Diversity and uses by farmers of cashew (Anacardium occidentale L.) orchards weeds in Côte d’Ivoire

Latif Mory Konaté, Doudjo Noufou Ouattara, François N’Guessan Kouamé and Adama Bakayoko

Research

Abstract

Background: Weeds are always seen as pests and are continuously destroyed by farmers due to their impacts on crop production. But like many other plants, some have several virtues. This work aims to determine the uses of weed plants by cashew farmers in three 4 regions of Côte d’Ivoire.

Methods: In each region, an ethnobotanical survey using semi-direct interviews with 108 cashew producers let to identify the weeds of cashew orchards used by farmers and to highlight their uses.

Results: In total, 73 weeds were cited by farmers as useful for various uses, thus justifying their maintenance in their orchards. Five categories of uses of these weeds have been recorded, of which food weeds represent 42.39%. Weeds used in traditional medicine represent 34.78% while those used as fodder and in handicrafts represent 8.69% each; 5.34% of these weeds are used in other areas. The most used organs are fruits and leaves with a rate of 39% each.

Conclusion: These uses of weeds should induce a new consideration of these plants by farmers who could implement the cashew orchards in Côte d’Ivoire as an agroforestry systems.

Keywords: Cashew, Côte d’Ivoire, weeds, richness and uses

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Résumé

Contexte: Les adventices sont toujours considérées comme des pestes et continuellement détruites par les agriculteurs en raison de leurs impacts sur la production agricole. Mais comme beaucoup d’autres plantes, certaines adventices ont plusieurs vertus. Ce travail vise à déterminer les usages de ces adventices par les producteurs d’anacarde dans 4 régions de la Côte d’Ivoire.
**Context**

The definition of the term weed has always been the subject of debate among specialists. It is considered by some authors as species that live in a place where it should not be, causing serious problems for crops (Labrada 2005). The term weed is sometimes rejected by other authors because of the negative connotation for the plant thus designated (Ipou 2005). Weed can also be defined as a plant introduced voluntarily by humans or spontaneously into cultivated biotopes (Ipou 2005). Indeed, some weeds provide socio-economic services to farmers. In Mexico, farmers maintain certain species in association with the main crop, which they call "buen monte" (good plants) and only eliminate "mal monte" (bad plants) in traditional agroecosystems (Altieri 1987). Indeed, these species are maintained in the fields and used for various purposes: food, medicine, religious ceremonies, soil improvement (Ruthenberg 1976, Glissman 1988). In Côte d’Ivoire, previous studies on the identification of the weed flora were conducted on several cultivated species areas. Aman et al. (2004) and Ipou (2005) investigated on the weeds of cotton (Gossypium herbaceum L.) farms, while Traoré et al. (2010) focused on the weeds of palm (Elaeis guineensis Jacq.) plantations. Mangara et al. (2010) studied the weeds in pineapple (Ananas comosus (L.) Merr.) farms when Tano et al. (2016) assessed the weeds of banana (Musa paradisiaca L.) farms and Traoré et al. (2019) on those of the sugarcane (Saccharum officinarum L.) farms. The weed flora of rice was inventoried by Kouamé et al. (2011), Konan et al. (2014) and Touré (2014). Indeed, many species were harvested from these biotopes by communities for several purposes. Touré et al. (2018) have shown that the riparian communities of the Sanaimbo forest reserve, in the south Côte d’Ivoire, knew and maintained the weed species used as traditional medicine, food, house construction and basketry material in their fields. For the cashew (A. occidentale L.) few is known about both on the diversity and the use of the associated weed species by farmers. In savannah zones, this crop occupies increasingly large areas (Dugué et al. 2003) and its relations with other species in the farms and the importance of these plants for farmers should be understood. Furthermore, it is necessary to know the useful weed species preserved during the maintenance operations in the cashew orchards. In order to gather these data, this study was conducted in the regions of Gontougo, Bounkani, Marahoué and Kabadougou. The objective of this manuscript was to show the richness and diversity of the useful weeds in the cashew orchards and their uses by farmers in the savannah area of Côte d’Ivoire.

**Materials and Methods**

**Study area**

The study was carried out in the regions of Bounkani and Gontougo (Northern-east), of Kabadougou (Northern-west) and Marahoué (Center-west) in Côte d’Ivoire (Figure 1) from July to October 2020 when all the weeds especially herbaceous species were alive and could be easily named botanically. The regions of Kabadougou and Bounkani are characterized by a Sudanese climate with an average temperature of 30 °C with a Sudanian savannah vegetation (Monnier 1983). The annual rainfall of these regions ranged from 800 to 1 200 mm (Krogba et al. 2016). The regions of Gontougo and Marahoué are in a forest-savannah mosaic vegetation (Monnier 1983) where the climatic regime was similar to the Guinean zone with an average annual rainfall varying between 1,200 and 1,500 mm. The annual average temperature is 28.4 ° C (FAO 2005).

**Data collection**

This study was conducted in 108 cashew farms (Figure 2, Table 1) encompassing three villages in each region of Bounkani and Gontougo, and six villages in each region of Kabadougou and Marahoué. In each village, six cashew orchards were visited, and a semi-direct questionnaire (Appendix) proposed by Touré et al. (2018) was used to interview the owner of each visited farm.
Figure 1. Localization of the studied regions on the map of Côte d'Ivoire.

Figure 2: A picture of a cashew orchard in the Northern Côte d'Ivoire

**Specimen identification**

The collected weeds were identified in the field using the West African weed guide of Akobundu and Agyakwa (1989), the Adventrop, weeds from Sudano-Sahelian Africa of Bourgeois and Merlier (1995), and the trees, shrubs and lianas of the drylands of West Africa of Arbonnier (2009) or at the herbarium of the Centre Suisse de Recherches Scientifiques en Côte d'Ivoire. The nomenclature of
Cronquist (1981, 1983) updated by APG (2016) was followed in this work.

Table 1. Sociodemographic characteristics of the cashew farmers interviewed.

| Variables       | Modalities | Number of farmers | Percentage (%) |
|-----------------|------------|-------------------|----------------|
| Sex             | Men        | 91                | 84.26          |
|                 | Women      | 17                | 15.74          |
| Age (years)     | 0-30       | 7                 | 6.48           |
|                 | 31-50      | 59                | 54.63          |
|                 | > 50       | 42                | 38.89          |
| Study level     | Analphabetic | 71              | 65.74          |
|                 | Primary    | 21                | 19.44          |
|                 | Secondary  | 13                | 12.04          |
|                 | University | 3                 | 2.78           |

Data analysis
The diversity index of the useful weeds in the farms was calculated using the ratio of the species number on the genera number (Aké Assi 1984, Aman et al. 2004). The relative importance of the categories of the weeds uses and of the organs used were analyzed by a simple descriptive statistical method as the percentage.

Results
Profiles of the interviewed farmers
The 108 farmers surveyed were between 15.74% of women and 84.26% of men; this population was at 54.63% between 31 and 50 years old and at 38.89% older than 50 years (Table 1). The illiteracy rate of farmers was about 65.74% while the farmers with a university level was set only at 2.78% (Table 1).

Useful weed flora richness and diversity in the cashew farms
A total of 73 useful weeds for the farmers were assesse in the cashew farms of the four visited regions. These useful weeds species belong to 64 genera and 33 families (Table 2) of which the most represented were Malvaceae (25%), Fabaceae (17%) and Dioscoreaceae (11%). The generic diversity index was set between 1.08 in Kabadougou region and 1.29 Marahoué region (Table 3). The Gontougo region showed the highest percentage of cultivated weeds and lowest percentage of spontaneous weeds (Table 4) while the lowest percentage of cultivated weeds was found in the Kabadougou Region.

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In terms of morphological types, all regions showed 23 weedy trees, 28 weedy shrubs, 14 weedy lianas and 8 herbaceous weeds (Figure 3). The Gontougo region showed the highest number of both useful weed trees and lianas species while the Marahoué region experienced the poorest useful weeds trees species (Table 5). The highest number of useful weeds shrubs was found in the Marahoué region and the lowest number of both useful weeds lianas and shrubs was recorded in the Kabadougou region of (Table 5). The herbaceous useful weeds were higher in Kabadougou region and poorer in Marahoué region (Table 5).

Uses categories
The uses of weed species could be encompassed into the categories of food, of medicine, of crafts, of fodders and of other (Figure 4). The farmers used more the weeds for food and health care in the study area. The Marahoué region showed the highest number of weeds used in the farmers’ diets while the lowest number was obtained in the Kabadougou region (Table 6). Similar number of weeds were recognized in both Marahoué and Gontougo regions as medicinal plants while fewer species were experienced in Kabadougou region (Table 6). In all regions, few weeds were used as fodders, handicrafts and others (Table 6).

Parts of weeds used
All the organs of weedy species were used, except for the flowers (Figure 4). The fruits and the leaves were the most used organs with a proportion of 39% each while the stems and the roots were the least used with respectively 14% and 8% of uses (Figure 5).
Table 2. List of useful weeds in the cashew farms of the studied regions.

| Family         | Scientific names of species                        | Origins | Uses categories | Organs | Regions |
|----------------|----------------------------------------------------|---------|----------------|--------|---------|
|                |                                                    | Cul     | Sporang | Foo | Med | Cra | Fod | Oth | Fru | Roo | Lea | Rod | Bou | Gon | Kab | Mar |
| Malvaceae      | Adansonia digitata L.                              | x       | x       | x   | x   | x   | x   | x   | x   | x   |     |     |     |     |     |     |
| Passifloraceae | Adenia cissampeloides Harms                       | x       | x       |     |     | x   |     |     |     |     |     |     |     |     |     |     |
| Zingiberaceae  | Aframomum albiovaleceum K. Schum.                 | x       | x       |     | x   | x   |     |     |     |     |     |     |     |     |     |     |
| Fabaceae       | Albizia adianthifolia W.F. Wight                  | x       |     |     |     | x   |     |     |     |     |     |     |     |     |     |     |
| Fabaceae       | Albyzia zygia (DC.) J.F. Macbr.                   | x       | x       |     |     | x   |     |     |     |     |     |     |     |     |     |     |
| Euphorbiaceae  | Alchornea cordifolia Müll.-Arg.                   | x       | x       |     |     | x   |     |     |     |     |     |     |     |     |     |     |
| Sapindaceae    | Allophylus africana P. Beauv.                     | x       | x       |     | x   | x   |     |     |     |     |     |     |     |     |     |     |
| Bromeliaceae   | Ananas comosus (L.) Merr.                         | x       | x       |     | x   |     |     |     |     |     |     |     |     |     |     |     |
| Araceae        | Anchomanes difformis (Blume) Engl.                |         |         | x   |     | x   |     |     |     |     |     |     |     |     |     |     |
| Annonaceae     | Annona senegalensis Pers.                         | x       | x       |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Combretaceae   | Anogeissus leiocarpa Guill. & Perr.               | x       | x       |     |     | x   |     |     |     |     |     |     |     |     |     |     |
| Gentianaceae   | Anthcleista djalonensis A. Chev.                  | x       | x       |     |     | x   |     |     |     |     |     |     |     |     |     |     |
| Moraceae       | Antiaris toxicaria Loes.                          | x       | x       |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Fabaceae       | Arachis hypogaea L.                               | x       | x       |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Meliaceae      | Azadirachta indica A. Juss.                       | x       | x       |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Sapindaceae    | Blighia sapida K.D. Koenig                       | x       | x       |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Malvaceae      | Bombax costatum Pellegr.                          | x       | x       |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Areceaceae     | Borassus aethiopum Mart.                          | x       | x       | x   | x   | x   |     |     |     |     |     |     |     |     |     |     |
| Caricaceae     | Carica papaya L.                                  | x       | x       | x   |     |     |     |     |     |     |     |     |     |     |     |     |
| Malvaceae      | Ceiba pentendra (L.) Gaertn.                      | x       | x       |     |     | x   |     |     |     |     |     |     |     |     |     |     |
| Asteraceae     | Chromoleana odorata R. King & H. Rob.             | x       | x       |     | x   |     |     |     |     |     |     |     |     |     |     |     |
| Rutaceae       | Citrus limon (L.) Osbeck                          | x       | x       | x   | x   | x   |     |     |     |     |     |     |     |     |     |     |
| Rutaceae       | Citrus maxima (Burm.) Merr.                       | x       | x       | x   | x   | x   |     |     |     |     |     |     |     |     |     |     |
| Rutaceae       | Citrus reticulata Blanco                          | x       | x       | x   |     |     |     |     |     |     |     |     |     |     |     |     |
| Connaraceae    | Cnestis ferruginea Vahl ex DC.                    | x       | x       |     |     |     |     |     |     |     |     |     |     |     |     |
| Areceaceae     | Cocos nucifera L.                                 | x       | x       | x   |     |     |     |     |     |     |     |     |     |     |     |     |
| Family          | Species                              | Rubiaceae | Fabaceae | Malvaceae | Sapindaceae | Moraceae | Ebenaceae | Anacardiaceae | Euphorbiaceae | Arecaceae | Verbenaceae | Moraceae | Fabaceae | Apocynaceae | Musaceae | Euphorbiaceae | Musaceae | Bignoniaceae | Musaceae | Fabaceae |
|-----------------|--------------------------------------|-----------|----------|-----------|-------------|-----------|-----------|---------------|---------------|-----------|-------------|----------|----------|-------------|----------|---------------|----------|--------------|----------|----------|
| Rubiaceae       | Coffea canephora Pierre              | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Rubiaceae       | Coffea arabica L.                    | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Malvaceae       | Cola nitida (Vent.) Schott & Endl.   | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Malvaceae       | Corchorus tridens L.                 | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Fabaceae        | Daniellia oliveri (Rolfe) Hutch. & Dalz. | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Sapindaceae     | Deinbollia pinnata Schum. & Thonn.   | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Fabaceae        | Dialium guineense Willd.             | x         |          |          |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Dioscoreaceae   | Dioscorea alata L.                   | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Dioscoreaceae   | Dioscorea bulbifera L.               | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Dioscoreaceae   | Dioscorea cayennensis Lam.           | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Dioscoreaceae   | Dioscorea odoratissima Pax            | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Ebenaceae       | Diospyros mespiliformis Hochst.      | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Arecaeeae       | Elaeis guineensis L.                 | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Moraceae        | Ficus exasperata Vahl                | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Moraceae        | Ficus sur Forssk.                    | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Malvaceae       | Griffonia simplicifolia (Vahl) Baill.| x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Euphorbiaceae   | Hevea brasiliensis (Willd.) Müll.-Arg.| x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Malvaceae       | Hibiscus asper Hook. f.              | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Malvaceae       | Hibiscus esculentus (L.) Moench.     | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Meliaceae       | Khaya senegalensis (Desv.) A. Juss.  | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Verbenaceae     | Lippia multiflora Moldenke           | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Euphorbiaceae   | Mallotus oppositifolius Müll.-Arg.   | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Anacardiaceae   | Mangifera indica L.                  | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Euphorbiaceae   | Manihot esculenta Crantz             | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Moraceae        | Milicia excelsa (Welw.) Berg         | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Apocynaceae     | Motandra guineensis (Thonn.) A. DC.  | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Musaceae        | Musa paradisiaca L.                  | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Musaceae        | Musa sapientum L.                    | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Bignoniaceae    | Newbouldia laevis (P. Beauv.) Seem.  | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Fabaceae        | Parkia biglobosa (Jacq.) R. Br.      | x         |          | x         |             |          |           |               |               |          |             |          |          |             |          |               |          |              |          |          |
| Family            | Genus                  | Cul  | Spo | Med  | Cra | Fol | Oth | Fru | Lea | Roo | Rod | Bou | Gontougo | Kab | Marahoué |
|-------------------|------------------------|------|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|--------|-----|----------|
| Poaceae           | *Paullinia pinnata* L. | x    | x   | x    |     |     |     |     |     |     |     |     |        |     |          |
| Phyllanthaceae    | *Phyllanthus amarus* Schum. & Thonn. | x    | x   |     |     |     |     |     |     |     |     |     |        |     |          |
| Fabaceae          | *Piliostigma thonningii* Milne-Redh. | x    |     |     |     |     |     |     |     |     |     |     |        |     |          |
| Myrtaceae         | *Psidium guajava* L.    | x    | x   | x    |     |     |     |     |     |     |     |     |        |     |          |
| Apocynaceae       | *Rauvolfia vomitoria* Afzel. | x    | x   | x    |     |     |     |     |     |     |     |     |        |     |          |
| Apocynaceae       | *Saba senegalensis* (A. DC.) Pichon | x    | x   | x    |     |     |     |     |     |     |     |     |        |     |          |
| Celastraceae      | *Salacia baumannii* Loes. | x    | x   |     | x   | x   |     |     |     |     |     |     |        |     |          |
| Rubiaceae         | *Sarcocephalus esculentus* (Sm.) Afzel. | x    | x   | x    |     |     |     |     |     |     |     |     |        |     |          |
| Anacardiaceae     | *Spondias mombin* L.   | x    | x   |     |     |     |     |     |     |     |     |     |        |     |          |
| Malvaceae         | *Theobroma cacao* L.    | x    | x   |     | x   |     |     |     |     |     |     |     |        |     |          |
| Balanophoraceae   | *Thonningia sanguinea* Vahl | x    | x   | x    | x   |     |     |     |     |     |     |     |        |     |          |
| Annonaceae        | *Uvaria chamae* P. Beauv. | x    | x   |     | x   |     |     |     |     |     |     |     |        |     |          |
| Asteraceae        | *Vernonia amygdalina* Delile | x    | x   |     |     | x   | x   |     |     |     |     |     |        |     |          |
| Sapotaceae        | *Vitellaria paradoxa* C.F. Gaertn. | x    | x   |     | x   | x   | x   |     |     |     |     |     |        |     |          |
| Lamiaceae         | *Vitex doniana* Sweet | x    | x   |     |     |     | x   |     |     |     |     |     |        |     |          |
| Poaceae           | *Zea mays* L.           | x    | x   |     |     | x   | x   |     |     |     |     |     |        |     |          |
| Zingiberaceae     | *Zingiber officinale* Roscoe. | x    | x   |     |     |     | x   |     |     |     |     |     |        |     |          |

Cul: cultivated, Spo: spontaneous, Foo: food, Med: medicinal, Cra: crafts, Fol: Fodder, Oth: other, Fru: fruits, Lea: leaves, Roo: roots, Rod: rods, Bou: Bounkani, Gontougo, Kab: Kabadougou, Mar: Marahoué
Table 3. Richness and generic diversity index of useful weeds in cashew orchards of the investigated regions

| Regions    | Families | Genera | Species | Generic diversity index |
|------------|----------|--------|---------|-------------------------|
| Bounkani   | 24       | 31     | 36      | 1.16                    |
| Gontougo   | 26       | 36     | 42      | 1.16                    |
| Kabadougou | 18       | 24     | 26      | 1.08                    |
| Marahoué   | 23       | 31     | 40      | 1.29                    |

Table 4. Origins of the useful weeds recorded in the cashew farms in each region

| Region       | Cultivated weeds | Spontaneous weeds |
|--------------|------------------|-------------------|
|              | Number | %     | Number | %     |
| Bounkani     | 13     | 36.12 | 23     | 63.88 |
| Gontougo     | 18     | 42.86 | 24     | 57.15 |
| Kabadougou   | 10     | 38.46 | 16     | 61.54 |
| Marahoué     | 15     | 37.50 | 25     | 62.50 |

Figure 3. Proportions of the morphological types of the useful weeds in the study area.

Table 5. Morphological types of useful weeds recorded in each region

| Life forms | Regions  | Trees | Shrubs | Lianas | Herbaceous |
|------------|----------|-------|--------|--------|------------|
|            | Number | %     | Number | %     | Number | %     | Number | %     |
| Bounkani   | 9      | 24    | 15     | 24    | 7      | 33    | 6      | 26    |
| Gontougo   | 11     | 26    | 15     | 24    | 9      | 43    | 6      | 26    |
| Kabadougou | 8      | 33    | 9      | 14    | 0      | 0     | 7      | 31    |
| Marahoué   | 7      | 17    | 23     | 37    | 5      | 24    | 4      | 17    |
Figure 4. Representativeness of the weeds uses categories.

Table 6. Number of weeds species per use-categories in the different regions

| Regions    | Food | Medicine | Crafts | Fodders | Others |
|------------|------|----------|--------|---------|--------|
| Bounkani   | 22   | 18       | 3      | 2       | 4      |
| Gontougo   | 25   | 21       | 6      | 3       | 4      |
| Kabadougou | 13   | 16       | 3      | 2       | 2      |
| Marahoué   | 26   | 21       | 3      | 3       | 4      |

Figure 5. Distribution spectrum of weed organs used by cashew farmers.
Weeds as food
Forty-four (44) edible species were encountered (Table 2). The organs generally consumed were the fruits, the tubers and the leaves. In all regions, the fruits of Mangifera indica, Citrus limon and Citrus maxima were directly consumed in the field and sometimes at home. The tubers of Dioscorea alata, Dioscorea cayennensis and Dioscorea odoratissima were cooked in water and eaten boiled or crushed. The fruits of Parkia biglobosa and Vitellaria paradoxa, and the leaves of Adansonia digitata, Bombax costatum and Ceiba pentandra were cooked and eaten in sauce in the regions of Boukani, Gontougo and Kabadougou. The leaves of Lippia multiflora were boiled and consumed as morning tea in Boukani and Kabadougou regions.

Weeds in traditional medicine
Thirty-five (35) weeds have been recognized by farmers as plants with therapeutic virtues for human health. The organ parts used were the fruits, the leaves, the roots and the stems. Thus, the useful species could be classified into three groups.

The first group gathers 29 weeds species whose the leaves only were used. In the Marahoué region, the leaves of Albyzia zygia, Antiaris toxicaria, Blighia sapida, Diospyros mespiliformis, Griffonia simplicifolia and Vernonia amygdalina were used by farmers to heal themselves. In both the Kabadougou and Boukani regions, the leafy branches of Annona senegalensis, Parkia biglobosa, Pilostigma thonningii, Sarcocephalus latifolius, Vitellaria paradoxa and Vitex doniana were used to heal several diseases. In the Gontougo region, farmers used the leaves of Alchornea cordifolia, Deinbollia pinnata, Mallotus oppositifolius, Motandra guineensis and Paullinia pinnata to heal themselves.

The second group of Diospyros mespiliformis, Mangifera indica, Lippia multiflora, Alchornea cordifolia and Sarcocephalus latifolius whose both the roots and leaves were used simultaneously to heal the diseases all the studied area.

The third and smallest group encompasses Anchomanes diffomnis, Phyllanthus amarus, and Thonningia sanguinea whose the entire plants were used against diseases.

Minor uses of weeds
Twenty-two (22) weeds species were used as fodders, in the crafts, as resting place for both animals and men, as source of income and as spiritual significance in the visited regions.

The leaves of Albizia adianthifolia, Albizia zygia, Antiaris toxicaria, Ficus exasperata and Ficus sur were used as fodders for domestic animals. The stems of Anthocleista djalonensis, Borassus aethiopum, Ceiba pentendra, Diospyros mespiliformis, Griffonia simplicifolia, Hevea brasiliensis and Milicia excelsa were used in construction, in carpentry, to make furnitures (chairs and stools) and as kitchen equipment (pestle). The fruits of Arachis hypogaea, Coffea canephora, Coffea arabica, Theobroma cacao and Zea mays are a significant source of income for the cashew farmers. Daniellia oliveri and Khaya senegalensis were supposed to be the farmers’ spiritually protection plants against the evil spirits or witchcraft in all the study area.

Discussion
The total number of 73 useful weed species accessed with 108 farmers represents almost 17% of the total weed richness found in 261 cashew orchards in the savanna area of Côte d’Ivoire (Konaté et al. 2020). At the families and genera levels, the useful weeds represent respectively 45 % and 24 % of the current known cashew orchards’ flora in Côte d’Ivoire (Konaté et al. 2020). The generic diversity index of 1.08-1.29 of the useful weeds in the cashew orchards is lower than those of all the weeds found by Konaté et al. (2020) and shows the high diversity of this useful weeds’ flora.

The higher number of useful weeds species (36-42 species) in Boukani and Gontougo both regions with 18 questioned farmers each than those in Kabadougou region (26 species) with a twice number of questioned farmers shows the lack of the interviewed farmers number’s impact on the knowledge of the weeds uses in the study area. The higher representatives of the spontaneous weeds (57-63 %) than those of the cultivated species in all regions shows that the cashews orchards in the study are more colonized by local natural pioneer species which germinate or resprout in these areas despite the human local activities. But the proportion between 36 % and 42 % of the introduced useful species by the farmers in their orchards experience also the high contribution of the cashew farmers to the flora of their farms. The lower representatives of both Lianas (0-21.95 %) and herbaceous (10.25-29.16 %) to the useful weeds flora in all regions reveals the higher contribution of both trees and shrubs to the useful weeds dominated by the food (13-26 species) and the medicinal (16-28 species) uses in the study area.

Many ethnomedical and ethnobotanical studies have been carried out in the Sudanian zone (Kouamé et al. 2008, Kouamé and Gnahuou 2009, Dro et al. 2013, Soro et al. 2014) and in the Guinean zone (Tra Bi 1997, Ambé 2001) of Côte d’Ivoire but none was on the cashew orchards. The 73 species of useful weeds found in cashew orchards of the four regions is close to the 75 species of useful plant species obtained by Ambé
(2001) in the natural vegetation of the northern-western Côte d'Ivoire. And this richness is also very similar to those of the 72 food plants species found by Kouamé et al. (2008) in the natural vegetation of the central-western Côte d'Ivoire.

The presence of both spontaneous weeds species and introduced weeds species in all assessed farms shows that the cashew orchards in Côte d'Ivoire are not single crop farms as a part of local and native flora is preserved in these orchards. Moreover, the presence of trees and shrubs indicate that an agroforestry system could be developed in these cashew orchards. Tiébré et al. (2016a, 2016b) showed that utilitarian species are scarcely available in savannah and degraded opened forests. However, these authors argued that the cultivated areas, the fallows and the opened forests are the reservoirs of utilitarian plants in northern Côte d'Ivoire. This study showed similar results in the Marahoué region in the central-western Côte d'Ivoire where 40 weeds species were preserved in cashew orchards.

Among the four identified ecosystems services described by Brauman et al. (2007), only the provisioning services and a lesser extent cultural services seemed to drive farmer’s decision to conserve or not weeds species in their orchards. In fact, the weeds kept preserved in the cashew orchards are used most often for food (42.39%), traditional medicine (34.78%) and minor uses. Touré et al. (2018) found similar results in central-eastern Côte d'Ivoire. More awareness among the cashew farmers about other services provided by plants could lead to the maintenance of more biodiversity in cashew orchards. Tra Bi (1997) indicated that the people of the Central-western Côte d'Ivoire consumed the fruits of *Deinbollia pinnata* and the leaves of *Triplochiton scleroxylon*. The consumption of *Deinbollia pinnata*’s fruit is confirmed in the studied area but the edibility of *Triplochiton scleroxylon* was not cited by farmers during this survey. Kouamé and Gnahoua (2009) found that the young leaves of *Sterculia tragacantha* and *Triplochiton scleroxylon* were consumed among the cashew farmers about other services provided by plants could lead to the maintenance of more biodiversity in cashew orchards.

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**Conclusion**

This study shows that the cashew orchards in the four studied regions in Côte d’Ivoire host 73 useful weed species including the shrubs, the trees, the lianas and the herbaceous in a decreasing percentage order. These useful weeds represent 17% of the total weed richness known in the cashew orchards in Côte d’Ivoire and their flora is highly diverse. Their number varies with the regions independently of the number of the questioned farmers. These weeds provide many services (food, medicine, craft and fodder) to the focal population but the consumed species and those in traditional medicine are most abundant. All their organs are used except the flowers. Hence, the weeds that are sometimes taken to be the pest of the cashew should have another consideration because in the current context of the natural vegetation very fast disappearing, the services of these plants to the local population become more important and pertinent. Of course, if the local population knew the implication of the Fabaceae weeds in the local soil fertilization process, the total number of these useful weeds in the cashew orchards would be higher than the 73 species found in this work.

**Declarations**

**List of abbreviations:** FAO: food and agriculture organization, APG: angiosperm phylogeny group; Cul: cultivated, Spo: spontaneous, Foo: food, Med: medicinal, Cra: crafts, Fol: Fodder, Oth: other, Fru: fruits, Lea. leaves, Roo: roots, Rod: rods, Bou: Bounkani, Gon: Gontougo, Kab: Kabadougou, Mar: Marahoué

**Ethics approval and consent to participate:** The data were collected with respect to confidentiality, anonymity and consent. All respondents were informed about the aim of this study.

**Consent for publication:** Not applicable

**Availability of data and materials:** The data were not deposited in public repositories.

**Competing interests:** The authors declare no conflict of interest.

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la chaîne de valeur de l’Anacarde (PPCA) funded this study.

**Authors’ contributions:** Latif Mory Konaté developed the research protocol, collected the data and wrote this article. François N’Guessan Kouamé supervised and improved this article from its protocol to its writing. Doujdjo Noufou Ouattara and Adama Bakayoko helped with data analysis and the provision of literature to consolidate the discussion.

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Appendix: Survey sheet according to Touré et al. (2018)

Collector information

Collector name........................................ Collection date........................................

Socio-demographic characteristics and constraints

District........................................ Village/Camp........................................ Field

No................. Name of the respondent .................. Age of producer [___] years; Ethnicity

........................................Level of education 0=none; 1=primary; 2=secondary; 3=higher education [___]

Asked questions

1. What useful plants do you know in your orchard?
2. Which part of the plant do you use and how?
3. Why do you keep these species orchard?
4. Did you or someone else planted it?

| N° | Weeds’ scientific names | Frequency | Used organs | Origin of weeds |
|----|-------------------------|-----------|-------------|----------------|
|    |                         |           | Fruit       | Cultivated     |
|    |                         |           | Leave       | Spontaneous    |
|    |                         |           | Root        |               |
|    |                         |           | Stem        |               |
| 1  |                        |           |             |               |
| 2  |                        |           |             |               |
| 3  |                        |           |             |               |
| 4  |                        |           |             |               |
| 5  |                        |           |             |               |
| 6  |                        |           |             |               |
| 7  |                        |           |             |               |