

Sociological characteristics of producers and traditional weed management methods practiced by sorghum (*Sorghum bicolor* (L.) Moench) producers in northern Côte d'Ivoire

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Abstract

Weed management in sorghum cultivation has become a major problem for producers, who are generally poor. The overall objective of this study is to identify weed management methods and determine the weed flora in sorghum fields. Sixty sorghum producers were asked to complete a questionnaire on weed management techniques and weeds commonly found in sorghum fields during the growing cycle. The results showed that producers aged between 35 and 55 are more likely to grow sorghum. Family farming is the most common type of farming operation. Regarding weed management, more than 70% of producers combine manual weeding and herbicide application. In addition, they weed two to three times during the growing cycle. These weeding are carried out either immediately after sowing (100%), during growth (33.33%) and/or during flowering (66.67%) of the sorghum. In terms of recurring weeds, producers reported that 28 weeds are frequently observed in sorghum fields. These weeds mainly belong to the Poaceae family (15 species). Therophytes (42.86%) and grasses (75%) are the most abundant biological and morphological types, respectively, in the weed flora. Knowledge of recurring weeds and traditional weed management techniques could enable the implementation of an effective weed management method and optimization of sorghum crop yields.

Keywords: Weed Management; Recurring Weeds; Yield Optimization; Sorghum

1. Introduction

Sorghum ranks fifth in the world in terms of production after wheat, rice, corn, and barley. In Africa, its production reaches 27 million tons, with global production estimated at 57 million tons per year (Togo, 2019) [1]. In Côte d'Ivoire, sorghum is grown in northern regions above the 8th degree of north latitude, with an average annual production of around 40,000 tons (Akanvou *et al.*, 2007) [2]. This production falls short of domestic demand. Thus, to meet its sorghum needs, Côte d'Ivoire must import approximately 10,000 tons of sorghum grain annually (Akanvou *et al.*, 2007) [2]. This situation is reportedly due to several constraints facing the crop. Indeed, sorghum cultivation faces several constraints, including the use of traditional cultivars with low yield potential (Dede *et al.*, 2020) [3], biotic factors (diseases, weeds, birds) and abiotic factors (poor soil quality, shorter rainy seasons, changes in sowing dates and prolonged droughts) that severely reduce its yield (Akanvou *et al.*, 2006) [4]. Among biotic factors, weeds play a significant role in yield losses (Le Bourgeois and Marnotte, 2002) [5]. They can cause up to 25% of production losses in

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tropical areas and 5% in temperate areas. Weeds generally serve as host plants, refuges, and reservoirs for certain pests (Kouamé 2014; Yapi 2017) [6, 7].

Several weed management methods are used by producers to reduce the impact of weeds on farms (Yapi et al., 2020) [8]. However, there is no specific weed management method for sorghum crops. In light of the above, effective weed management strategies must be implemented in order to meet national demand. To achieve this goal, it is necessary to have in-depth knowledge of the flora and traditional management techniques used by farmers in sorghum cultivation. Unfortunately, few studies have addressed weed management practices in sorghum cultivation in Côte d'Ivoire. This led to the initiation of a study on the identification of farmers' weed management practices and the social characterization of producers.

2. Material and methods

2.1. Study site

The department of Kong is located in northern Côte d'Ivoire, in the Tchologo region, and covers an area of 8,400 km². It is bordered to the north by the department of Téhini and Burkina Faso, to the south by the department of Dabakala, to the east by the Comoé River and the department of Bouna, and to the west by the departments of Niakaramadougou and Ferkessedougou. The geographical coordinates are 9°09'00" North, 4°37'00" West. A total of sixty producers were interviewed in four localities in the Kong department. These are the localities of Sidana, Nafana, Manogota and Bilimono (Figure 1).

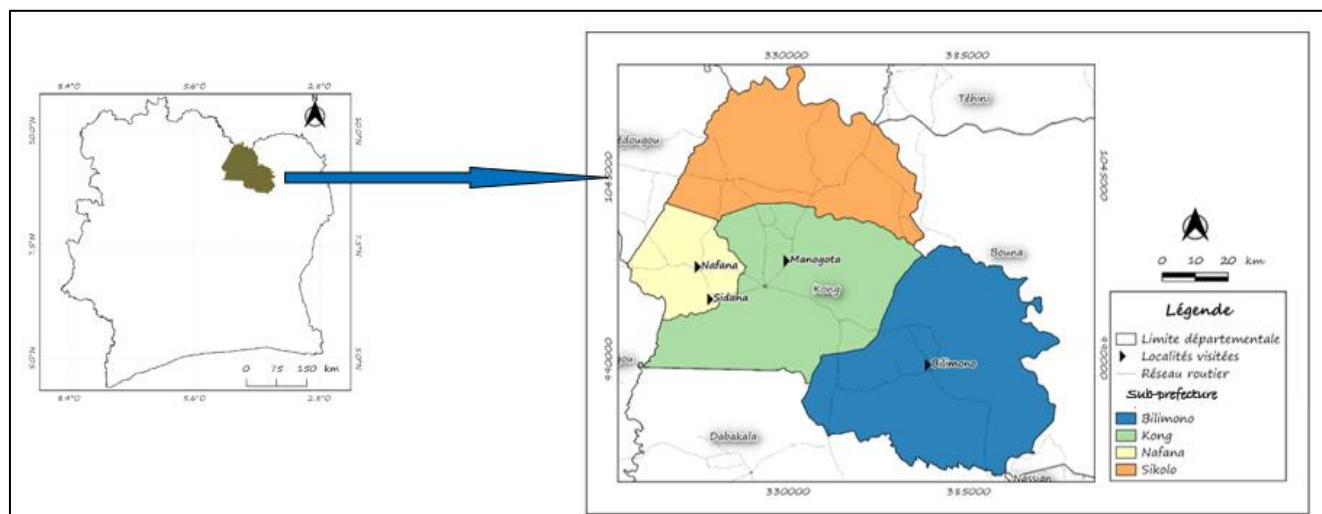


Figure 1 The location of the four study sites in Kong Department (Traoré, 2024) [9]

2.2. Data collection

Field data collection consisted of semi-structured interviews with 15 sorghum producers per village. Each selected sorghum producer was interviewed in their field. The information collected focused on sociological variables such as gender, age, ethnicity, marital status, and method of land acquisition, as well as agronomic variables related to sowing methods, weeding methods, weeding period and frequency, common weeds, and type of tillage. Data collection took place between July and October 2023.

2.3. Data processing and statistical tests

The information relating to the various variables (sociological and agronomic) in the questionnaire was processed using Excel software. For each variable, proportion calculations were performed by locality.

Several statistical tests were performed

- A Chi-square test was performed to verify whether there was a correlation between the variables studied and the locations sampled

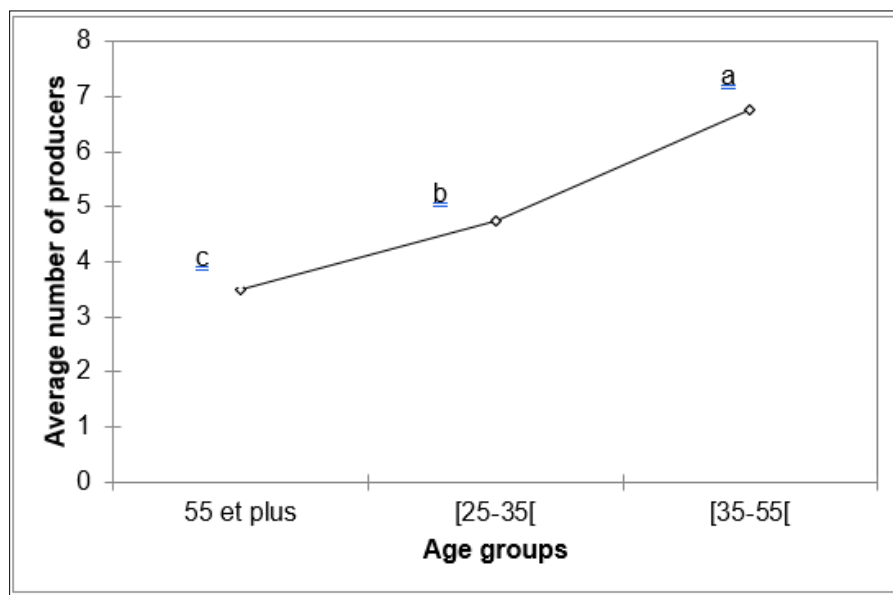
- An analysis of variance (ANOVA) and a Kruskal Wallis test were performed respectively to compare the average values for the number of weedings and the age of the producers.

3. Results

3.1. Sociological profile of the producers surveyed

The sorghum producers surveyed are aged between 25 and 69, with an average age of 42.73. The results of the statistical analysis show that there is a significant difference between age groups. Three homogeneous groups can be distinguished (Figure 2). Producers in the 35 to 55 age group constitute group "a." Group "b" includes producers aged between 25 and 35. The age group representing producers over 55 years old constitutes group "c." In terms of gender, regardless of location, sorghum cultivation is practiced more by men (83.33%) than by women (16.67%). The statistical analysis performed ($U= 12.00$; $p\text{-value} < 0.05$) indicates that the distribution of producers by gender depends on the locality (Table 1).

With regard to land acquisition methods, four main methods were observed in the study area. Land rental was the most common method of land access, with an estimated 61.67% of producers surveyed using this method. This was followed by sharecropping, with 26.67%. Producers who grow sorghum on inherited plots (6.67%) and on plots owned by landlords (5%) are in the minority. This distribution varies from one locality to another ($p\text{-value} < 0.05$). In the localities of Bilimono (66.67%), Manogota (66.67%) and Nafana (80%), farmers grow sorghum more on leased plots (Figure 3). In Sidana (66.67%), sharecropping is the most common farming method.



(Averages followed by the same letter are not significantly different, Anova, HSD test; $\alpha = 0.050$).

Figure 2 Distribution of sorghum producers by age group

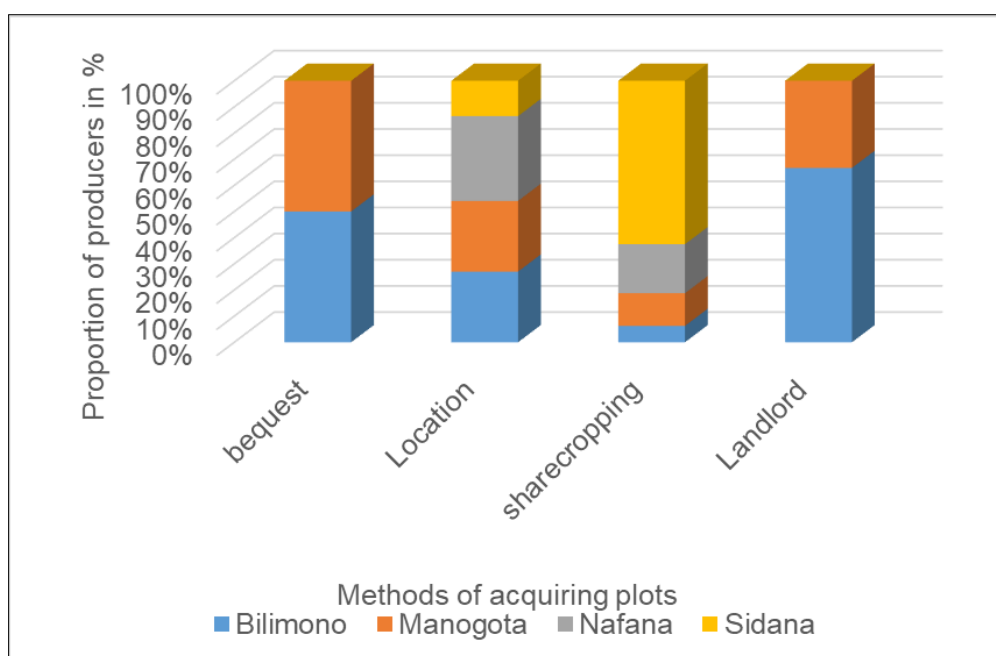


Figure 3 Distribution of sorghum producers according to the method of access for acquiring the plot

Table 1 Proportion of sorghum producers by gender and location

	Proportion of women (%)	Proportion of men (%)
Bilimono	1.67	23.33
Manogota	0.00	25.00
Nafana	5.00	20.00
Sidana	10.00	15.00
Study area	16.667	83.333
	$U= 12.00; p\text{-value}=0.029$	

3.2. Agrotechnical characteristics of farms

In Kong Department, sorghum is grown in furrows or on flat ground. The study showed that, regardless of location, sowing on flat ground is the most common practice, with more than 60% of producers doing so (Figure 4). Statistical analysis indicates that sowing on flat ground does not depend on location ($p\text{-value} > 0.05$). With regard to plowing, the study shows that almost all producers plow their fields. However, this plowing is done more manually (81.33%) than with oxen (18.67%). The Fischer test ($p\text{-value} < 0.05$) indicates that the distribution of producers according to plowing method is linked to location (Table 2). In the area, more than 50% of sorghum producers manage their farms with family labor. However, this proportion varies from one locality to another (Figure 5).

3.3. Techniques, frequencies and periods for managing grass cover

Four weed management techniques were observed during the study. Manual weeding combined with chemical control is the most common weed management technique, used by an estimated 70% of producers. Fisher's test ($p\text{-value} < 0.05$) indicates that the distribution of producers according to weeding technique is related to location (Table 3). In Kong Department, two to three weeding are carried out during the sorghum growing cycle. Analysis of variance indicates that there is no statistical difference between the average number of weedings. The ranking and grouping of the groups are not significantly different (Table 4).

Regarding weeding periods, producers weed after sowing, during growth, and during flowering of the sorghum. Almost all producers (100%) weed after sowing, while 33.33% weed during the plant growth phase and 67.67% during the flowering phase (Figure 6).

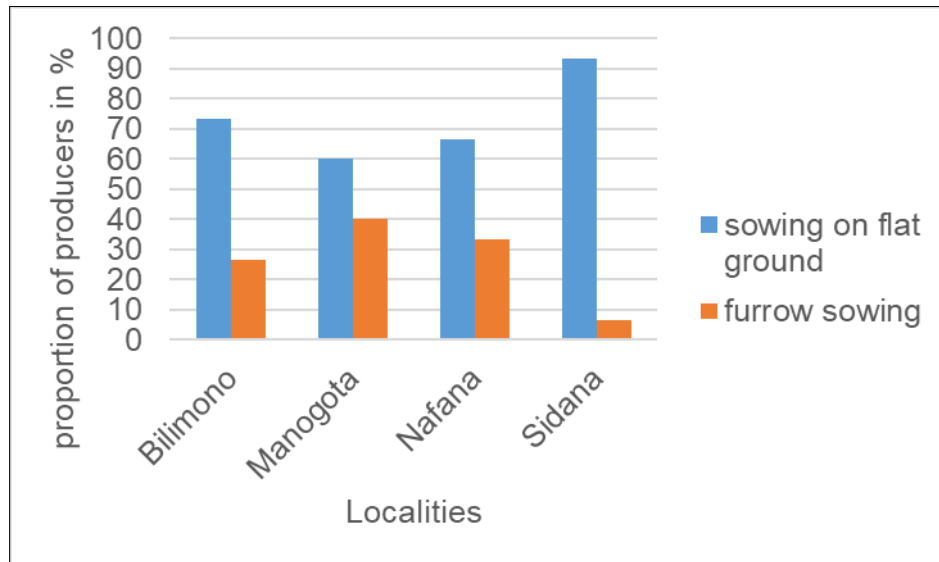


Figure 4 Histogram of producer proportions by type of crop

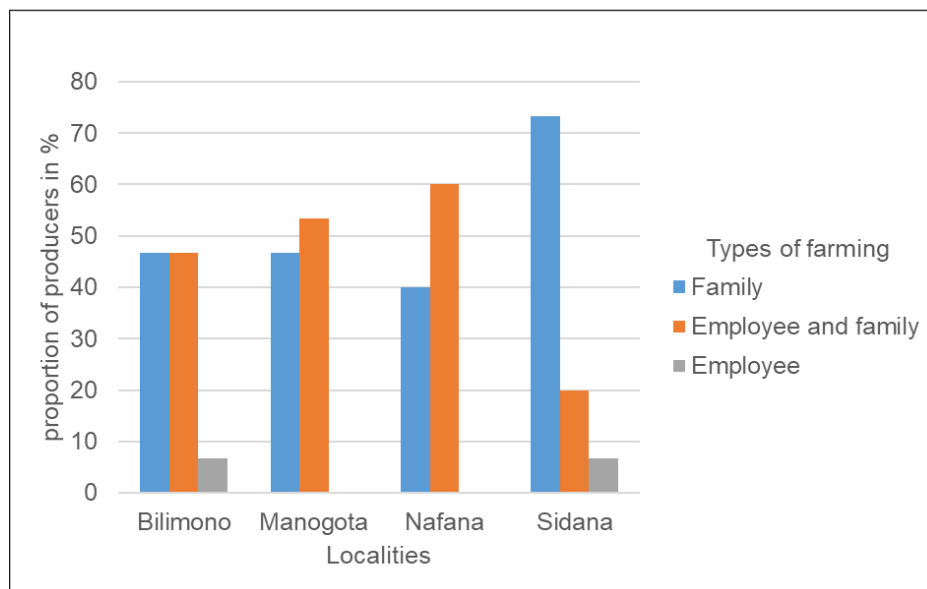


Figure 5 Histogram of types of farming encountered in the study area

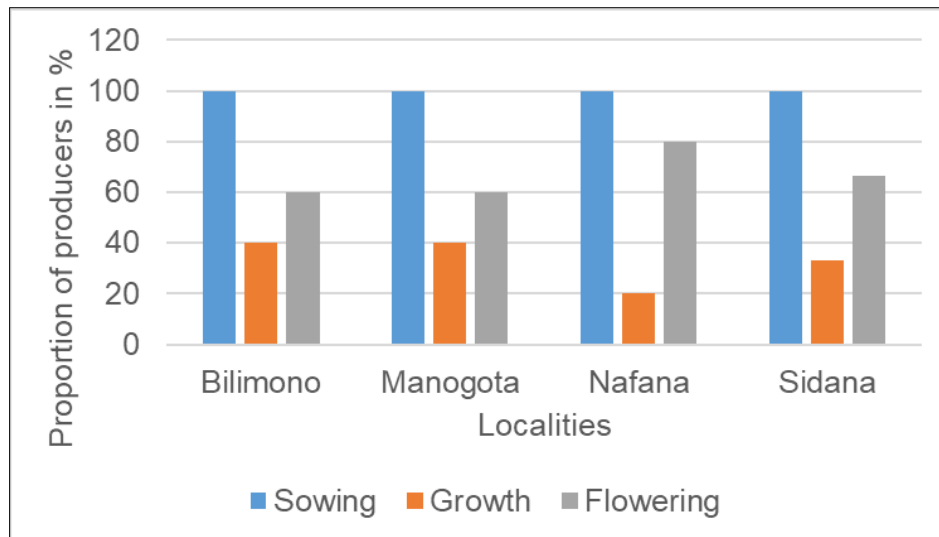


Figure 6 Distribution of sorghum producers according to weeding periods

Table 2 Distribution of producers according to location and plowing method

	Plowing method (%)	
	Harnessed	Manual
Bilimono	40.00	60.00
Manogota	26.67	73.33
Nafana	6.67	93.33
Sidana	0.00	100.00
Study area	18.33	81.67

Table 3 Distribution of producers by location and weeding method during the crop cycle

	Chemical-Mechanical	Manual only	Manual-Chemical	Chemical-Manual-Mechanical
Bilimono	50.00	12.50	21.43	50.00
Manogota	37.50	0.00	26.19	50.00
Nafana	12.50	12.50	3095	0.00
Sidana	0.00	75.00	21.43	0.00
Total	100	100	100	100

Table 4 Classification and grouping of localities according to homogeneous groups based on weeding frequency

Localities	Average weeding frequency	Standard error	Groups
Nafana	2.80	0.118	A
Sidana	2.80	0.118	A
Manogota	2.67	0.118	A
Bilimono	2.60	0.118	A

(Averages followed by the same letter are not significantly different, ANOVA, HSD test; $\alpha = 0.050$).

3.4. Main weeds identified in sorghum fields

The survey of sorghum producers in the study area identified 28 weeds that are common during the crop cycle (Table 5). These weeds belong mainly to eight families, with the Poaceae family (15 species) being the most prevalent. Three biological types dominate the recurring weed flora. These are therophytes (42.86%) and nanophanerophytes and hemicryptophytes, each accounting for 21.43% (Figure 7). Grasses are the most commonly observed morphological type (75%) among the frequently cited weeds (Figure 8).

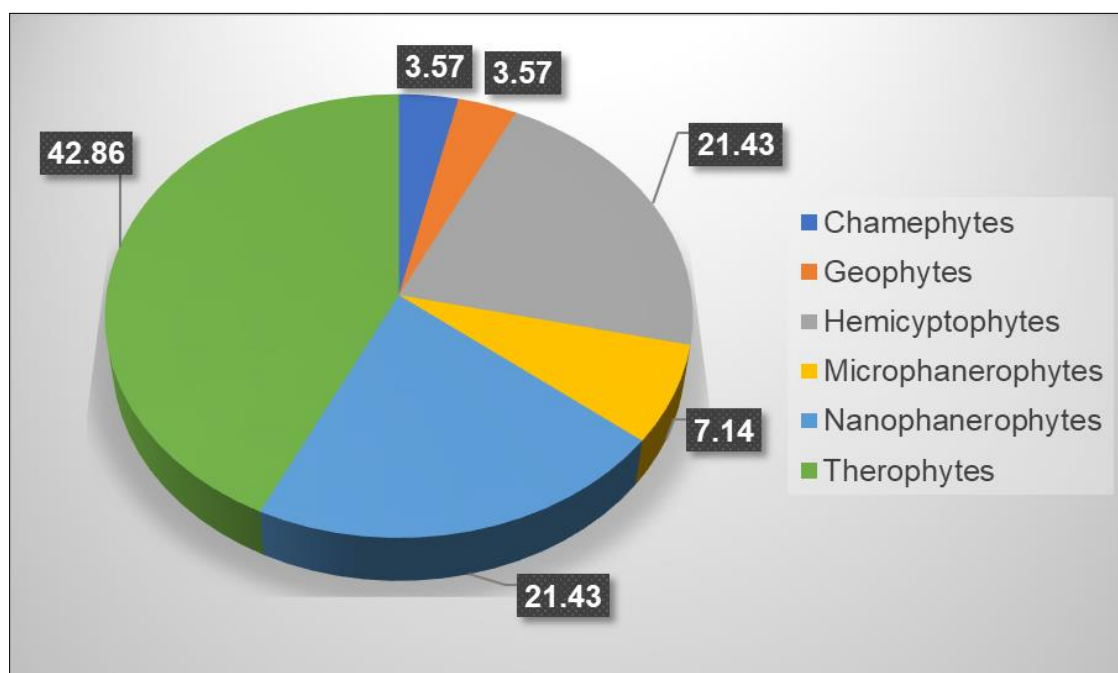


Figure 7 Spectrum of biological types of the most frequently cited weeds

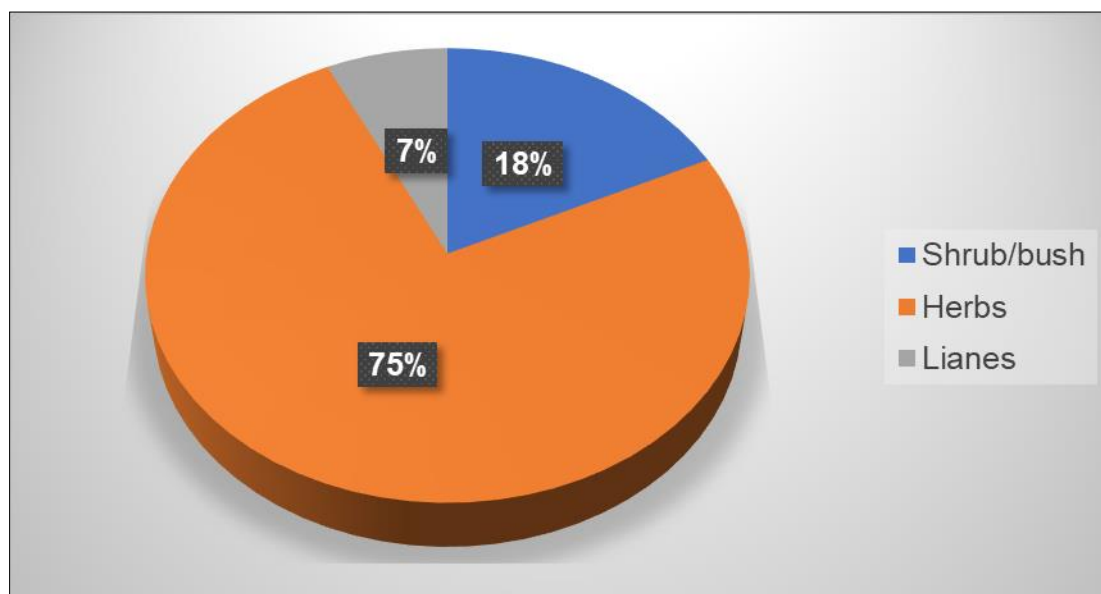


Figure 8 Spectrum of morphological types of the most common weeds

Table 5 Main weeds found in sorghum fields in the study area

N°	Species	Family
1	<i>Acroceras amplexans</i>	Poaceae
2	<i>Acroceras zizanioides</i>	Poaceae
3	<i>Ageratum conyzoides</i>	Asteraceae
4	<i>Axonopus compressus</i>	Poaceae
5	<i>Bidens Pilosa</i>	Asteraceae
6	<i>Bolboschoenus maritimus</i>	Cyperaceae
7	<i>Brachiaria lata</i>	Poaceae
8	<i>Calopogonium mucunoides</i>	Fabaceae
9	<i>Centrosema pubescens</i>	Fabaceae
10	<i>Chloris Pilosa</i>	Poaceae
11	<i>Chromolaena odorata</i>	Asteraceae
12	<i>Commelina benghalensis</i>	Commelinaceae
13	<i>Commelina diffusa</i>	Commelinaceae
14	<i>Cyperus iria</i>	Cyperaceae
15	<i>Cyperus podocarpus</i>	Cyperaceae
16	<i>Dactyloctenium aegyptium</i>	Poaceae
17	<i>Digitaria horizontalis</i>	Poaceae
18	<i>Echinochloa pyramidalis</i>	Poaceae
19	<i>Euphorbia heterophylla</i>	Euphorbiaceae
20	<i>Hyptis suaveolens</i>	Lamiaceae
21	<i>Imperata cylindrica</i>	Poaceae
22	<i>Oryza barthii</i>	Poaceae
23	<i>Panicum laxum</i>	Poaceae
24	<i>Paspalum conjugatum</i>	Poaceae
25	<i>Paspalum scrobiculatum</i>	Poaceae
26	<i>Paspalum vaginatum</i>	Poaceae
27	<i>Setaria barbata</i>	Poaceae
28	<i>Striga hermonthica</i>	Scrophulariaceae

4. Discussion

The study conducted among 60 sorghum producers in the Kong department showed that the producers' ages range from 25 to 69. These results reflect the withdrawal of minors from weeding sorghum fields (Odunfa, 2003) [10]. The age group of producers [35-55 years old] is similar to that of the working population in Côte d'Ivoire. Similar results were observed by Kouamé (2014) [6] in rice farming in the Yamoussoukro district and by Yapi (2017) [7] in plantain and cassava farming in southeastern Côte d'Ivoire.

Men (83.33%) are more involved in sorghum cultivation in the study area. The low proportion of women involved in sorghum cultivation could be explained not only by the hard nature of agricultural work, but also by the fact that women are responsible for household tasks and other income-generating activities such as trade. Kouamé's (2014) [6] work in

the Yamoussoukro district found that men are more active in rice production. The same applies to the work of Soro (2025) [11] on rice cultivation in the department of Niakaramadougou in northern Côte d'Ivoire.

Flat-bed cultivation (60%) is the most common cultivation practice for sorghum in the Kong department, regardless of the location sampled. This observation can be explained by the fact that the soil is generally plowed, so producers no longer find it useful to make furrows. Almost all producers plow before sowing, which could be explained by the fact that the soil in this area is very tired (N'guessan et al., 2019) [12]. Turning the soil by plowing could loosen it and create favorable conditions for sorghum seeds to germinate. The high percentage of farmers who plow manually is justified by the small size of the fields. In addition, women organize themselves into groups at the beginning of the farming season to carry out the activities involved in preparing the plots (furrows, ridges, sowing). This explains the high level of involvement of family labor in the management of the fields. These results contradict the findings of N'guessan et al. (2019) [12] in the department of Korhogo, where plowing with draft animals is the most common method of plowing used in cotton cultivation.

With regard to commonly encountered weeds, producers identified 28 species. Of these, 15 belong to the Poaceae family. The work of Soro (2025) [11] identified 22 major weeds, most of which belong to the Poaceae family. This similarity between the two results can be explained by the fact that both studies were conducted in northern Côte d'Ivoire, where the dominant flora consists of heliophilous species. In addition, these species grow rapidly and are highly adaptable to disturbed environments. Herbaceous plants and therophytes are the predominant biomorphological types among the species inventoried. Indeed, this part of Côte d'Ivoire is a savanna zone (Guillaumet and Adjanohoun, 1971) [13], which is favorable to herbaceous plants and therophytes.

The most common weed management technique is manual weeding combined with chemical weed control (70%). Similar observations were made by Yapi et al. (2024) [14] in okra cultivation in southeastern Côte d'Ivoire. Indeed, following the socio-political crisis that the country experienced in 2002 and the law prohibiting the employment of minors in agricultural operations (Odunfa, 2003) [10], synthetic herbicides have become the main alternative for weed control in fields (Ipou et al., 2016) [15]. In sorghum cultivation in the study area, almost all producers use chemical weed control immediately after sowing to effectively control weeds and reduce weed infestation on their plots. This situation can be explained by the fact that sorghum producers are mainly cotton producers. They would use most of the pesticides (herbicides) received from cotton companies for weed management in other crops.

5. Conclusion

Sorghum cultivation in the Kong department is dominated by men (83.33%) and is undertaken by producers aged between 25 and 69. Producers generally rent plots (61.67%) and cultivate on flat land (60%). Manual weeding combined with chemical control is the most common weed management technique (70%). Before sowing, 81.33% of producers plow manually, 18.67% plow with oxen, and 100% weed after sowing. Twenty-eight weeds are frequently encountered during the crop cycle. Among the families identified, the Poaceae family is the most common. The species are generally therophytes (42.86%) and grasses (75%). Two to three weedings are carried out during the sorghum growing cycle. These weedings are carried out either after sowing, during growth and/or during flowering of the sorghum.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that there is no conflict of interest related to this work.

Contribution of authors

All authors contributed substantially to the completion of this study. They participated in the drafting of the manuscript and critically reviewed its intellectual content. All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Declaration of Informed Consent

Informed consent was obtained from all individual participants included in the study.

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