

Original Research Article
**DIAGNOSIS IN PRODUCTION AND POST-HARVEST
PROCESSING OF NUTS OF COLA NITIDA
(MALVACEAE) IN COTE D'IVOIRE**

ABSTRACT

Aims: To determine some characteristics involved in the cola path and to reveal the main constraints related to the production and trading of cola nuts.

Study design: Field investigation from farmers in the main regions of the cola cultivation in Côte d'Ivoire. Main concerns from the cola farmers probed. Survey extended to traders of cola nuts. Responses recorded through individual questionnaire brought during visitations at farming lands.

Place and Duration of Study: From countryside farmers in 4 Districts of Côte d'Ivoire, and then from citizens traders; between 2014 and 2015.

Methodology: Study conducted in the main areas of production of cola nuts in Côte d'Ivoire, namely Districts of Mountains, Comoé, Lagoons and Down-Sassandra. Field investigation performed from 178 producers of cola nuts. Information requested about the profile, the cultural practices, the production, the plantation maintenance and the economy of the cola farmers. Data gathered through individual or collective interviews. Post-harvest treatment of the cola nuts also investigated, from 9 whole traders in the commune of Anyama.

Results: Male gender is overriding (98.9%) in cola culture. The adults between 41 and 60 years old are more represented (55.9%). Most of the farmers (68.1%) do not belong neither in cooperative nor other management structure. Hard overall farmers (94.7%) acquire their cola seeds from the neighbouring plantations or purchase them from free markets. These seeds are consisted in 66.5% of traditional variety of cola, but the percentages of users are different from the regions ($v = .309$; $p < .001$). Moreover, cocoa remains the top plant for intercropping with the cola (47.9%). The investigated districts are mainly with adult cola plants (56.5%) flowering twice a year, as well as the fruit harvesting and trading. However, the plants provide low yield from 42% of the farmers, major rate of them having any access to substantial manpower (58%) and to phytosanitary products (76.1%) for treating plants which generally have large concerns with diseases (92%) or parasites (75%). These farmers also do not rely on any information about the effective technical practices in cultivation of cola. Cola nuts seem profitable for 86.7% of the actors, but lower purchasing prices are provided to farmers (74.5%) by traders. Traders are mainly (76.6%) from "Malinké" ethnic group. In the whole trade centers, cola nuts are kept fresh using chemical pesticides. The processing is achieved by employees displaying large ignorance (89%) about health hazards involving the pesticides.

Conclusion: The production and trading of cola nuts are concerned with many troubles, and chemicals used for nuts post-harvest processing could incur serious risks for user and consumer of cola nuts. Efficient technical routes for production of cola nuts should be developed, including availability of improved seeds and storage of cola products with safety products.

Keywords: *Cola nitida* - descriptive investigation - diagnosis – farmers.

1. INTRODUCTION

Cola nitida (Malvaceae) is originated from the African rainforest. It is one of the plant species of Cola genus, for which West Africa region encloses the largest gene bank, with 40 species described [1]. The cola is usually grown for its edible fruits called cola nuts [2, 3].

In the world, Cote d'Ivoire is the top country in production and exportation of cola, with about 100,000 tons of fresh cola nuts per year [4], especially from the *Cola nitida*. Varieties resulting in white and red nuts are the most known types of cola [5]. According to the Interprofessional Fund for Agricultural Research and Council [6], most of the production of cola nuts in this country comes from the cocoa

culture area. They are of great economic interests in exchanges between Côte d'Ivoire and Sahelian countries, with annual exportation revenue close to 130 billion CFA francs [7].

Cola nuts are widely known for their high content in caffeine, between 1.84 to 2.56% [8]. They are used in food industry for production of energizing beverages [9, 10]. The pharmaceutical industry also works their caffeine and theobromine [11], which are active principles found in coffee and cocoa, for developing drugs against sleep, thirst and hunger [12]. Other uses of cola nuts are regarding with textiles and cosmetics where they record respective uses for dying and manufacturing of cosmetic products [13]. In addition, the cola nut has a social importance for various cultural and customary rituals such as births, marriages and funerals [14, 15].

Despite its obvious socio-economic importance, the sector of cola nut is concerned with several troubles regarding production, and trading and the final quality of the marketed product. The seeds used in implementation of cola plantations are generally with lower yield, and farmers remain facing difficulties in the maintenance of their plots. Moreover, post-harvest preservation of the cola nuts for fresh is a permanent concern in farms, especially as the higher polyphenols content [8] involves in faster enzymatic browning as soon as the nuts are wounded. However, the market chain in Ivorian cola business is mainly supported by smallholder farmers, rural hawkers, rural storage points, communal storage sites, and wholesale stores in Anyama and Bouake. From this chain, the purchasing prices provided to the cola producers are not always attractive and many of them forsake their cola plots for accounting other crops such as cocoa and rubber that seem more profitable.

Such difficulties reflect the lack of information accounting with the sector of cola nuts, particularly in terms of providing management and technical assistance, cultural practices, availability of suitable seeds, and standards of quality and set price for farmers. The current investigation aims in providing data on main characteristics and constraints for addressing the culture of *Cola nitida* in Côte d'Ivoire and improving its profitability.

2. MATERIAL AND METHODS

2.1 Investigation site

The study was conducted in the main areas of production of cola nuts in Côte d'Ivoire, namely Districts of Mountains, Comoé, Lagoons and Down-Sassandra. The investigated regions are located between 2°30' and 8°30' of West longitude and between 4°30' and 10°30' of North latitude (figure 1). The districts of Comoé, Lagoons and Down-Sassandra extend between 0 m and 200 m of altitude, while district of Mountains displays various altitudes with many peaks rising over 1,000 m. Nevertheless, all the areas record a bimodal climate with two rainy seasons (March-July and October-November) alternating with two dry seasons (December-February and August-September). The mean rainfall in the areas varies between 1,600 mm and 2,400 mm per year.

2.2 Descriptive survey

An investigation at field was conducted from a total number of 178 farming producers of cola nuts in the overall districts investigated. In this intention, farmers were asked about their profile, cultural practices, production, plantation maintenance, and their economy, using questionnaire guides. Data were gathered through individual or collective interviews. The survey was also performed upon the post-harvest treatment of the cola nuts from the wholesale actors in the commune of Anyama with a questionnaire duly filled by 9 owners of cola nuts shops.

2.3 Statistical analysis

The collected data were entered using the Sphinx Plus software (version 4.5) then treated with Statistical Program for Social Sciences software (SPSS Version 20.0). The statistical analysis consisted in Pearson chi-square (χ^2) non-parametric tests from each parameter, and then dynamic cross tables were built, at 5% significance level. Results were expressed in percentage.

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Figure 1: Map showing the different administrative districts of the Republic of Côte d'Ivoire.
In red colour, the main districts investigated.

3. RESULTS AND DISCUSSION

3.1 Profile of the cola farmer

Table 1 shows various characteristics from the farmers investigated. The cola culture is a male gender overriding activity (98.9%), accounting yet 1.1% women. It involves in greater number of 41 to 60 years old people (55.9%), with 22.9% from 41 to 50 years and 33% from 51 to 60 years. From the overall respondents, 83.6% record 11-40 years of farming practice, with 40% between 21 and 30 years of experience. Oppositely, only 9% and 6.4% of them provide farming experience below 10 years and over 40 years, respectively. Also, the farmers do not belong to any cooperative or management structure (68.1%), only 2.1% of them being into an organization.

Furthermore, 18.1% farmers do not use any employee; but most of them (81.9%) use between 1 and 12 employees in their cola plantations. However, those employing 1 to 5 workers (67.6%) are the most represented, including 19.7%, 14.9% and 12.8% for respective 2, 3 and 5 employees. These employees are paid in cash (45.7%) or with payment in kind (43.1%), especially as some of them operate in family duties.

88 **Table 1:** Main characters highlighting the profile of the cola farmers investigated

Investigation parameters	Responses recorded (%)
Gender of farmer	Male (98.9%); Female (1.1%)
Age range of farmers (years)	0-10 (0.5%); 11-20 (0%); 21-30 (4.3%); 31-40 (18.6%); 41-50 (22.9%); 51-60 (33%); 61-70 (15.4%); 71-80 (3.2%); 81-90 (2.1%)
Farming experience (years)	0-10 (9%); 11-20 (26.1%); 21-30 (39.9%); 31-40 (17.6%); 41-50 (3.7%); 51-60 (2.7%); 61-70 (0%); No response (1.1%).
Number of employees per farmer	None (18.1%); 01 (11.2%); 02 (19.7%); 03 (14.9%); 04 (9%); 05 (12.8%); 06 (4.6%); 07 (5.3%); 08 (1.1%); 09 (0.5%); 10 (1.6%); 12 (0.5%); No response (0.5%)
Type of remuneration of employees	In cash (45.7%); Other means (43.1%); No response (11.2%)
Belonging in any organization of the cola path	Yes (2.1%); No (68.1%); No response (29.8%)

89

90 **Table 2:** Number of farmers, acreages and number of cola trees in fields from the different localities
91 investigated.

Investigated areas (Districts)	Locations	Number of farmers	Fields Acreages (ha)	Number of trees
District of Mountains	Daineu	17	6.33	988
	Danane	27	38.63	6,027
	Zouan-Hounien	12	31.28	4,880
	Overall	56	76.25	11,895
Districts of Comoé and Lagoons	Aboisso	10	62	9,672
	Agboville	10	6.98	1,089
	Agou	10	6.26	977
	Akoupé	9	4.94	770
	Biannoua Attiékro	10	39.74	6,200
	Yakassé Attobrou	7	1.72	269
	Overall	56	121.65	18,977
District of Down-Sassandra	Béréby	10	10.54	1,645
	Dogbo	8	7.6	1,185
	Gabiadji	7	4.36	680
	Grabo	15	39.65	6,186
	Ménéké	8	22.73	3,546
	Touih	10	5.35	835
	Watte	8	5.26	821
	Overall	66	95.5	14,898
Overall		178	293.4	45,770

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93 **3.2 Data from cola plantations**

94 The areas of the cola plantations and the number of plants are shown in table 2. Districts of Comoé and
95 Lagoons gather 121.65 hectares of cola plantations from 56 fields and about 18,977 cola plants.
96 Regarding the District of Mountains, 56 separate parcels of cola are also found, but they cover only 76.25

97 ha for overall number of 11,895 cola trees. With District of Down-Sassandra, 95.50 ha of cola plantations
 98 are recorded from 66 parcels containing 14,898 cola plants. A greater percentage of the investigated
 99 plantations (56.5%) are settled for 11 to 40 years. But 18.1% plantations are older, between 41 and 90
 100 years, when only 2.6% are younger trees below 10 years of age (table 3).

101 3.3 Cultural techniques used by farmers

102 For achieving in cola plantations, 94.7% farmers use self-providing of seeds from their own means,
 103 picking cola nuts from neighbouring plantations or pre-existing cola trees, especially as 34% of the
 104 investigated farmers stated having found cola plants on the spot when implementing the plantations. Only
 105 2.7% of the planted seeds originate from structures such as National Centre of Agronomic Research
 106 (CNRA). Also, the planting of cola seeds is preceded by steps of nurseries from 22% farmers; while 44%
 107 use direct growing of the cola nuts in the field soil. The other farmers (34%) seem ignoring the plantation
 108 technical practiced (table 4).

109 Most of the farmers have never processed for any replacement of the cola trees (65%). But 19% of them
 110 claim having replaced the cola plants for at least one occasion with other perennial crops such as cocoa
 111 and coffee. In 73% of cases, farmers do not make any distinction between cola nuts' appearances, which
 112 are generally white, red, purple, or indigo. These colours have important role in consumer habits and
 113 customs and are significant factor for the trading of cola nuts (table 4).

114

115 **Table 3:** Age group of cola trees planted in the districts investigated

Age groups of cola trees	Percentage of responses by location (%)			Overall
	District of Mountains	Districts of Comoé and Lagoons	District of Down-Sassandra	
0-10 years	0.5	0.5	1.6	2.6
11-40 years	12.2	17.1	27.2	56.5
41-90 years	6	11.1	1.0	18.1
No answer	12.2	5.3	5.3	22.8
Overall	30.9	34.0	35.1	100

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117 **Table 4:** Some parameters of cultural practice for cola plantation

Settings	Responses
Way of acquiring of cola seeds	Individual (94.7%); Governmental (2.7%); No Answer (2.6%)
Nursery implementation	Yes (22%); No (44%); No response (34%)
Presence of previous cola trees while achieving the plantation	Yes (34%); No (12%); No response (55%)
Knowing the different colours of the cola nuts from trees	Yes (14%); No (73%); No response (13%)
Substitution of some cola trees by other perennial crops	Yes (19%); No (65%); No response (16%)

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119 Statistically, tables 5 to 7 show divergences between investigated regions regarding with varieties of
 120 planted seeds ($v = .309$; $p < .001$) and crops associated with the cola plants ($v = .38$; $p < .001$). Thus, the
 121 seeds deriving from traditional cola varieties are preferred by a greater rate of farmers (66.5%), from
 122 which 31.4% are found in Districts of Comoé and Lagoons against less than 20% in each of both Districts
 123 of Mountains and Down-Sassandra. The preference of improved varieties is assumed by only 20.7%

125 farmers, mainly in the Districts of Down-Sassandra (11.7%) and Mountains (8%). Besides, 12.3% of
 126 farmers use combination of traditional and improved seeds for achieving their cola plantations (table 5).

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128 **Table 5: Responses for seeds of cola varieties planted by farmers from the investigated areas**

Seed varieties	Responses from Districts (%)			Overall
	District of Mountains	Districts of Comoé and Lagoons	District of Down-Sassandra	
Traditional	19.10	31.40	16.00	66.50
Improved	8.00	1.00	11.70	20.70
Combination of Traditional and Improved	3.30	1.60	7.40	12.30
No answer	0.50	0.00	0.00	0.50
Overall	30.90	34.00	35.10	100.00
Statistical data		$\chi^2 = 0.309$; $p < 0.001$		

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130 Furthermore, the mixed cola planting in association with other perennials crops (especially coffee and
 131 cocoa) is more practiced (81.4%) than the monoculture observed from only 18.6% of the visited farms
 132 (table 6). For the intercropping, cocoa is used in 47.9% of the mixed cola plantations, against 13.3% for
 133 coffee and 19.7% with the combination of both cocoa and coffee. The intercropping of cola with cocoa is
 134 significantly practiced in the District of Down-Sassandra (26.6%), whereas in this area, any simple
 135 association of cola with coffee is recorded. For the combination of coffee and cocoa in association with
 136 cola, the District of Mountains is more provided (12.3%) as shown in table 7.

137 **Table 6: Responses of farmers according to the method of cola culture from the investigated areas.**

Crop types	Responses from Districts (%)			Overall
	District of Mountains	Districts of Comoé and Lagoons	District of Down-Sassandra	
Monoculture	3.8	9.0	5.8	18.6
Mixte	27.1	25.0	29.3	81.4
Overall	30.9	34.0%	35.1	100

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140 **Table 7: Responses of farmers related to the plants intercropping with cola from the investigated areas.**

Intercropping	Responses from Districts (%)			Overall
	District of Mountains	Districts of Comoé and Lagoons	District of Down-Sassandra	

Cocoa	8.0	13.3	26.6	47.9
Coffee	6.9	6.4	0.0	13.3
Cocoa / Coffee	12.3	4.2	3.2	19.7
No answer	3.7	10.1	5.3	19.1
Overall	30.9	34.0	35.1	100
statistical data			v = 0.38; p < 0.001	

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142 **3.4 Production of cola nuts**

143 Activities related to the cola nuts production from cola trees, namely plants flowering, pods harvesting and
 144 plantations maintenance, occur at various seasons each year.

145 Figure 2 shows that cola trees flower twice a year: a large flowering period mainly recorded in the third
 146 quarter of the year (from July to September) with peak in August (24.4%), and another flowering season
 147 accounting lower rates from December to February, and peaking in January (6.4%). Two separate
 148 periods of cola nuts harvesting and trading are also mentioned in the areas visited. The higher campaign
 149 runs from September to February with top yield in November-December according to 17.7% farmers. The
 150 small harvesting season extends between March and June, and April is more indicated by farmers
 151 (10.7%). For the maintenance of the cola plantations, the period of August to January is more
 152 appropriate. The months of October and December record respective rate of 18% and 31% farmers for
 153 weeding their plantations (figure 2).

154 The flowering of the cola trees is diversely appreciated. Indeed, 35.5% visited farmers stated on lower
 155 flowering of the cola trees, while 10.1% of them found the flowering medium-yielded, and 26.1% with
 156 statement of higher flower production from cola trees. From flowers to fruits, the table 8 highlights
 157 ignorance of the main development stages of the follicles upon the cola trees from more than the half of
 158 the investigated farmers (50.5%), while these steps are clearly identified by 43.1% of them. The cola
 159 trees provide low yield of cola nuts from above 58% farmers as revealed in the caption. But the yield is
 160 found medium-sized by 20.3% farmers and only 5.3% persons are for higher yield estimation. In fact, the
 161 number of cola follicles varies strongly from trees. For 68% farmers, this number is between 0 to 10
 162 follicles per tree. Oppositely, 8.5% opinions indicate fluctuation between 11 and 30 follicles per tree, and
 163 beyond 40 follicles per tree from 2.7% farmers (table 8).

164 Generally, cola producers are with disposal of lands for growing other perennial crops (94.1%) such as
 165 cocoa, coffee and rubber. However, these crops result in lower yield for 52.1% farmers, when only 14.4%
 166 find them highly productive (table 8).

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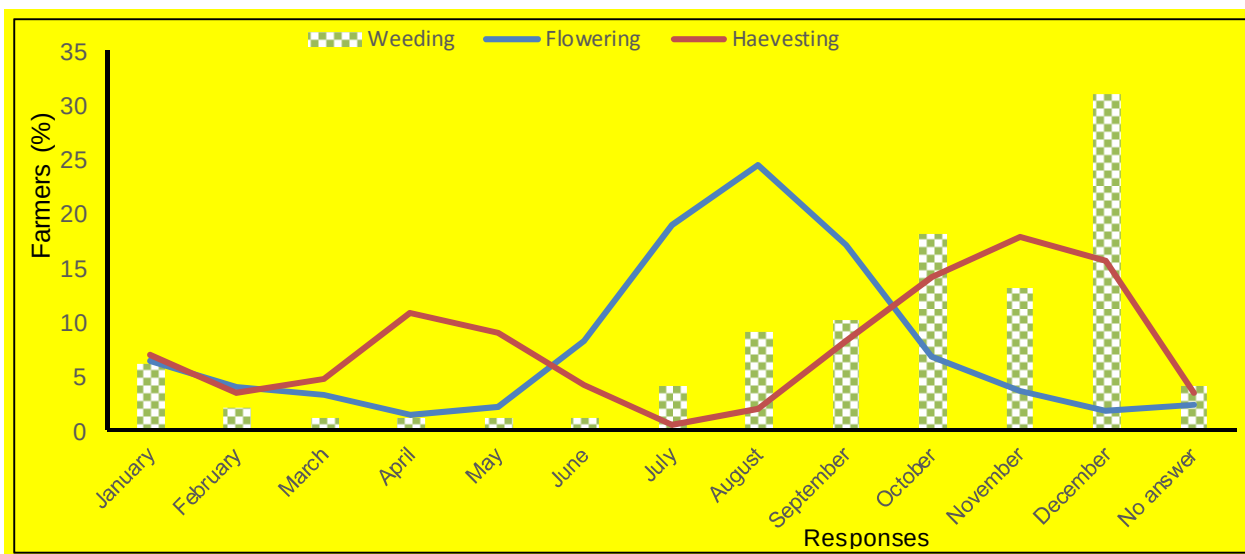


Figure 2: Curves of farmers' responses relating to periods of flowering, harvesting and weeding from their plantations of *Cola nitida*.

Table 8: Harvesting parameters from cola trees in Côte d'Ivoire

Harvesting parameters	Responses from farmers (%)
Quantity of flowers from cola trees	Very low (1.1%); low (33.5%); medium (10.1%); high (26.1%); No answer (29.3%)
Yield of the cola trees	Very low (16.5%); low (42%); medium (20.3%); high (5.3%); very high (0.5%); No answer (15.4%)
Number of pods per cola tree	0-10 (68.6%); 11-20 (4.8%); 21-30 (3.7%); 31-40 (2.7%); 41-50 (1.1%); 51-60 (0%); 61-70 (1.1%); 71-80 (0.5%); More 81- (0.5%); No response (17%)
Knowing the various development stages of pods	Yes (43.1%); No (50.5%); No Answer (6.4%)
Having other perennial crops	Yes (94.1%); No (4.8%); No Answer (1.1%)
Yield from other perennial crops	Very low (9.5%); Low (42.6%); medium (24.5%); High (10.1%); Very high (4.3%); No Answer (9%)

3.5 Maintenance in cola plantations

Every year, 83% cola farmers process in weeding their plantations at the same seasons. But 13.8% farmers weed the parcels at various periods during years. For the maintenance of fields, the manpower is available for only 38.3% farmers, while 58% report not having access to workers (table 9). Most farmers (76.1%) do not use pesticides for maintaining their cola parcels, unlike a lower number of persons accounting for 22.3%.

Still, almost the overall farmers admit the obvious presence of diseases (92%) or parasites (75%) from their cola trees. The hazards involving with these agents are identified by 25% farmers and remain

183 unknown from beyond 68%. Consequently, few farmers engage fighting against the plants diseases
 184 (11.7%) or parasites (17.5%), while there isn't any control method applied from 71.8% and 41.5% of
 185 them, respectively (table 10).

186

187 **Table 9:** Farmers' responses according to the cola plantations maintenance in Côte d'Ivoire

Response options	Rate per parameters (%)		
	Invariability of weeding periods from years	Availability of manpower	Use of phytosanitary products
Yes	83	38.3	22.3
No	13.8	58	76.1
No answer	3.2	3.7	1.6
Overall	100	100	100

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189

190 **Table 10:** Responses of farmers regarding with the health status of their plantations and reactions
 191 against diseases

Parameters	Responses rate per parameter (%)			
	Yes	No	No answer	Overall
Attacked cola trees	92	5.30	2.70	100
Knowing of diseases	25	68.10	6.90	100
Fighting against diseases	11,70	71,80	16.50	100
Presence of parasites on cola trees	75	3.70	21,30	100
Fighting against parasites on cola trees	17.50	41,50	41	100

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194 **3.6 Socio-economical aspects**

195 From the overall responses, the production of cola nut is a profitable activity for farmers (86.7%). It
 196 accounts major contribution in the livelihoods of 52.1% farmers, of which 12.2% find it significant.
 197 However, 74.5% farmers state that the cola nuts are sold with lower purchasing prices. In fact, table 11
 198 reveals that 76.6% farmers sell their crops to only Malinké ethnic speaking traders. Few proportion of
 199 farmers have alternative in selling the cola nuts through structures (19.7%) or other means (2.7%).

200 **Table 11:** Actors of trading and financial impact of the cola nuts sale in revenues of cola farmers

Parameters	Percentage of response per parameter (%)
Main traders of cola nuts	Malinké (76.6%) - Structures / Malinké (19.7%) - Other (2.7%) - No Answer (1.1%)
Profitability of the culture of cola	Profitable (86.7%) - Not profitable (12.2%) - No Answer (1.1%)

Appreciation of field price of cola nuts	Yes (22.9%) - No (74.5%) - No Answer (2.6%)
Part of sale of cola nuts in general incomes	Very important (12.2%) - Important (39.9%) - Medium (10.6%) - Low (12.2%) - very low (17%) - No Answer (8%)

3.7 Post-harvest treatments of the cola nuts

Whole traders store the cola nuts in shops. An unvarying rate (33%) of these stores employs from 20 to 30 workers and 30 to 40 workers. Oppositely, the number of employees is not sounded from 34% of the visited stores (table 12). However, in the overall storage sites, employees have a relative lower level of scholar background: 50% have never been to school and are often illiterate, 33% have received primary education, against only 17% for the college level of formal education and none for the superior education. These persons are gathered into several age groups. Thus, 21% employees are below 20 years old, from which 9% having less than 15 years of age. Table 12 shows adults employees of 31 to 40 years old (28%) and above 40 years (28%) most commonly used in the shops. The cola nuts are washed with insecticides once a quarter in 67% stores and 2 twice a quarter in 33% stores. The hazards surrounding with the misuse of these insecticides remain unappreciated by 89% employees and only 11% of them provide information thereabout (table 12).

Table 12: Profile of employees in trading and processing of cola nuts

Parameters	Percentage of response per parameter (%)
Number of employees per shop	20-30 (33%) - 30-40 (33%) - No Answer (34%)
Education level of employees	No schooling (50%) - Primary school (33%) - College (11%) - High School (6%) – Superior Education (0%)
Age range of employees	Below 15 (9%) - 15-20 years (13%) - 21-30 years (22%) - 31-40 years (28%) - beyond 40 years (28%)
Number nuts soaked by quarter with use of insecticide	Once (67%) - Twice (33%)
Risks from the chemicals used	Known (11%) - unknown (89%)

DISCUSSION

This survey covers the main regions involving with the culture of cola in Côte d'Ivoire. It highlights the general constraints from the production, trading, and post-harvest processing of the cola nuts. From the overall zones visited, the cola is mainly planted by men who are generally at the second age, between 41 and 60 years old. Similar observation was made from other perennial crops such as coconut [16]. This is even more logical that cola trees are mostly adult or old; less than 3% being younger trees of below 10 years.

The farmers of *Cola nitida* are not gathered in neither cooperative nor other association and do not benefit from management provided by any structure; showing that the activity remains generally informal in Côte d'Ivoire. Thus, the self-acquired seeds from neighbouring plants or from markets could be not always resulting in healthy plants. Such seeds can be affected by parasites as *Balanogastriis Kolae*,

Sophrorhinus spp Characomasti ctigrapta or *Phosphorous virescens* [17, 18], leading to lower development of plants.

Farmers often use traditional cola seeds, corroborating previous observations of Tachie-Obeng and Nick [19] on the trend of lower uses in improved cola seeds by farmers. This trend could be derived from a hard access of farmers to improved seeds. The almost full cola trees are planted in intercropping scheme using perennial crops among with cocoa is the most representative. Similar practice was reported by Oladokun et al. [20] in cola farms from Ogun State in Nigeria, with 55% of cocoa-cola intercropping, 16% of cola- coffee-cocoa associations and only 29% cola monoculture. The advantage for the intercropping lies in the production of light shade by the cola trees, allowing better yield for cocoa or coffee. The feedback of such practices is related to the biomass deriving from the associated crops, improving the performance of cola trees [19, 20]. In the intercropping plantations, cola nuts are also sources of cash incomes for remunerating the manpower which is usually paid after harvesting of coffee and cocoa.

The survey also revealed that flowering of cola trees and nuts harvesting seasons appear two times per year. The great flowering season comes before the main harvesting period, while the little flowering season of cola leads to the minor production of nuts. The bimodal appearance of agronomic traits of cola in Côte d'Ivoire was reported by Alloco et al. [5] and Seri [7]. According to these authors, the lower harvesting of cola nuts is recorded from months of April and May and the higher season occurs between October and November. It's especially during the great harvesting season, resulting therefore in better incomes, that the plantations are weeded. In this case, the weeding is performed for facilitating harvesting of the cola nuts.

Yet, Oladokun et al. [20] reported that continuous weeding could improve the yield of cola trees. Indeed, the investigated farmers noted the overriding of lower numbers of cola flowers and pods per tree. Lower production is also reported from the other crops associated with (coffee and cocoa). Beyond obvious inadequate agro-climatic conditions, this could result from insufficient maintenance in plantations. In fact, most of the farmers are with lack of access to manpower and phytosanitary products such as Super Callifan 40 EC, Rund up 360 SL, Thiosulfan 60 EC, etc. These needs are necessary for maintaining the plots. The lack of financial revenue and accurate information in use of phytosanitary products regarding with the cola culture remain the main causes mentioned, especially as overall farmers are aware of the diseases and parasites in the plantations. These parasites are able to infect the cola nuts at the earlier development stage [21].

In socio-economic terms, the production of the cola nut is a profitable livelihood which provides significant contribution in the family incomes for farmers, despite the lower purchasing prices. The mean price for purchasing cola nuts from fields is about 150 FCFA/kg. This price is insignificant compared to the 1,300 FCFA/kg of the exported cola nuts [7]. The monopoly of traders originating from Malinké ethnic group and the lack of cooperative in the sector could explain such a lower cola nuts price from the farming lands. However, the cost involving with the post-harvest processing of the nuts from wholesale traders should also be considered. Indeed, once acquired, the nuts undergo two ways of processing. They are sorted for removal of default nuts and soaked in chemical pesticides for resulting in fresh nuts for long. Thus, cola nuts are dipped 1 or 2 times every quarter in chemical pesticides solution, in order to fight against pests and keep them fresh nuts for the sale.

The storage activities regularly involve over 20 adult employees per shop. They are persons with rather lower level of education and whose ignorance of the main warnings in use of chemicals could derive in serious risks [22, 23] for themselves and for cola nut consumers. For worst, traders often use prohibited pesticides in Côte d'Ivoire such as DDT. Several studies have found pesticides residue levels more beyond the limits set by standards [23].

4. CONCLUSION

This study was conducted in the Districts of Mountains, Comoé, Lagoons, and Down-Sassandra, and has beforehand identified the main actors from the path of *Cola nitida* in Côte d'Ivoire. Then, it showed that the production and trading systems are facing many troubles, including the lack of organization and management for farmers, the unavailability of improved seeds, and especially the lower purchasing price provided to farmers at the field level. The investigation also revealed the use of chemical pesticides for

storage of the cola nuts, incurring serious possible risks for users and consumers of cola nuts. The development of efficient technical routes in the production of cola nuts should be stressed, incorporating production of improved seeds and storage of cola products with safety for users and consumers.

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