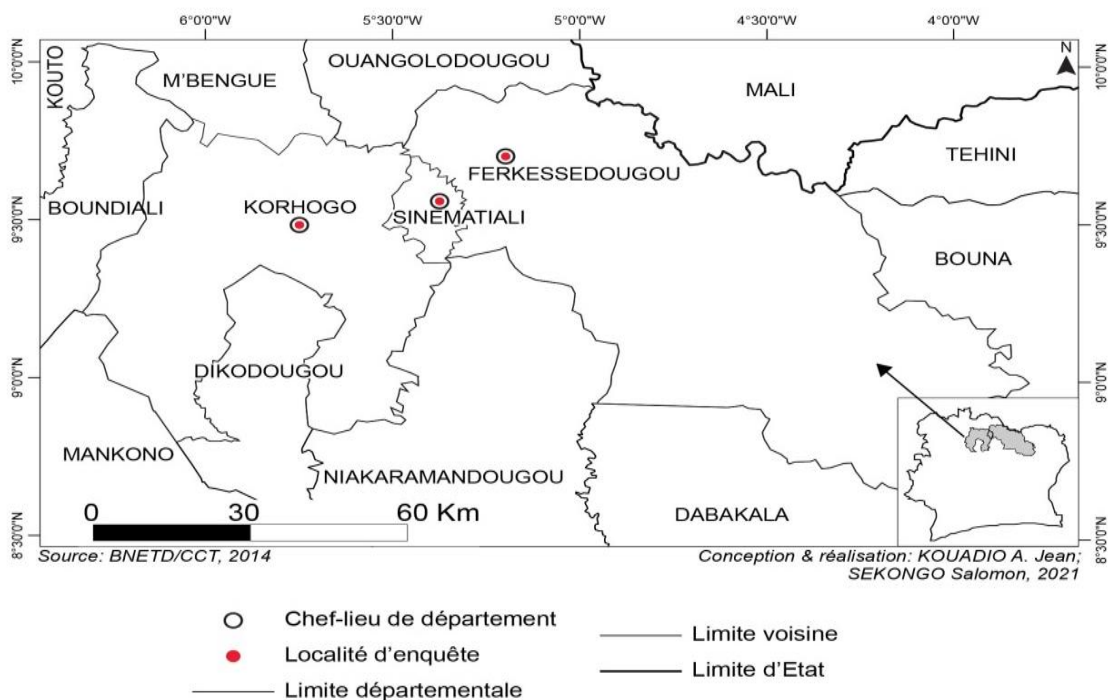


Figure 1: Location of the study area and surveyed localities

### 2.2 Data collection

The study took place in the towns of Korhogo and Sinématiali in the Poro region and in the town of Ferkessedougou in the Tchologo region, localities of mango production per excellence in Côte d'Ivoire. A questionnaire, taking into account the entire value chain; has been developed with four sections reserved for producers, processors, exporters and local market traders. Among local producers and traders, their sociological profile, product marketing and post-harvest difficulties were studied. Among processors and exporters, in addition to their sociological profile, processing units and packaging plants were characterized respectively.

The investigation period covered the months of April to June 2021, with the production season generally running from March to July. During the interviews, the questions were broken down into logical sequences for the respondent. The Paper and Pencil Interview (IPC) method of (Bahouayila, 2016) was used. Regarding the size of the samples, 25 exporters and 13 processors were chosen. On the other hand, for producers and traders, a workforce of 153 actors has been adopted for each of them.

### 3. RESULTS

#### 3.1 Producers

##### 3.1.1 Orchard areas and years of experience of producers

The most numerous producers have production areas between 5 and 25 ha (58.8), followed by those whose fields are over 25 ha in size (Table 1). In addition, 45.1% of producers have an activity experience of between 15 and 25 years in mango cultivation. They are followed by those totaling between 25 and 35 years (26.8%).

**Table 1: Relative proportions of orchard areas and number of years of experience of actors: F., Ferkessedougou, K., Korhogo and S., Sinematiali.**

Area orchards (hectares)	F. K. S.			Total	Years			Total	
	F.	K.	S.	(n=153)	F.	K.	S.	(n=153)	
Less than 5	11.8	10.0	11.5	11.1	Less than 5	3.9	10.0	1.9	5.2
Between 5 and 25	45.1	74.0	57.7	58.8	Between 5 and 15	9.8	14.0	5.8	9.8
More than 25	43.1	16.0	30.7	30.1	Between 15 and 25	45.1	44.0	46.2	45.1
					Between 25 and 35	23.5	26.0	30.8	26.8
					35 and over	17.6	6.0	15.4	13.1

##### 3.1.2 Varieties of cultivated mangoes

Of the 153 producers surveyed, 100% grow the Kent variety. The Brook variety is the most cultivated after the Kent variety, with a rate of 32.0%. Among the mangoes intended for export, the Keitt variety is the least cultivated (12.4%). There are also some wild varieties (Seguela, Dadjani, etc.) in the orchards (Figure 2).

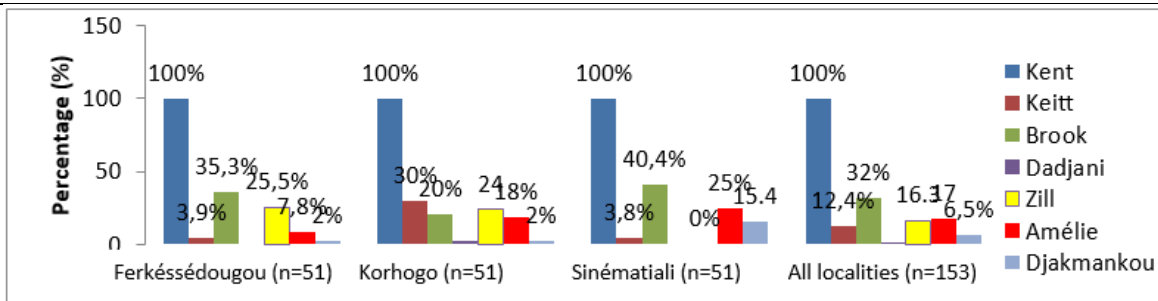


Figure 2: Varieties of cultivated mangoes in the study localities

### 3.1.3 Constraints

Respondents who find that production losses are very significant (higher risks) are the most numerous (64.1%). Next come those who think that the losses are significant (19.6%). This is shown in Figure 3. Diseases are the main causes of these losses (56.9%). Natural phenomena (31.4%) are the second cause of production losses. Insufficient treatment seems to have little effect on production with only a rate of 1.3% of those surveyed (Figure 4). Regarding the types of diseases, anthracnose and bacteriosis are the ones that most attack the orchards with respectively 60.8 and 54.9%. Soft nose and mealybug are the least common diseases in orchards (Figure 5).

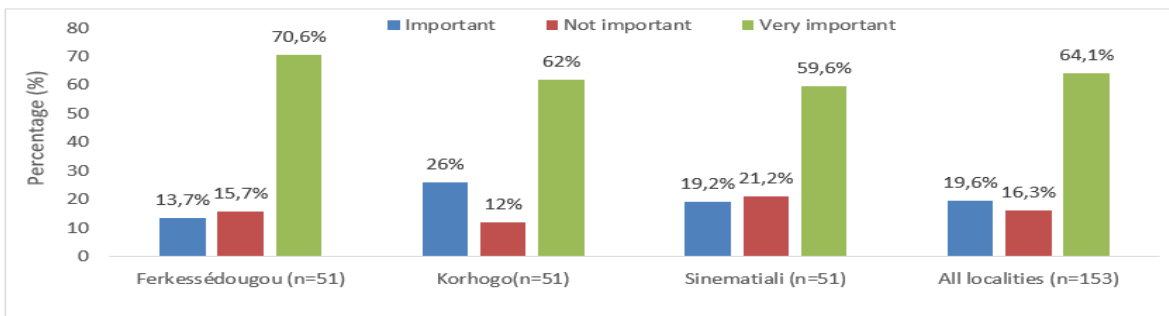


Figure 3: Levels of losses at the production level

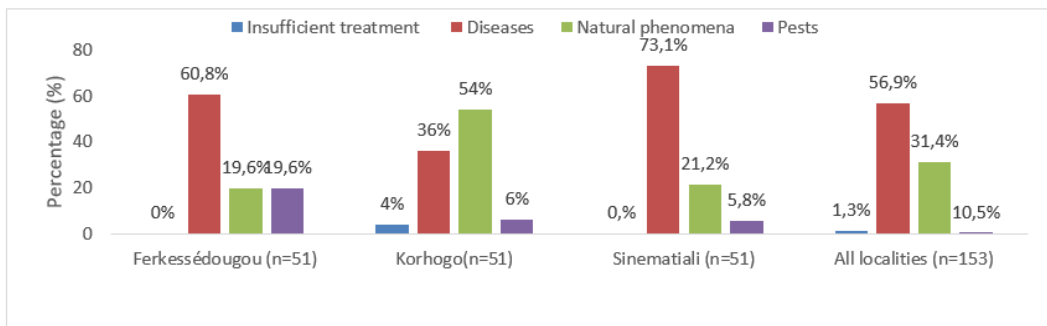
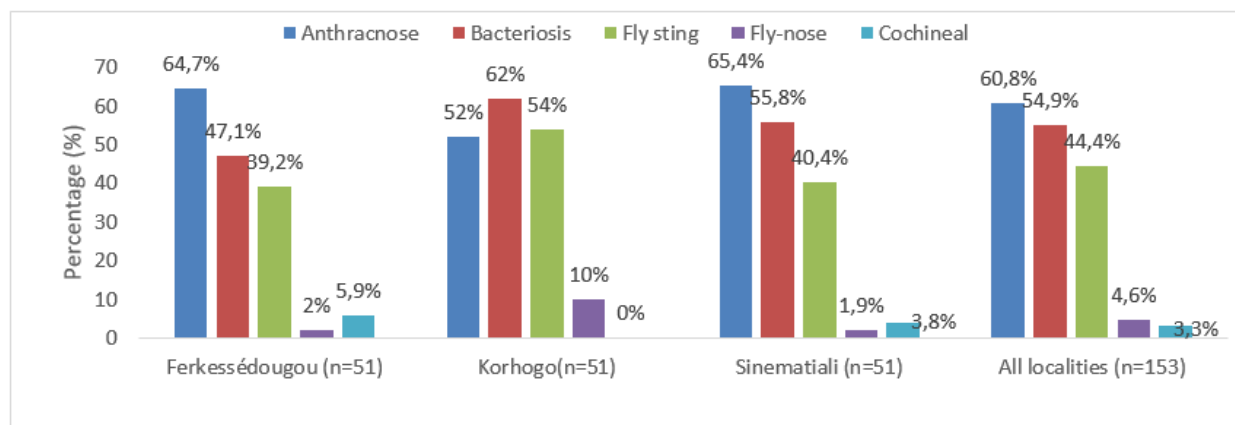


Figure 4: Causes of production losses



**Figure 5:** Observed mango diseases

### 3.1.4 Means of controlling pests and diseases

In addition, to fight against pests and diseases, producers use phytosanitary treatments (Table 2). Thus, the survey reveals that 41.8% and 19.6% of producers respectively apply Cypercal 50 EC (molecule) and pesticides for the sanitary maintenance of their orchards. But, Hexanal is the least used in all the areas surveyed 0.7%.

**Table 2:** Phytosanitary products used by producers

	Ferkessédougou	Korhogo	Sinematiali	Total (n=153)
No response	5.9	20.0	5.8	10.5
Cypercal 50 EC	29.4	60.0	36.5	41.8
Hexanal	0.0	0.0,	1.9	0.7
Pesticide	21.6	10.0	26.9	19.6
Pyriforce 480 EC	17.6	6.0	28.8	17.6
Success bait	25.5	4.0	0.0	9.8

### 3.1.5 Marketing and production difficulties

Mangoes are sold to exporters by box unit, each containing 40 to 50 mangoes. Prices vary depending on the harvest season (early, mid or late). The most applied selling price is 2350F (61.4%) per box of mango. The lowest applied price is 2400F per case. Lack of loans and lack of

organization are the major constraints at producer level (38.5% and 24.8%). Labor and crop space issues are minor constraints (Table 3).

**Table 3: Selling price and constraints related to the marketing of mangoes, F., Ferkessédougou, K., Korhogo and S., Sinematiali.**

Wholesale Price	Total			Constraints at producers' level	Total				
	F.	K.	S.		n=153	F.	K.	S.	n=153
2300 FCFA	39.2	2.0	25.0	22.2	High cost of materials	2.0	24.0	0.0	8.5
2350 FCFA	51.0	68.0	65.4	61.4	Dependence On intermediary	0.0	12.0	0.0	3.9
2400 FCFA	0.0	2.0	0.0	0.7	Cultivation area	0.0	4.0	1.9	2.0
2500 FCFA	9.8	28.0	9.6	15.7	Lack of organization	29.0	0.0	44.2	24.8
					Lack of Treatment	11.8	2.0	0.0	4.6
					No factory	13.7	18.0	15.4	15.7
					No loan	43.1	38.0	34.6	38.5
					No labor	0.0	2.0	38.0	2.0

**3.2 Transformers**

The vast majority of these industries produce between 30 and 60 tons of dried mangoes per year. 84.6% of the 13 processors surveyed have semi-industrial factories and 15.4% have industrial-type factories. However, in the locality of Ferkessédougou, all the factories are of the semi-industrial type (Table 4). All processors use the Kent variety. After this variety comes the Brook variety. These two varieties are used in all areas, while the Amélie and Keitt varieties are each used in two out of three areas (Figure 6).

The majority of processors (79.9%) believe that losses are very high (Figure 7). These losses are mainly due to technical failures and insufficient resources (Figure 8). The processors who note the absence of diseases are the most numerous, that is, 46.2% over all the areas surveyed. Regarding diseases, anthracnose and bacteriosis are only found in one out of three localities each, while the fly bite is found in two out of three localities (Figure 9).

The major constraint for processors is the seasonality of the sector (23.1%). Next come competition and order dependence (Table 5).

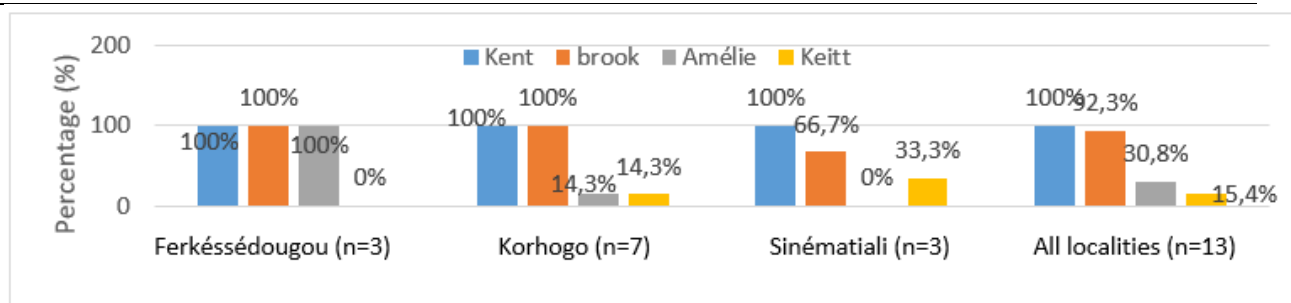


Figure 6: Mango varieties used by processors

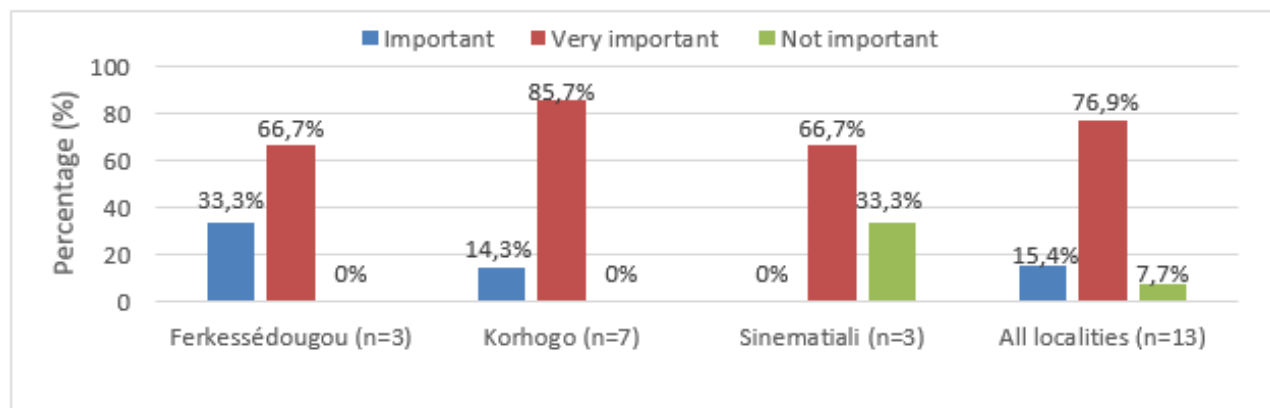


Figure 7: Loss in production at processors

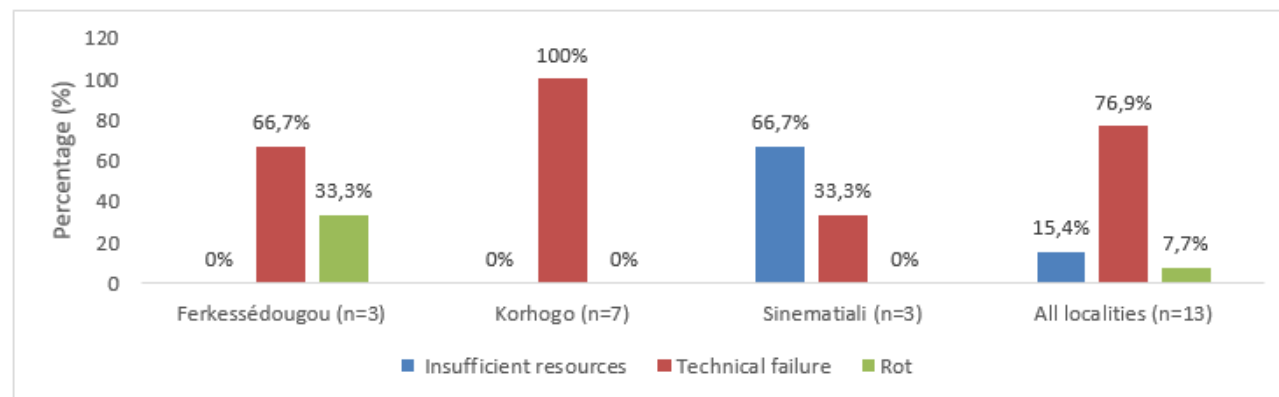


Figure 8: Causes of production losses

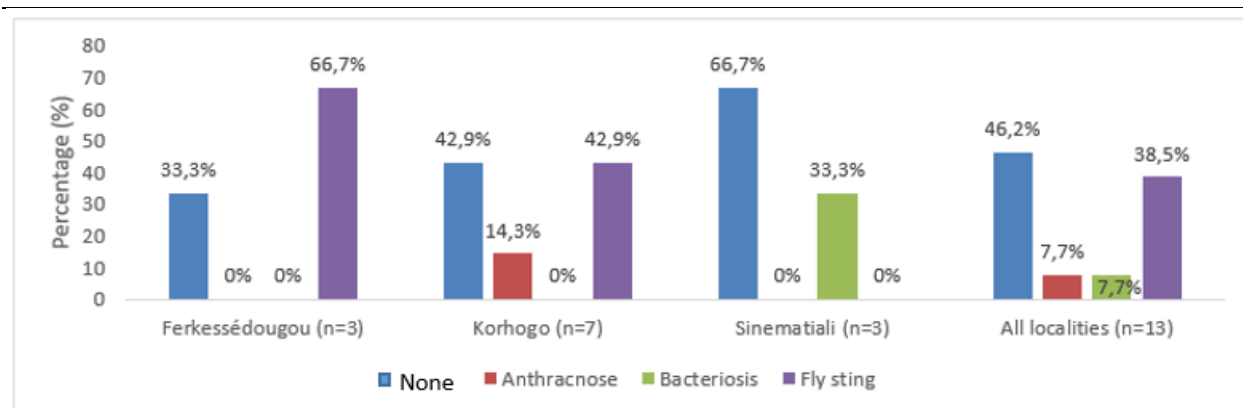


Figure 9: Diseases recorded on mangoes

Table 4: Types of processing units and monthly production of dried mangoes, : F., Ferkessédougou, K., Korhogo and S., Sinematiali.

Units of transformation	F. (n=3)	K. (n=7)	S. (n=3)	Total (n=13)	Production of dried mangoes / month	F. (n=3)	K. (n=7)	S. (n=3)	Total (n=13)
Industrial	0.0	14.30	33.3	15.4	<5 tons	0.0	28.60	33.3	23.0
Semi-industrial	100.0	85.7	66.7	84.6	30 to 45 tons	66.7	14.3	33.3	30.8
					45 to 60 tons	33.3	42.9	0.0	30.8
					>60 tons	0.0	14.30	33.3	15.4

Table 5: Constraints at transformers' level

Constraints	Ferkessédougou (n=3)	Korhogo (n=7)	Sinematiali (n=3)	Total (n=13)
Competition	0.0	0.0	66.7	15.4
Technology cost	33.3	00.0	33.3	15.3
Order dependency	33.3	14.3	0.0	15.4
Unavailability of raw material	0.0	14.3	0.0	7.7
Lack of funding	33.3	0.0	0.0	7.7
Technical breakdown	0.0	14.3	0.0	7.7



Sector seasonality	0.0	42.9	0.0	23.1
Drought	0.0	14.3	0.0	7.7

### 3.3 Exporters

At the intellectual level, most exporters have a good level with 80% having the superior level. Only 4% have the primary level. Also, those who have embraced this activity mostly have less than 10 years of experience (56.0%). Next come those whose years of experience are between 10 and 20 years (24%). Exporters with more than 20 years of experience are the least numerous (20%). With regard to the quantities of fresh mangoes exported, the quantities between 500 and 700 tons are the most exported, i.e. 44% of exporters. Next come quantities between 700 and 1000 tons (39%) from exporters. The purchase price applied per kilogram is 200F. This price is charged by 84.0% of exporters. The price of 280f/kg is practiced by 12.0% of exporters. In terms of storage time, 80.0% of exporters store it between 1 and 3 days compared to those who store it between 4 and 6 days (Table 6). In terms of the constraints mentioned, there is firstly the lack of equipment (48.0%) and secondarily the ripening of the fresh mango during transport (24%) (Table 7).

In addition, the most exported varieties are the Kent variety (100% of the actors), those who export the Keitt and Amélie varieties are only 32.0 and 28.0% (Figure 10). In terms of loss, the majority of those surveyed believe that it is significant (52.0%). Those who find that the losses are very significant represent only 4.0% (Figure 11). Regarding the causes of these losses (Figure 12), the maturation (36.0%) is the main cause. Next come diseases (32.0%) and technical breakdowns (32.0%). The main diseases reported are fly sting (52.0 %), anthracnose (36.0 %), bacteriosis (8.0 %) and fly-nose (16.0 %) (Figure 13).

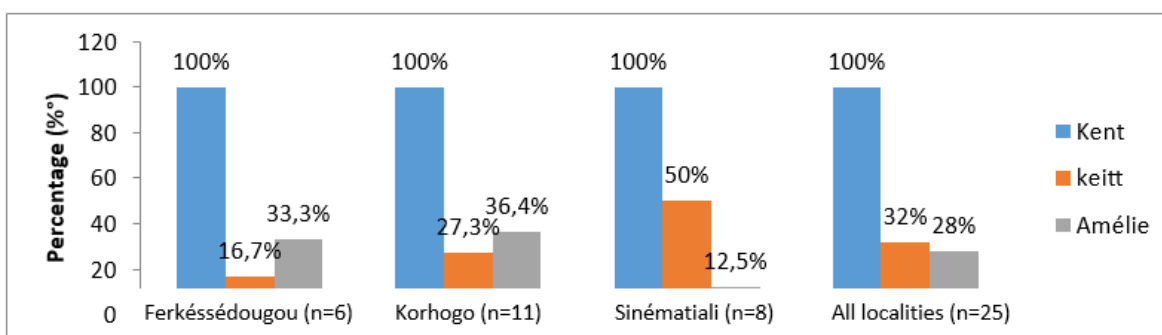
**Table 6: Quantities of fresh mangoes exported, purchase price and storage duration, F., Ferkessédougou, K., Korhogo and S., Sinematiali.**

Quantities of fresh mangoes exported (tons)	F.			K.			S.			Total n=153
	F.	K.	S.	Total =153	Purchase price (FCFA)	F.	K.	S.		
< 500	0.0	27.0	12.5	13.0	200	83.3	81.8	87.5	84.0	
500 to 700	33.3	45.5	50.0	44.0	240	16.7	0.0	0.0	4.0	
700 to 1000	66.7	27.3	25.0	39.0	280	0.0	18.2	12.5	12.0	
More than 1000	0.0	0.0	12.5	4.0	<b>Storage duration</b>	<b>F.</b>	<b>K.</b>	<b>S.</b>	<b>Total n=153</b>	
					1 to 3 days	66.7	72.7	100.0	80.0	

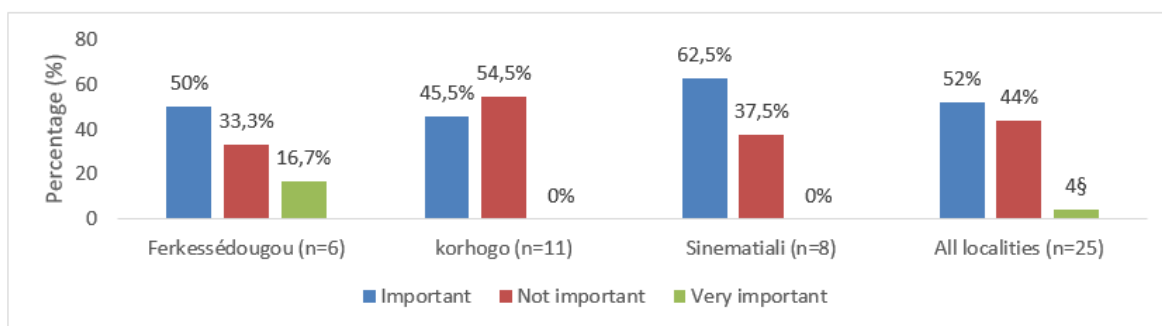
4 to 6 days	33.3	27.30	0.0	20.0

**Table 7: Constraints at the level of exporters.**

Constraints	Ferkessédougou (n=3)	Korhogo (n=7)	Sinematiali (n=3)	Total (n=13)
Lack of Material	50.0	18.2	87.5	48.0
Ripening	0.0	54.5	0.0	24.0
Technical failure	33.3	9.10	0.0	12.0
Few producers	0.0	9.10	0.0	4.0
Transport problem	16.7	9.10	12.5	12.0



**Figure 10: Mango varieties exported by exporters**



**Figure 11: Losses at the exporter level**

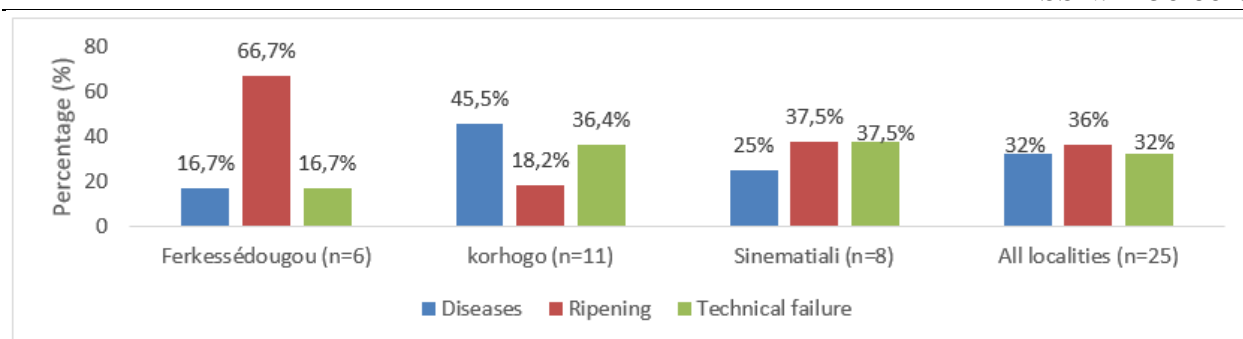


Figure 12: Causes of losses

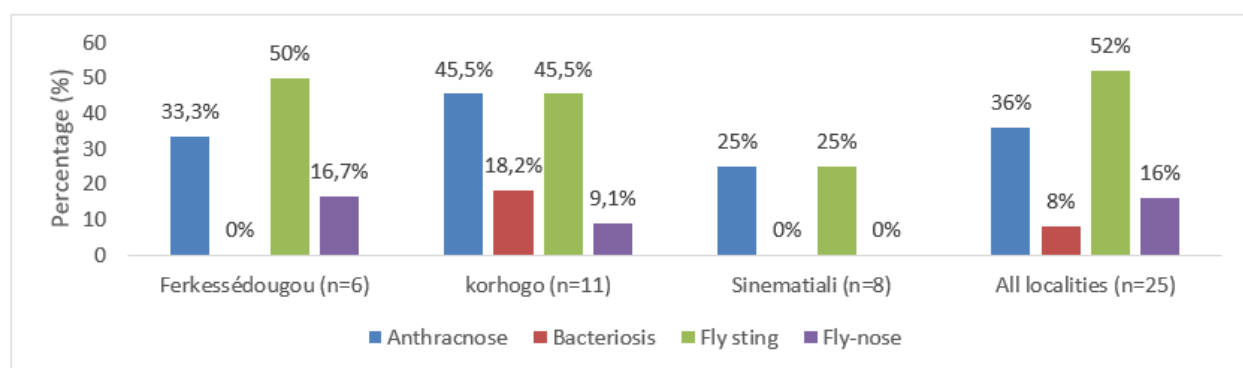


Figure 13: Diseases recorded on mangoes

### 3.4 Retailers in markets

Retail salespeople mostly have at most 5 years of experience (45.4%). Next come those with more than 10 years of experience (33.6%). The least numerous are those whose number of years of experience is between 6 and 10 years (21.0%). These retail vendors market one to eight bags a day. Retailers who sell less than 2 bags per day are the most numerous (80.8%). Next come those whose sale is between 2 and 4 bags (11.2%). Finally, those who sell more than 4 bags per day are the least numerous (8.0%). Six varieties are sold. The Kent variety is the most marketed by (98.7%) of sellers. As for the others, including Brook, Keitt, Amélie, Zill and Dadjani, they are respectively 59.2%, 31.6%, 4.6%, 21.1% and 3.3% between them.

Relative to the selling price, it varies on the market depending on the month (Figure 14). Thus, during the month of March, a mango was sold between 25f and 50f. This price evolved to reach in July, 115 to 130F (figure 14). In all localities, the most used means of storage is the disposal of mangoes in bulk (47.4%). Other non-negligible means are nets and bags (19.1 and 17.8%). Figure 15 shows the mango storage means. Figure 16 shows the shelf life of mangoes. The longest shelf life is between 5 and 10 days, or 75.5% of respondents. The shortest shelf life is less than 5 days (Figure 16). When it comes to losses at the retail level, those who find them very significant are the most numerous, at 77% of respondents. Only 4.6% of sellers surveyed believe that the losses are not significant (Figure 17). The main cause of these losses is the rotting of mangoes (62.5%). Market injury and saturation affect mangoes very little (Figure 18). The

diseases causing the losses are largely anthracnose (38.8%) and fly bites (32.9%). Soft nose is the disease that attacks mangoes the least (Figure 19).

Lack of funds is the major constraint (50.7%) of exporters. The high cost of transport comes second (20.4%) for exporters. Lack of space is the minor constraint (Table 8).

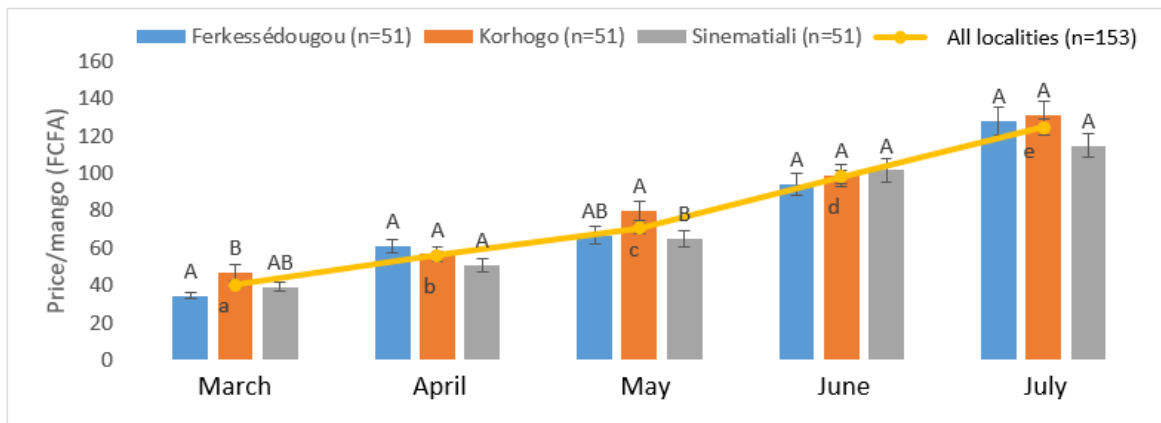


Figure 14: Evolution of selling prices on local markets

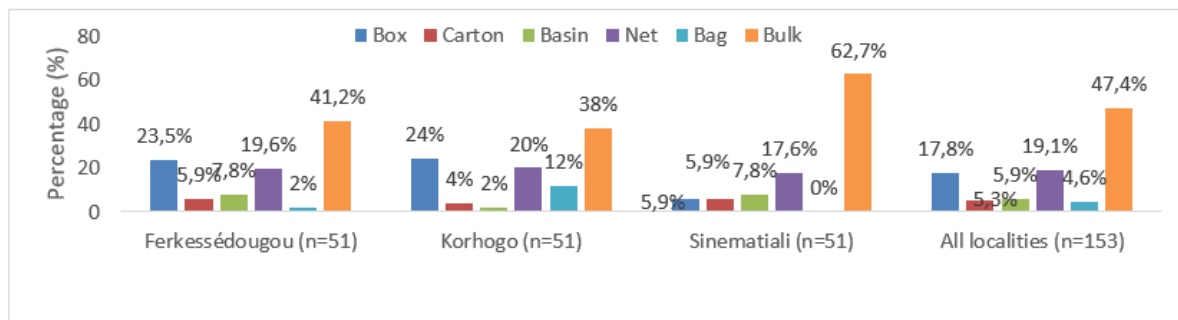


Figure 15: Way of preserving mangoes in the markets

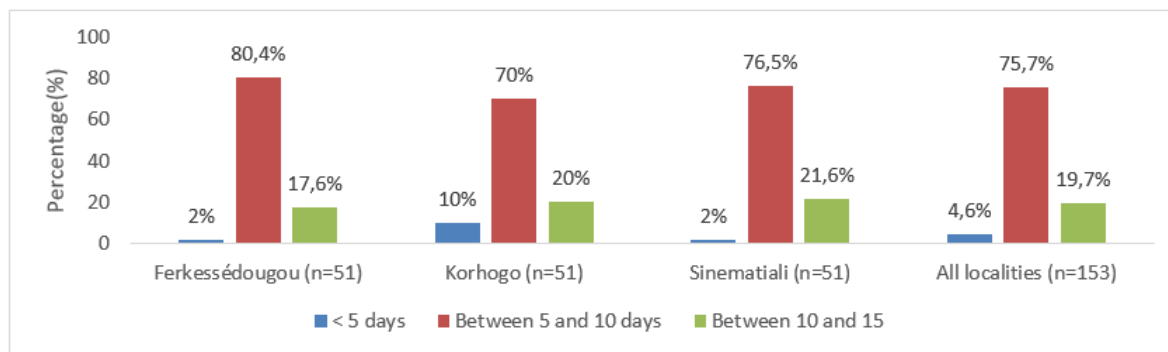


Figure 16: Shelf life of mangoes

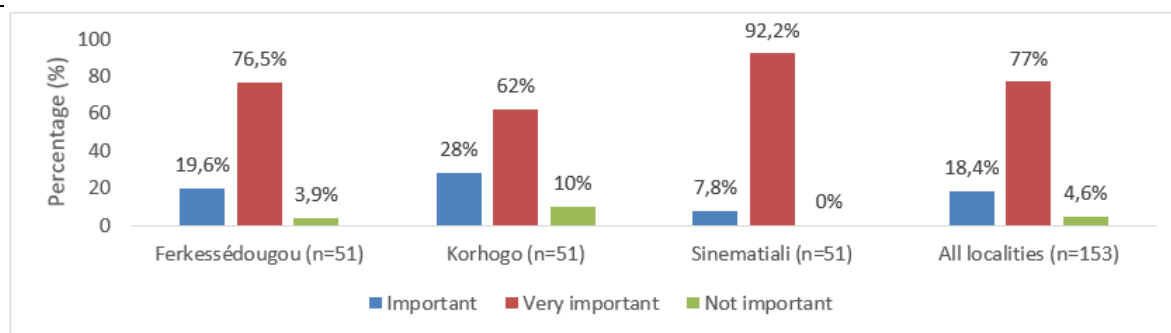


Figure 17: Assessment of losses at retail level

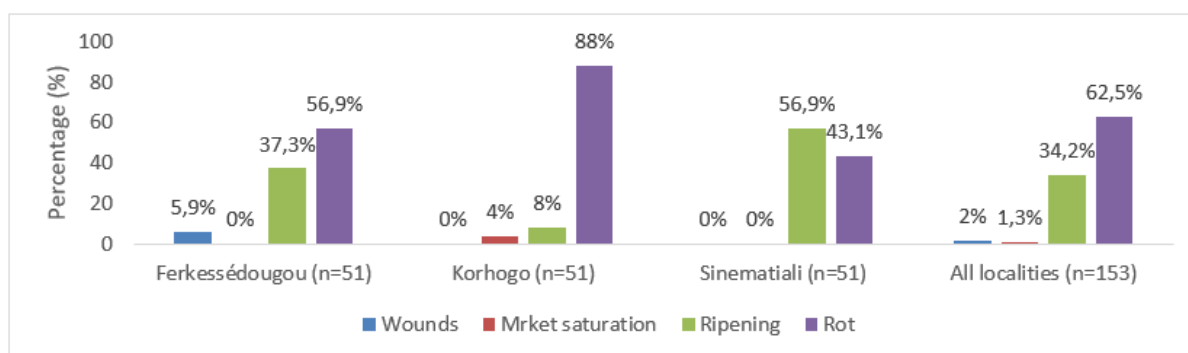


Figure 18: Causes of losses at retail level

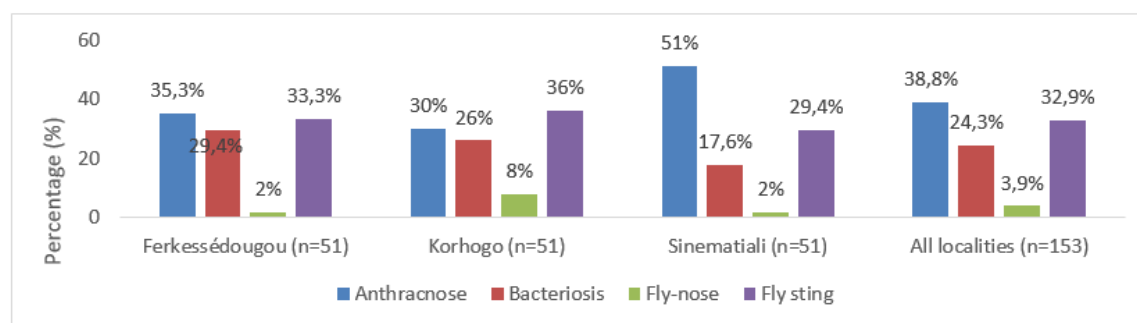


Figure 19: Diseases recorded on mangoes

Table 8: Constraints at the level of exporters

Constraints	Ferkessédougou (n=51)	Korhogo (n=51)	Sinematiali (n=51)	Total (n=153)
Transportation cost	31.0	14.0	15.7	20.4
Lack of funds	51.0	50.0	51.0	50.7

Lack of space	0.0	2.0	2.0	1.3
Unstable price	2.0	22.0	5.9	9.9
Organizational problem	7.8	2.0	19.6	9.9
Sector seasonality	7.8	10.0	5.9	7.8

#### 4. DISCUSSION

There are two types of mango processing units in our study area. These are mainly semi-industrial units (84.6%) against (15.4%) industrial units. The high rate of raw materials could be explained by the lack of funds for investment in processing plants. This typology is similar to that identified in Mali through the diagnostic study of the agricultural product processing sector (PCDA, 2005). Indeed, in the mango processing activity, 56.0% of the factories are semi-industrial units against 56.0% of the industrial type.

The results obtained during this study showed a diversity of cultivated mango varieties, the main ones being the Kent, Keitt, Amélie varieties and the wild varieties Dadjani and Djakmankou. However, the Kent variety, in addition to being produced by all producers, is the most cultivated and marketed. The preference of this variety would result in the fact that it combines many commercial qualities and its pleasant taste. According to Diallo et al. (2004) the Kent variety was the most appreciated because it has good transport resistance, a long shelf life of the ripe fruit kept cold, a large portion of pulp, good juiciness and a beautiful color of the fruits produced in adequate conditions. Similarly, CBI (2015) notes that this variety is the most sought after on the market of European Union countries where it is considered the benchmark for mangoes sold.

The results reveal a period of abundance of mangoes on the market from March when a mango was sold between 25f and 50f and a period of shortage in July with an equivalent price between 115f and 130f. This situation is justified by the ratio of demand and supply factors on the market. Minten et al. (2006) believe that two major factors explain this difference in the price level on the market. These are the variation in production due to climatic conditions and poor management of the lean season.

The shelf life of mangoes varies between 1 and 5 days for exporters against 5 to 15 days for local traders. The mango remains a fruit characterized by rapid ripening due to its post-harvest metabolism (respiration, production and action of ethylene, etc.). The short shelf life may be associated with microbial and parasitic diseases. This observation was also reported by FAO (2017), explaining that this perishable nature would therefore make mangoes very vulnerable to microbial contamination from picking to marketing, which makes its shelf life relatively short.

Huge losses are recorded among the various actors. Indeed, 64.1% of producers believe that the losses are very significant, 76.9% among processors and 77.0% among retail sellers, while 52.0% of exporters consider these losses significant. These heavy losses are due to several factors, including diseases (anthracnose, bacteriosis, fly bites, soft-nose and cochineal), technical

breakdowns, injuries, market saturation and ripening. These high losses could be explained by a real lack of knowledge of good practices among the actors and especially the diseases. Consequently, this generates a shortfall in monetary values for all the actors in the sector. N'guettia et al. (2014) reported anthracnose incidences of 26% and 24% from fruits collected from Ferkessedougou and Odienné regions respectively. This fungal disease is very present in all the study areas. Kansci et al. (2003) globally estimated mango post-harvest losses in the world at around 80%. Among the causes, it is necessary to note the overabundance of mangoes on the markets generating stocks of unsold products. The various traumas (shocks, injuries) increase the production of ethylene and compromise the quality of the mango. As it concerns ripening and rotting of mangoes, this could be justified by the lack of control over the dosages of the chemicals used. Ministry of Agriculture of India (2013) notes that the practice of ripening mangoes using the chemicals ethylene (C<sub>2</sub>H<sub>4</sub>), acetylene (C<sub>2</sub>H<sub>2</sub>), ethephon (C<sub>2</sub>H<sub>6</sub>ClO<sub>3</sub>P) and calcium carbide (CaC<sub>2</sub>) is allowed on condition that the dosage and the conditions of application are controlled. The dosage is made according to the variety, the duration of treatment and the temperature.

## 5. CONCLUSION

This study, conducted in the Poro and Tchologo regions, shows a diversity of cultivated mango varieties. However, the Kent variety, in addition to being cultivated by all producers, is the most appreciated and exported. Mangoes are mainly stored in bulk by traders and in cold storage by exporters. Huge losses are recorded due to diseases, mainly anthracnose, technical breakdowns, injuries, market saturation and ripening. Among the difficulties of the sector, it is necessary to note the lack of funds to support the sector and the seasonal nature of production.

Ultimately, other ways such as the use of bio-pesticides, training in new fly control techniques, strengthening the technical capacities of producers and preparation for certification should therefore be considered in order to increase the income of players in the mango sector.

## REFERENCES

- Bahouayila B., 2016. Les déterminants du décrochage scolaire chez les adolescents du Congo, 27 p.
- CBI, 2015. (Centre for the Promotion of imports from developing countries). Caractéristiques produits pour les mangues fraîches. [www.cbi.eu/disclaimer](http://www.cbi.eu/disclaimer), consulté le 03/09/2021.
- Diallo T. M., Rey Y., VAnnière H., Didier C., Keita S. et Sangaré M., 2004. La mangue en Afrique de l'Ouest francophone : variétés et composition variétale des vergers. *Fruits*, 59(3): 191-208.
- FAO, 2017. Database, Top Mango Producing Countries of the World. [http://www.unescap.org/sites/default/files/Module%202.1%20Mango%20story\\_edSD.pdf](http://www.unescap.org/sites/default/files/Module%202.1%20Mango%20story_edSD.pdf), consulté le 10/07/2021.
- FIRCA, 2014. Présentation des filières fruitières. La filière du Progrès n°13 du 1er trimestre, 4-5.
- Kansci G., Koubala B. and Lape I. M., 2003, Effect of ripening on the composition and the suitability for jam processing of different varieties of mango (*Mangifera indica*). *African Journal of Biotechnology*, 2(9): 296-300.
- Kouassi A., 2012. Revue Nationale pour identifier les initiatives de valorisation non alimentaire de la mangue en Côte d'Ivoire. *Revue Nationale*, 12(3): 5-43.

- Ministry of Agriculture of India, 2013. Post-harvest profile of mango. Department of agriculture & cooperation, Directorate of marketing & inspection Branch head office Nagpur, 141 p.
- Minagri, 2012. Rapport d'activités 2012. Ministère de l'agriculture (Côte d'Ivoire), Direction régionale des savanes, 53 p.
- Minten B., Barrett C., Randrianarisoa C., Randriamiarana Z. et Razafimanantena T., 2006. Riz et pauvreté à Madagascar. Africa Region Working Paper Series n°102, 186 p.
- N'guettia M. Y., Kouassi N., Diallo H. A. and Kouakou R., 2014. Evaluation of anthracnose disease of mango (*Mangifera indica* L.) fruits and characterization of causal agent in Côte d'Ivoire. *International Journal of Agriculture Innovations and Research*, 2(6): 2319-1473.
- Ouattara N., 2015. Situation des ressources génétiques forestières de la Cote d'Ivoire. Rapport d'étude. FAO/IPGRI/CIRAF, 193 p.
- PCDA, 2005. Etude diagnostique du secteur de la transformation des produits agricoles. Programme Compétitivité et Diversification Agricoles, Rapport final, LTA/IER, janvier 2005, Mali, 106 p.
- Perraud A., 1971. Les sols. Le milieu naturel de la Côte d'Ivoire, Mémoires ORSTOM n° 50, 269-391 pp.
- Talnan C., 2009. Répartition spatiale, gestion et exploitation des eaux souterraines : cas du département de Katiola, région des savanes de Cote d'Ivoire. Thèse de Doctorat, Université d'Abobo-Adjamé, Côte d'Ivoire, 142 p.
- Touré S., 2012. Etude nationale Mangue. La Côte d'Ivoire et le centre du commerce International, 1-27.
- Yao F. Z., Reynard E., Fallot J. M. et Ouattara I., 2018. Analyse de la variabilité climatologique dans le bassin versant agricole du Bandama blanc, nord de la Cote d'Ivoire. [Sciencesconf.org/aic2018:1999243](https://www.sciencesconf.org/aic2018:1999243) : 399-404/