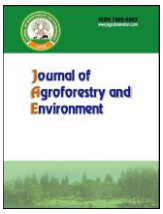
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Socio-economic Services of Living Hedges in the Sudano-Sahelian Zone of Cameroon

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Abstract: Living hedges are among the linear agroforestry systems that structure agricultural landscapes and play an important role in the livelihoods of local populations. They provide various socio-economic services to communities. The objective of this study was to contribute to the promotion of living hedges. The study consisted of a survey conducted among 234 living hedge owners in 18 localities distributed along the 800, 900, and 1000 mm isohyets, with six localities selected from each isohyet. The results revealed that living hedges are established by farmers primarily to protect crops, livestock, and houses (76.5%) against wind, erosion, and, more generally, climatic hazards. In addition, living hedges provide products such as fuelwood and timber (65.3%), vegetables (59.4%), fodder (27.1%), and medicinal products (35.6%). Living hedges also serve as an alternative solution to land conflicts (57.2%) and agro-pastoral conflicts (54.5%). The main species used include *Jatropha curcas*, *Jatropha gossypifolia*, *Commiphora africana*, *Commiphora kerstingii*, *Manihot esculenta*, *Euphorbia kamerunica*, *Euphorbia* sp., *Erythrina sigmoidea*, *Azadirachta indica*, *Senna siamea*, *Ziziphus mauritiana*, *Agave sisalana*, *Ipomoea carnea*, *Acacia polyacantha*, *Acacia nilotica*, *Eucalyptus camaldulensis*, *Moringa oleifera*, and *Thevetia neriifolia*. Products obtained from this system are either consumed or marketed and contribute to improving household incomes. These findings are useful for promoting and developing sustainable management strategies for living hedges in the Sudano-Sahelian zone of Cameroon.

Keywords: Agroforestry; Living Hedges; Ecosystem Services; Sudano-Sahelian Zone; Cameroon.

INTRODUCTION

The Sudano-Sahelian zone of Cameroon is characterized by intense agricultural and livestock production activities. However, it remains an ecologically fragile region. It is marked by significant environmental degradation resulting from agricultural exploitation, overgrazing, and natural phenomena (Jabkalbe *et al.*, 2010). These factors affect both the agroecological and socio-economic sectors of rural communities (Ousmane *et al.*, 2017). In response to this situation, adaptation to climate change has become a major priority for rural populations in the region (Watang, 2015). Currently, millions of africans face difficulties in meeting their food needs. The Intergovernmental Panel on Climate Change (IPCC) reports that by 2050, an increase in temperature of approximately 1.2 to 1.9°C could raise the number of undernourished africans by 25 to 95% (Munang *et al.*, 2014). According to the United Nations Development Programme (UNDP, 2010), the poverty rate in the region reaches 65.9%. The

Sudano-Sahelian zone of Cameroon is among the regions most affected by food insecurity, where household living conditions remain highly precarious (WFP, 2005). Another major challenge facing this region concerns not only land tenure conflicts but also agro-pastoral conflicts. The lack of clear demarcation between grazing lands and cultivated areas frequently leads to disputes between farmers and herders (Abdoulaye, 2014).

Given these challenges, the present study addresses the question of which local populations to improve their socio-economic living conditions adopt strategies. Among the available management practices, agroforestry systems constitute an alternative solution. Agroforestry systems integrate crops, trees, and/or livestock on the same land unit either simultaneously or at different time intervals. Among the agroforestry technologies that play an important socio-economic and ecological role in the Sudano-Sahelian zone are living hedges. Indeed, the introduction of trees in the form of living hedges into agricultural landscapes is of great importance for the management of rural Sudano-Sahelian areas, given the prevailing livestock production systems and agricultural practices (Yossi *et al*., 2006). Living hedges perform several functions that are beneficial to agricultural activities. They provide a source of energy and contribute to biodiversity conservation, thereby supporting sustainable development objectives (Poitou-Charentes, 2013).

Numerous studies on living hedges have been conducted in several agroecological zones across african countries, including Burkina Faso, Mali, Senegal, and others (Jennifer, 2008; Diatta *et al*., 2012). In contrast, very few studies have been devoted to this subject in Cameroon. Furthermore, living hedges have never been the focus of research in the Sudano-Sahelian zone of the country. The lack of documented knowledges on this agroforestry technology constitutes a major constraint to a better understanding of the practice and its sustainable management, thereby justifying the need for the present study. The main objective of this research is to contribute to the understanding of the socio-economic services provided by living hedges

MATERIALS AND METHODS

Description of the Study Area

The Sudano-Sahelian agroecological zone of Cameroon lies between 8°36′ and 12°54′ N latitude and between 12°30′ and 15°42′ E longitude. It covers the North and Far North Regions, representing an area of approximately 10.2 million hectares, of which 0.56 million hectares are under cultivation. The region is currently highly affected by climate change, which disrupts both agricultural and pastoral activities (Saha, 2019). Annual rainfall ranges from 500 to 1/000 mm on average. Rainfall is concentrated within a short rainy season, generally extending from July to October. In the southern parts of the zone, particularly in areas adjacent to the Sudanian savanna, annual precipitation may reach approximately 200 mm, whereas in the northern areas towards the Lake Chad Basin, it may decrease to around 300–500 mm per year (Fita *et al*., 2015; UNDP, 2007).

The mean annual temperature in the Sudano-Sahelian zone of Cameroon generally ranges between 28 °C and 29 °C, with maximum temperatures exceeding 40 °C during the dry season (MINEPDED, 2018; UNFCCC, 2005; Suchel, 1988; Letouzey, 1985). Topomorphic and hydromorphic Vertisols occupy the floodplains and alluvial areas of the Diamaré region (UNDP, 2007). Bitom-Mamdem *et al*. (2024) highlighted that digital soil mapping in northern Cameroon reveals a predominance of Vertisols and Tropical ferruginous soils in the semi-arid plains. Tamfuh *et al*. (2018) described the Vertisols of northern Cameroon as black clay soils with high agricultural potential but difficult to cultivate during the rainy season. According to Brabant and Gavaud (1985), Tropical ferruginous soils cover approximately 60% of the cultivated lands in northern Cameroon.

The vegetation of the Sudano-Sahelian zone of Cameroon is mainly composed of savannah formations adapted to semi-arid climatic conditions, characterized by an alternation of herbaceous vegetation and drought-resistant woody species. The vegetation includes tree and shrub savannahs, Sahelian steppes, and gallery forests harboring species such as *Ficus sycomorus* and *Khaya senegalensis*. Agroforestry parklands are also common, with the most frequent species including *Borassus aethiopum*, *Faidherbia albida*, and *Vitellaria paradoxa* (Dongock Nguemo *et al*., 2023; Sandjong *et al*., 2018; Haiwa *et al*., 2024).

To conduct the present study, three isohyets (800, 900, and 1000 mm) were selected as the study gradients (Fig. 1).

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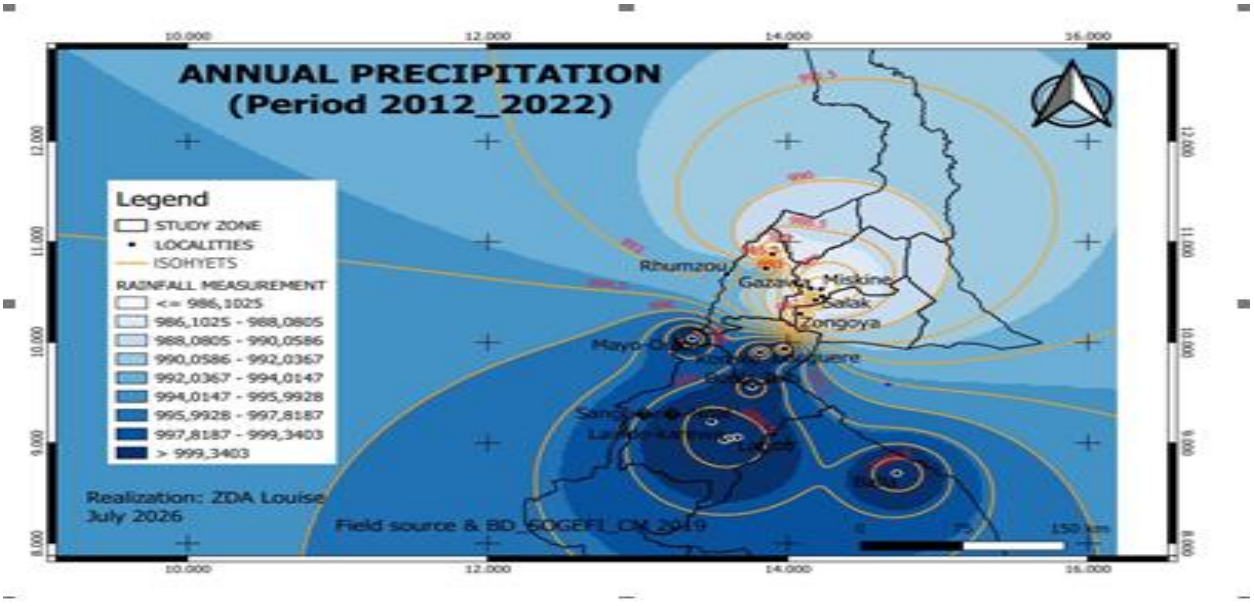


Figure 1. Location map of the study sites

Data Collection and Analysis

A socio-economic survey was conducted among local populations to assess the importance of living hedges. Semi-structured interviews were carried out using a pre-designed questionnaire. Indeed, rural populations possess extensive local knowledge regarding agricultural and forestry production systems (Yamaego, 2017). In particular, rural societies worldwide have accumulated empirical knowledge about the territories they inhabit. Investigating this knowledge therefore contributes to the development of action strategies addressing the challenge of sustainable resource management within the agricultural sector as a whole (Bousset, 2015).

Preliminary interviews were conducted with administrative and traditional authorities (12 sub-divisional officers, 5 mayors, 7 delegates of agriculture/livestock services, 4 delegates of water and forestry services, and 18 traditional chieves) in order to present the objectives of the study and gather information on the practice of living hedges. A socio-economic survey was then carried out among 234 living hedge owners across 18 localities distributed along the 800, 900, and 1000 mm isohyets, with six localities selected per isohyet. Interviews were also

conducted with nursery operators and resource persons involved in living hedge practices to collect additional information on activities related to the establishment and management of living hedges.

The questionnaire included closed, open-ended, and multiple-choice questions. For closed questions, respondents either agreed or disagreed; for open-ended questions, they expressed themselves freely; and for multiple-choice questions, they selected one or more responses. The methodology was adapted from Mapongmetsem (2000). The main sections of the questionnaire included: socio-demographic characteristics of respondents, reasons for establishing living hedges, main ecosystem services, and products derived from hedges, crops protected by hedges, land tenure, and uses of hedge-derived products.

At the end of each interview, a floristic inventory of the living hedges was conducted. Species identification was performed *in situ*, while unidentified specimens were collected and brought to the Plant Biology and Applications Laboratory for further identification.

Collected data were entered into Microsoft Office Excel 2016. Percentages were calculated and graphs were generated.

RESULTS

Reasons for the Adoption of Living Hedges

Living hedges provide various services to populations in the Sudano-Sahelian zone of Cameroon. In the study area, several reasons motivate farmers to establish living hedges. These include environmental protection in general and crop protection in particular. They are also considered less costly and more durable. In addition, they help reduce land tenure and agro-pastoral conflicts and provide several timber and non-timber forest products to landowners. The main reason for establishing living hedges, according to respondents, is protection (76.5%). Living hedges protect against animals, wind, floods, and other climatic hazards. Several products for domestic use (70.6%) are harvested from living hedges and constitute a source of income for owners in the Sudano-Sahelian zone. In the 900 mm isohyet zone, the main reasons for hedge establishment are protection (68.6%) and durability (56.9%). In the 1000 mm isohyet zone, the dominant reasons are protection (63.8%) and reduction of agro-pastoral conflicts (57.8%) (Fig. 2).

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These results highlight the crucial role of living hedges in protecting crops against animals, theft, and climatic hazards, thereby contributing to improved agricultural production in rural settings.

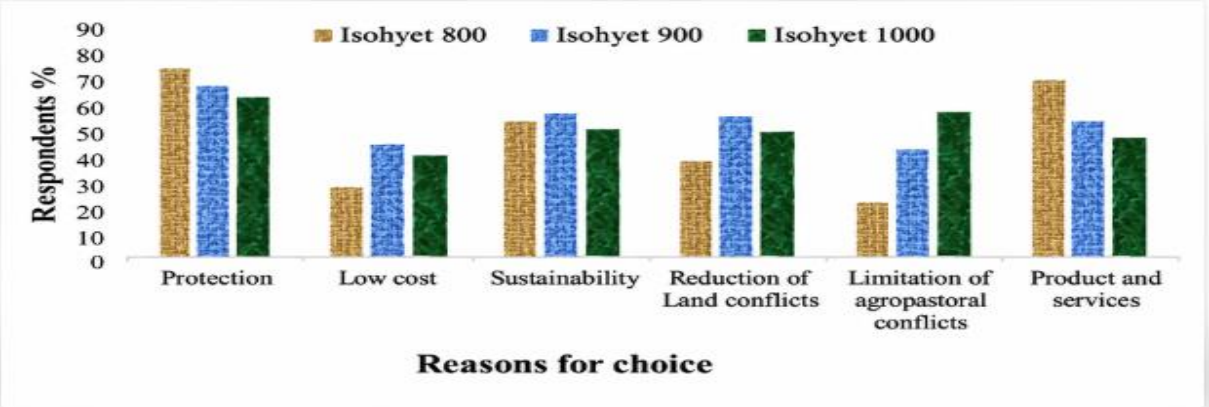


Figure 2. Percentage of farmers citing reasons for establishing living hedges

Respondents indicated that the main areas protected by living hedges in the study zone include crop fields, household compounds, orchards, etc. Living hedges primarily protect crops. The percentage of respondents ranges from 73.8% in the 800 and 1000 mm isohyets to 70.6% in the 900 mm isohyet zone. Regarding orchards, the values range from 47.1%, 46.1%, and 35.3% in the 800, 900, and 1000 mm isohyets respectively. This situation can be explained by the fact that in rural areas, the main activities are agriculture and livestock production. Respondents also indicate that living hedges play an ornamental role around houses (Fig. 3). This situation is explained by the fact that farming and livestock production are the predominant activities in rural communities.

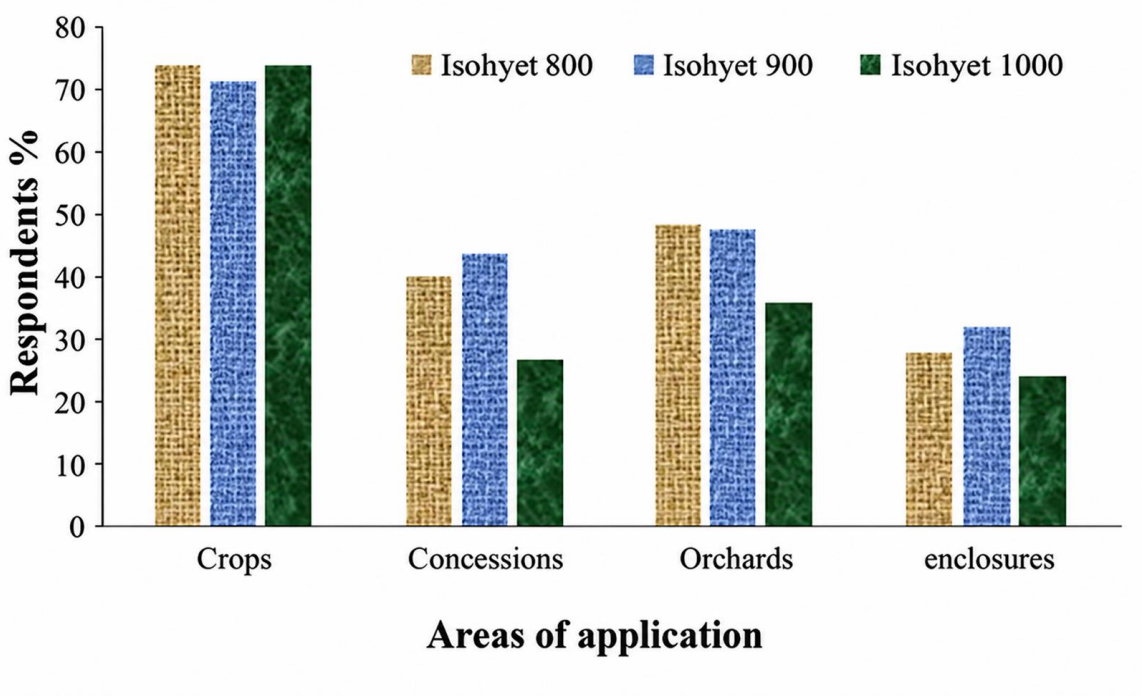


Figure 3. Percentage of farmers citing the uses/areas of establishment of living hedges

Typology of Living Hedges

According to local populations, living hedges perform different functions. Four main types of living hedges are identified: protection production, conflict-management, and microclimate-creation hedges (Table 1).

Protection hedges are mainly used against destructive animals (48.6%). In addition, hedges used for microclimate creation account for 40.2% of use. Furthermore, some

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hedges are used as boundary markers in land tenure management (46.4%) and agro-pastoral conflict resolution (55.8%). Production hedges, particularly those providing fuelwood, are widely recognized (65.3%).

Table 1: Types of Living Hedges

Types of living hedge	Function	Isohyet 800	Isohyet 900	Isohyet 1000	Mean
Protection	Against destructive animals	48	52.9	45.1	48.6
	Against wind	57.8	54.9	31.4	48
	Against erosion/flooding	24.5	45.1	29.4	33
	Against thieves	54.9	31.4	34.3	40.2
Ecological	Microclimate creation	66.3	44.6	54.5	55.1
Conflict management	Land tenure	67.3	29.4	42.6	46.4
	Agro-pastoral	58.8	41.2	67.3	55.8
Production	Fuelwood	69.6	63.7	62.7	65.3
	Timber	26.7	59.8	42.2	42.9
	Handicrafts	23.5	16.7	18.6	19.6
	Vegetables	44.1	37.3	59.4	46.9
	Fodder	39.2	20.6	21.6	27.13
	Medicinal uses	37.3	46.1	23.5	35.6
	Seeds/pods/fruits	46.1	54.9	29.4	43.4
	Fertilisers	28.4	45.1	42.2	38.5
	Support	17.6	32.4	7.8	19.2

Floristic Composition of Living Hedges

Out of 180 living hedge systems surveyed in the study area, a total of 117,829 individual plants were recorded, belonging to 88 species, 67 genera, and 37 families (Table 2). This composition varies along the rainfall gradient. Species richness, as well as the number of genera and families, decreases from the 800 mm isohyet to the 1000 mm one The 800 mm isohyet shows the highest species richness, followed by the 900 mm one (57 species) and then the 1000 mm isohyet (55 species). This pattern may be explained by the fact that farmers in the 800 mm isohyet area have more developed living hedge practices than those in the 900 and 1000 mm zones. Since living hedges are also a form of reforestation practice, the need for wood and tree planting is more pronounced in the 800 mm isohyet, where precipitation is lower, compared to the 1000 mm isohyet where vegetation is more abundant and farmers can still collect wood from natural stands.

A total of 34 species are common to all three isohyets, while 14 are exclusive to the 800 mm isohyet, 12 to the 900 mm isohyet, and 4 to the 1000 mm isohyet.

Table 2: Floristic Composition of Living Hedges

Isohyets(mm)	Individuals	Species	Genera	Families
800	39674	61	53	27
900	45598	57	46	26
1000	32557	55	43	26

Main Ecosystem Services of Living Hedges

Living hedges provide various ecosystemic services to populations in the Sudano-Sahelian zone of Cameroon.

Provisioning Services

Fuelwood and Craft Production

Among the different products harvested from living hedges, wood occupies an important place. It is used as a primary energy source, as well as for timber and service wood. Nowadays, it is difficult to find wood in natural bush

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areas for use. When farmers retain certain tree species in fields or within their living hedges, they can obtain wood for cooking as well as for other needs such as house construction and building of shelters (Tab 5).

Overall, the main product derived from living hedges is fuelwood (65.3%). Responses vary from 69.6% in the 800 mm isohyet to 62.7% in the 1000 mm isohyet. In this regard, all woody species in living hedges are utilized as fuelwood, including *Azadirachta indica*, *Faidherbia albida*, *Acacia polyacantha*, and *Anogeissus leiocarpa* (Fig. 4). These results are explained by the fact that, in all surveyed households, the only energy source for cooking is wood or charcoal. For improved energy efficiency, some households use improved cookstoves.

Service wood harvested from living hedges is used in the construction of traditional houses and even in the construction of small bridges over streams. Poles extracted from hedges are widely used for various purposes. Beyond fuelwood, hedge species are also used for the production of numerous artisanal items such as mortars, stools, chairs, beds, doors, animal feeders, spatulas, tool handles (hoes, axes, sickles), and structures such as shelters or crop-drying platforms.

The most commonly used species include *Khaya senegalensis*, *Azadirachta indica*, *Terminalia brunnii*, and *Vitellaria paradoxa*, with an average usage rate of 42.8% among living hedge owners (Fig. 4).



Figure 4. Fuelwood and stakes after pruning of a living hedge

Craft Production Products

The leaves of *Hyphaene thebaica*, found in living hedges, are widely used for the production of mats, baskets, hats, trays, and fans (Fig. 5). Some living hedge species such as *Ipomoea carnea*, *Andropogon gayanus*, and *Thevetia neriifolia* are used in the fabrication of *sekos* (Fig. 6). Ropes and strings are produced using species such as *Piliostigma thonningii*, *Thevetia neriifolia*, and *Andropogon gayanus* (Table 3). These products are used in the construction of sheds or crop-drying structures.

Table 3: Percentage of populations citing craft objects

Craft products	Main species	Iso800	Iso900	Iso1000	Means
Mortars	*Khaya senegalensis, Vitellaria paradoxa*	13.7	30.4	18.6	20.9
Stools	*Azadirachta indica, Sena siamea*	21.6	24.5	29.4	25.1
Benches	*Khaya senegalinsis, Vitelaria paradoxa*	10.8	19.6	13.7	14.7
Chairs	*Anogeissus leocarpa Azadirachta indica*,	16.7	23.5	14.7	18.3
Hats	*Hyphaene thebaica*	5.9	2	0	2.6
Basquets	*Hyphaene thebaica, Anona senegalinsis*	11.8	2	8.8	7.5
Mats	*Hyphaene thebaica*	0	3.9	0	1.3
Fans	*Hyphaene thebaica*	5.9	0	3	2.9
Trays	*Hyphaene thebaica*	9.8	8	0	5.9
Spatulas	*Balanites aegyptiaca, Mangifera indica,*	29.4	21;6	23.5	24.8
Beds	*Anogeissus leocarpa, Azadirachta indica, Khaya senegalensis*	12.7	19.6	7.8	13.6

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Leather tanning	*Acacia nilotica*	16.7	21.6	19.6	19;3
Handles (hoes, sickles, axes, etc.).	*Terminalia brunii, Senna siamea, Balanites aegyptiaca, Tamarindus indica*	44,1	34.3	48	42.1
Feeders	*Khaya senegalensis, Azadirachta indica.*	10.8	20.6	28.4	19.9
Doors	*Azadirachta indica, Senna siamea*	15.7	11.8	19.6	15.7
Sheds/drying racks	*Senna siamea, Azadirachta indica, Commiphora kerstingii, Commiphora, Anogeissus leocarpa, Terminalia brunii*,	37.3	33.3	57.8	42.8
Oil/grease product	*Azadirachta indica, Khaya senegalensis, Ricinus communis, Vitellaria paradoxa*	43.1	35.3	37.3	38.5
Seko	*Thevetia neriifolia, Ipomoea carnea, Andropogon gayanus*	32.4	44.1	39.2	38.5
Ropes/strings	*Piliostigma tonningii, Thevetia neriifolia, Andropogon gayanus*	26.5	16.7	5.9	16.3
Dish washing sponges	*Lupha cylindrica*	9.8	14.7	10.8	11.76

Leaves of Hyphaene thebaica are regulary used to braid table mat (Fig: 5). Where are regularly where as puning of Ipo,ea carnea are for seko (Fig.6).



Figure 5: Traditional tray making using leaves of *Hyphaene thebaica*



Figure 6: Seko crafted from prunings of *Ipomoea carnea* from a live fence for the construction of onion storage granaries.

Food

Among the various products obtained from live fences, some are used for human consumption, while others are used as animal feed.

Animal feed

Owners of live fences harvest fodder from their hedgerows to feed their livestock, as grazing resources have become increasingly scarce due to population growth. In the Sudanian–Sahelian zone, where natural pasture is limited, farmers cut branches from fodder species growing within their agroforestry systems to feed their animals (Tab 5). The most frequently cited fodder species include *Leucaena leucocephala*, *Ziziphus mauritiana*, *Afzelia africana*, and *Prosopis africana* (Fig. 7).



Figure 7: Fodder harvested from a live fence of *Hematostaphis barteri* and browsed by free-ranging livestock.

Human food

The respondents also reported that many live fence species provide a variety of food products for human consumption, including leafy vegetables, fresh and dried fruits, roots, and tubers. Among the fruit-producing species most frequently cited by agropastoralists are *Ziziphus mauritiana*, *Balanites aegyptiaca*, *Carica papaya*, and *Anacardium occidentale*. Pods and seeds produced by certain live fence species such as *Azadirachta indica, Acacia nilotica* are used for oil extraction, tanning, and direct consumption (Tab 5).

Leafy vegetables were the most commonly harvested products, accounting for 60.3% of the responses. The proportion of respondents reporting the harvest of leafy

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vegetables ranged from 68.6% in the 800-mm isohyet zone to 57.8% in that of 1000-mm zone. Species commonly grown as live fences that provide edible leaves include *Moringa oleifera*, *Manihot esculenta*, and *Celtis integrifolia* (Fig. 8).

Live fences of *Manihot esculenta* provide not only edible leaves, which are commonly prepared with groundnut paste or with locally produced groundnut cake known as "magani"(Fig 9.) in local language, a widely consumed and marketed food in the Sudanian–Sahelian zone, but also edible roots. The roots, commonly known as cassava, are processed into cassava flour locally referred to as "gourka " in local language. The sale of this product provides an important source of income, enabling rural households to purchase necessities such as soap, meat, and fish.

Yams (*Dioscorea bulbifera*) growing on live fences produce tubers both underground and on the aerial parts of the vine (Fig.8). All parts of *Leptadenia hastata* are useful: its leaves and flowers are consumed as vegetables. Likewise, *Momordica charantia* is used either as a leafy vegetable or as a condiment to season sauces with its characteristic bitter taste (Tab 5).



Figure 8. Live fences of *Manihot esculenta* (in left) and *Moringa oleifera* (in right), from which leafy vegetables are harvested



Figure 9. Magani made from *Manihot esculenta* leaves

Protection services

Annual or seasonal crops

In general, within the study area, the most commonly cultivated and protected crop by live fences is cotton (54.9%). Its prevalence ranges from 62.7% in the 800 mm isohyet to 47.1% in that of 1000 mm zone. This finding can be explained by the fact that the study area lies within the Sudanian–Sahelian zone, where cotton is the main cash crop.

Groundnut cultivation ranks second (54.5%), with its importance varying from 64.7% in the 800 mm isohyet to 55.9% in the 900 mm isohyet. This trend reflects the importance of northern Cameroon as a major groundnut production basin. Maize cultivation ranks third (53.2%), ranging from 58.9% in the 800 mm isohyet to 44.1% in the 1000 mm isohyet. Millet and market gardening crops follow (Table 4). In Cameroon, millet cultivation is mainly restricted to the Sudanian–Sahelian zone. These crops are typically rotated from one season to another and over successive years on plots protected by live fences.

Tableau 4: Percentage of famers' citations of cops protected by live hedges

Isohyet (mm) /Crops	800	900	1000	Mean
Arichis hypogaea	64.7	55.9	43,1	54,5
Zea mays	59.8	55.9	44,1	53,2
Pennisetum glocum, Sorghum bicolor,Digitaria exilis	36.5	58.8	56,9	50,7
Ipomoea batatas	41.2	41.2	32,4	38,2
Manihot esculenta	29.4	30.4	29,4	29,7
Saccharum officinarum	15.7	29.4	19,6	21,5
Sesamum indicum	38.2	36.3	21,6	32
Gossypium hirsutum	62.7	47.1	54,9	54,9
Vigna unguiculata	41.2	40.2	28,4	36,6
Vigna subterranea	27.5	33.3	19,6	26,8
Oryza sativa	20.6	32.4	30,4	27,8

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Allium cepa	52	12.7	23,5	29,4
Market gardening crops	44.1	45.1	50	46,4

Dry-season crops

In the study area, respondents reported that several crops are cultivated during the dry season, including onions (*Allium cepa*, 18.0%), tomato (*Solanum lycopersicum*, 29.7%), lettuce (*Lactuca sativa*, 19.9%), groundnut (*Arachis hypogaea*, 11.1%), eggplant (*Solanum melongena*, 21.2%), chili pepper (*Capsicum* spp., 23.2%), leafy vegetables (*Corchorus olitorius*, *Hibiscus sabdariffa*, *Amaranthus hybridus*, *Solanum nigrum*, *Brassica oleracea*, *Ceratotheca sesamoides*, etc.; 41.2%), and a group of crops collectively referred to as green condiments, including *Petroselinum crispum*, *Ocimum basilicum*, *Allium ampeloprasum*, and *Capsicum annuum* (40.9%).

Leafy vegetables were the most commonly cultivated dry-season crops (41.2%). Their cultivation represented 20.6% of responses in the 800 mm isohyet and 16.7% in both the 900 mm and 1000 mm isohyet zones. Green condiments accounted for 40.9% of the responses, with the highest proportion recorded in the 900 mm isohyet (47.1%), followed by the 1000 mm isohyet zone (41.2%). Tomato cultivation ranged from 35.3% in the 1000 mm isohyet zone to 29.4% in the 900 mm isohyet zone (Fig. 10).

During the dry season, livestock are commonly allowed to roam freely, exposing these crops to browsing and trampling. To prevent crop damage, farmers systematically protect their fields using live fences, dead fences, or barbed wire. According to the respondents, live fences are the preferred option because they are less expensive and more durable than other types of fencing.

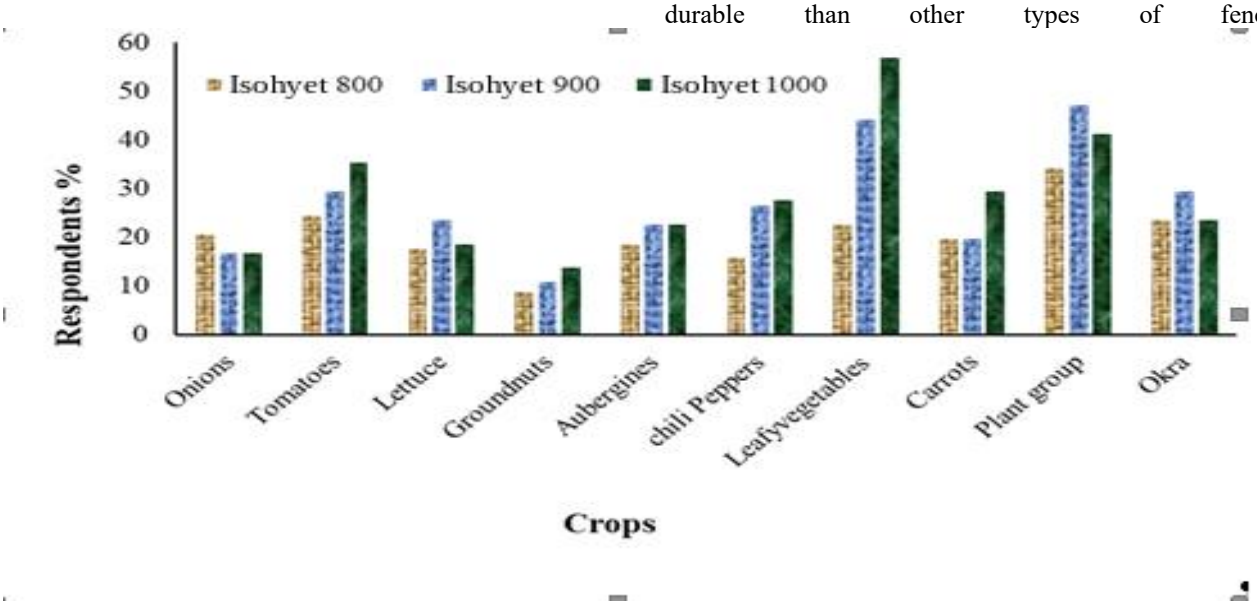


Figure 10. Dry-season crops cultivated in the study area

Supporting services

Live fences also serve as natural supports for climbing and trailing plant species. Five such species were identified: *Dioscorea bulbifera*, *Luffa cylindrica*, *Leptadenia hastata*, *Momordica charantia*, and *Cucumis metuliferus*. These species are used for a variety of purposes, including food, traditional medicine, and other domestic uses (see the sections on food, medicinal uses, and the manufacture of household items) (Fig. 11).

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Figure 11. Yam (*Dioscorea bulbifera*) growing on a live fence (a) and harvesting of aerial bulbils from a live fence (b).

Ecological services

Live fence species help maintain or create a favorable microclimate, thereby improving resilience to the adverse effects of climate change. They provide shade for both people and livestock, reduce the impact of strong winds, and help mitigate flooding. In addition, they contribute to climate change mitigation through the ecological functions they perform.

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Table 5. Uses of products obtained from live fences.

Product from fences	Species	Iso 800	Iso 900	Iso1000	Average
Fuelwood	*Faiderbia albida, Acacia nilotica ; Acacia polyacantha; Acacia seyal, Anogeissus leocarpa Azadirachta indica, Erythrina sigmoidea, Eucalyptus camaldulensis, Isoberlinia doka, Senna siamea, Terminalia brunii*	69.6	63.7	62.7	65.3
Timbers	*Acacia polyacantha, Acacia seyal, Anogeissus leocarpa, Azadirachta indica, Erythrina sigmoides, Isoberlinia doka, Senna siamea; Terminalia brunii, Balanites aegyptiaca, Daniellia oliveri; Khaya senegalinsis*	26.7	59.8	42.2	42.9
Poles	*Ecalyptus camaldulinsis*	36.6	21.6	39.2	32.4
Craftwood	*Hyphaene thebaica, Acacia nilotica, Kahya senegalensis*	23.5	16.7	18.6	19.6
Fodder	*Faidherbia albida, Daniellia oliveri, Diospyros mespiliformis,Ficus sycomorus; Leucaena leucocephala; Ziziphus mauritiana*;	39.2	20.6	21.6	27.1
Medicinal use	*Ziziphus mauritiana*; *Jatropha curcas Acacia nilotica*, *Acacia albida, Moringa oleifera ,Khaya senegalensis, Azadirachta indica, Senna siamea, Anogeissus leocarpua, Carica papaya, Commifora kerstingii, Eucalyptus camaldulensis, Mangifera indica ; Erythrina sigmoidea, Vernonia colorata, Lepthedia hestata*, *Mormodica chorantica, Cucumis metuliferus*	37.3	46.1	23.5	35.6
Leafy vegetal	*Celtis integrifolia*; *Manihot esculenta, Moringa oleifera, Vernonia colorata*; *Leptadenia hastata*, *Mormodica chorantica*	68.6	54.9	57.8	60.4
Fruits	*Balanites aegyptiaca*, *Carica papaya*, *Citrus aurantifolia, Citrus reticulata, Ficus sychomorus,Hyphaene thebaica, Psydium guajava, Ziziphus mauritiana, Vitellaria paradoxa, Vitex doniana, Parkia biglobosa, Pithecellobium dulce, Anacardium occidentale, Haematostaphis barteri.*	46.1	46.1	29.4	40.5
Root vegetable	*Manihot esculenta*	13.7	12.7	0	8.8
Tuber vegetable		6.9	23.5	0	10.13
Stake	*Ecalyptus camaldulensis, Azadirachta indica, Senna siamea, Psydium guajava, Holarhena folribunda*.	64,7	54,9	57,8	59,13
Simple branches		32,4	23,5	31,4	29,1
Thorny branches	*Acacia nilotica, Ziziphus mauritiana, Ziziphus mucronata, Balanites aegyptiaca, Acacia polyacantha Acacaia seyal, Acacia senenegal*	59.8	24.5	55.9	46.7
Pods	*Acacia nilotica, Faidherbia albida, Parkia biglobosa*	32.4	26.5	23.5	27.4
Seeds	*Azadirachta indica, Khaya senegalensis, Cajanus cajan, Jatropha curcas, Ricinus communis*	34.3	42.2	37.3	37.9

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Economic Service

Live fences are a source of wood, fodder, food, and condiments, and they can provide additional income as well as a form of capital to their owners (Table 6). Several items made from materials and products derived from live fences are consumed and/or sold. The owners of live fences cite fence posts at 47.7%, followed by fuelwood at 47.3%, vegetables at 44.7%, thorny branches at 38.2% (Fig. 12), and timber at 33.1%. They state that these different products are the most sold (Table 7). The prices of these items or products vary from one isohyet to another and from one season to another. The money from the sale of these products enables farmers to meet household needs such as buying soap, oil, fish, salt, meat, clothing, etc.

Tableau 6: Marketing of manufactured items

Products and items sold	Quantity	Price (FCFA)	Iso 800	Iso 900	Iso1000	Means
Fuelwood	1unit 1 pousse	200-1000f 2500-5000	57.8	45.1	39.2	47.3
Timber	1 log	2500-10000	21.8	55.9	21.6	33.1
Thorny branches	1unit	500-2500	38.2	34.3	42.2	38.2
Seko	1 leaves	3000-5000	20.6	17.8	37.3	25.2
Vegetables	1 unit	100-1000	49	37.3	48	44.7
Fruits	1 unit	50-500	18.6	20.6	18.6	19.2
Fence posts	1	100-500	54.9	43.1	42.2	47.7
Ropes	1	200-500	69	6.9	5.9	6.5
Pods	1 cup	1000	18.6	14.7	21.6	18.3
Seeds	1 cup	300	16.7	19;6	23.5	19.9
Oil / butter	1l	3000-5000	34.3	21.6	28.4	28.1
Mortar	1	3500-10000	11.8	17.6	8.8	12.7
Benches	1	1000-25000	3.9	12.7	8.8	8.4
Stools	1	500-1500	5.9	17.6	13.7	12.4
Chairs	1	1000-3000	3.9	12.7	7.8	8.13
Hats	1	700-1500	5.9	6.9	0	4.3
Baskets	1	1000-5000	10.8	18.6	5.9	11.7
Plate	1	1000-2000	29	13.7	0	5.5
Spatular	1	500-1500	21.6	23.5	21.6	22.2
Beds	1	5000-15000	6.9	16.7	5.9	9.8
Tanning of hides	1	2000-5000	6.9	14.7	15.7	12.4
Tool handles (hoes, sickles, axes, etc.	1	500 à 1500f	28.4	21.6	31.4	27.1



Figure 12. Piles of thorny branches of *Acacia nilotica* (in left) and *Ziziphus mauritiana* (in right).

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Productive Services

Respondents (54.2%) indicated that live fences contribute to improved agricultural production. This proportion ranged from 68.6% in the 900 mm isohyet to 39.2% in the 1000 mm isohyet. According to the interviewed live-fence owners, these structures enhance agricultural productivity by protecting crops from wind (48.0%), predators (48.3%), theft (40.2%), water erosion and flooding (33.0%), and by improving soil fertility (38.5%) through leaf litter. In addition, live fences provide physical support (19.2%) for climbing crops such as yam (*Dioscorea* spp.) (Table 10).

The contribution of live fences to agricultural production occurs through several mechanisms, including soil fertilization and soil restoration. Certain live-fence species, such as *Faidherbia albida*, are capable of fixing atmospheric nitrogen, thereby promoting crop growth. Furthermore, fallen leaves from live fences decompose into humus, enriching the soil and benefiting crop development. Moreover, some live-fence species, such as *Acacia nilotica*, improve water infiltration in compacted soils, thereby enhancing water availability for plant roots. Species used as windbreaks protect crops from wind damage, helping to improve yields. Live fences also reduce crop losses by limiting damage caused by predators and restricting access by thieves, thereby securing harvests. In addition, they help mitigate the impacts of soil erosion and flooding, both of which can substantially reduce crop yields. Finally, yam cultivation requires adequate support for vine growth, and in many localities within the study area, live fences serve this function effectively.

Social Services

Traditional Medicine

Local communities reported that a wide range of live-fence species are valued for their medicinal properties and are used in the treatment of numerous diseases. A total of 20 medicinal plant species were identified in the live fences of the Sudano-Sahelian zone (Table 7). The plant parts commonly used include leaves, bark, flowers, pods, seeds, and roots. The method of preparation and administration depends on the disease being treated. A single species may be used to treat several ailments, with different preparation methods for each. For example, the seed oil extract of *Azadirachta indica* is used to treat stomach disorders and headaches, while a decoction of its leaves mixed with those of *Mangifera indica* and *Senna siamea* is used to treat typhoid fever.

The most widely recognized medicinal species found in live fences is *Jatropha curcas*, cited by 98.1% of respondents. Across all surveyed localities, farmers acknowledged its use for disinfecting wounds. In Mogodé, it is also regarded as an effective treatment for malaria. Locally, the Kapsiki people refer to it as "Rhedawa," meaning *malaria drug*. Some respondents reported using one or two seeds, while others use the roots to treat malaria (46%). Its widespread adoption is attributed to its accessibility and availability.

The second most frequently cited medicinal species is *Azadirachta indica* (43.1%), which is common in live fences and widely used because of its effectiveness against a broad range of diseases.

Moringa oleifera (42.5%) ranked third and is recognized for its numerous therapeutic properties. According to respondents, all parts of the plant including the leaves, roots, seeds, bark, and flowers are used in traditional medicine to treat various ailments, such as gastric disorders, diabetes, hypertension, and others. The fourth most important medicinal species is *Acacia nilotica* (33.3%). Its pods are used in the treatment of eye infections, diaper rash in infants, and chickenpox.

Ziziphus mauritiana was highly valued in all surveyed villages. Its roots, bark, and young shoots are used to treat stomach disorders. The bark of *Khaya senegalensis* is also used to treat stomach ailments, while oil extracted from its seeds is applied to the umbilical cord of newborns.

The leaves of *Eucalyptus* spp. and the bark of *Faidherbia albida* are used to treat coughs. *Erythrina sigmoidea* is used to treat both malaria and ringworm. *Haematostaphis barteri* is recommended by respondents for the treatment of anaemia. The entire plant of *Leptadenia hastata* (roots, stems, leaves, and flowers) is used to treat several diseases, including diabetes and malaria. Likewise, *Momordica charantia* is used to treat intestinal infections, while the fruit of *Cucumis metuliferus* is used both preventively and curatively to control epidemic diseases in poultry. Penda *et al*. (2018), working in India, reported that plant species intentionally maintained or established in live hedges serve a dual purpose: property delimitation and traditional medicine. Species such as *Adhatoda vasica* and *Azadirachta indica* are routinely harvested from live hedges to treat respiratory infections, fever, skin diseases, and several other ailments.

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Tableau 7: Percentage of citation of the main medicinal plants in living hedges by isoyet

				Isohyet (mm)			
Species	Diseases treated	Parts used	Mothodes ofpreparation and administration	800	900	1000	Moyenne
Jatropha curcas	Malaria, Injuries	Roots, seeds, Sap	Topicale application of sap to the woond, Oral consumption of seeds by chewing	66.7	38.2	33.3	46
Ziziphus mauritiana	Abdominal pain	roots, buds	Maceration of crushed dried ;roots followed by oral administration ,Mastication of young leaves or buds.	28.4	21.6	21.6	23.8
Acacia nilotica	Eyesnappy rash, Measles	Bark, Pod	Ophthamalic washing with pod infusion, decoction of the bark	36.3	34.3	29.4	33.3
Faidherbia albida	influenza	bark	Chew bark	30.4	23.5	17.6	23.8
Moringa oleifera	Various deseases such as Gastric ulcers, High blood pressure	roots, bark, Leaves, seeds	Direct oral consumption, maceration, decoction	41.2	27.5	58.8	42.5
Khaya senegalensis	Stomach pain, Newborn umbilical cord, Skin deseases	bark, oil extract seeds	Boil the bark, Topical application of oil to the umbilical region	9.8	19.6	12.7	14
Azadirachta indica	Various diseases such as Stomach aches, Malaria etc.	seeds, leaves	Topical application ,, Oral administration of oil and decoction	57.8	30.4	41.2	43.1
Senna siamea	Malaria, Typhoid fever	leaves, flowers	Decoction	14.7	21.6	26.5	20.9
Anogeissus leocarpa	Jaundice	bark, roots	Boil the bark and the root	8.8	11.8	11.8	10.8
Carica papaya	Malariae, Typhoid	Leaves, Seeds	Decoction of leaves Maceration of crushed seeds in cold water	17.6	23.5	25.5	22.2
Commiphora kerstingii	Tooth decay	bark	Simple decoction followed by topical washing	18.6	12.7	10.8	14
Eucaluptus camaldulensis	Flu	Leaves	Simple decoction followed by oral administration	35.3	25.5	10.8	23.8
Mangifera indica		Bark, leaves	Simple decoction followed by oral administration or by topical washing	41.2	23.5	24.5	29.7

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Erythrina sigmoidea	Dry skin patches,Malaria	bark	Decoction and then topical washing	9.8	14.7	3.9	9.4
Vernonia colorata	Stomach aches, Chickenpox	Leaves	Decoction as adminitration via enema and dietary intake as culinary vegetable in sauces	15.7	19.6	18.6	17.9
Heamatostaphis barterii	Anemia	Leaves, fruits	Simple decoction of leaves, oral con	21.6	1	13.7	12.1
Tamaridus indica	Chickenpox	Leaves	Boil the leaves for bothing qnd subsequent oral consumption	17.9	34.3	25.5	25.9
Leptedia hestata	Diabetes, Malaria,	Roots, stems, leaves and Flowers	Boil the leaves,stems, flowers and roots and orallyadminister the decoction	17.9 -	19.2	16.7	17.95
Mormodica chorantica	Malaria, Amoebiasis	Leaves, stems andfruits	Prepare the decoction for oral consumption. Consume as a vegetable ingredient in dietary preparation	11.8	20.5	12.8	15.03
Cucumis metuliferus.	Avian deseases outbreak	Fruits	Incorporate into poultry drinking water	16.7	10.9	12.7	13.43
Moyenne				26.3 3	21.6 9	21.4 2	23.14

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Land Conflicts

In the study area, respondents identified five main modes of land acquisition, namely: purchase, inheritance, donation, lease, and pledge (gage) (Fig. 13).

Some acquisition modes, such as inheritance, purchase, and donation, allow for direct land valorization by owners, while others, such as lease and pledge, allow for indirect land valorization. In the study area, children inherit land through the division of property after the death of their father, or the father distributes his assets, including land, while still alive due to advanced age.

Although Cameroonian civil law stipulates that pledge and donation apply only to movable property, in the study area the pledge system is commonly practiced on land. In this context, land is temporarily transferred when the owner is in need of money or goods; once the debt is repaid, the land is recovered. In some cases, land may remain under such arrangement for up to 30 years if repayment is not made. Chieves may also allocate land freely to individuals of their choice.

Lease practices are predominant in the 800 mm and 900 mm isohyets, with proportions of 63.7% and 60.8%, respectively. In contrast, in the 1000 mm isohyet, land purchase dominates (55.9%).

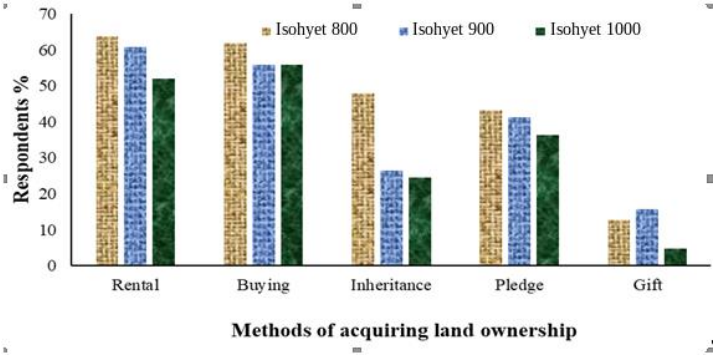


Figure 13. Distribution of land acquisition modes in the study area

Most respondents reported the recurrent occurrence of land-related conflicts in their localities. Some of those interviewed stated that they had lost a plot of land due to the absence of a formal land title. Others reported that their land was taken from them because of insufficient means of proper demarcation, which allowed boundary markers to be shifted by other parties (Fig. 14).

In response to this persistent issue, farmers consider live fences to be an appropriate solution for addressing land demarcation problems. However, it should be noted that beyond their role in boundary delimitation, live fences also function as a form of informal land tenure recognition for landowners (Fig. 14). Thus, only legally or socially recognized landholders are entitled to plant trees and establish live fences on their land, in contrast to users operating under lease or pledge arrangements.

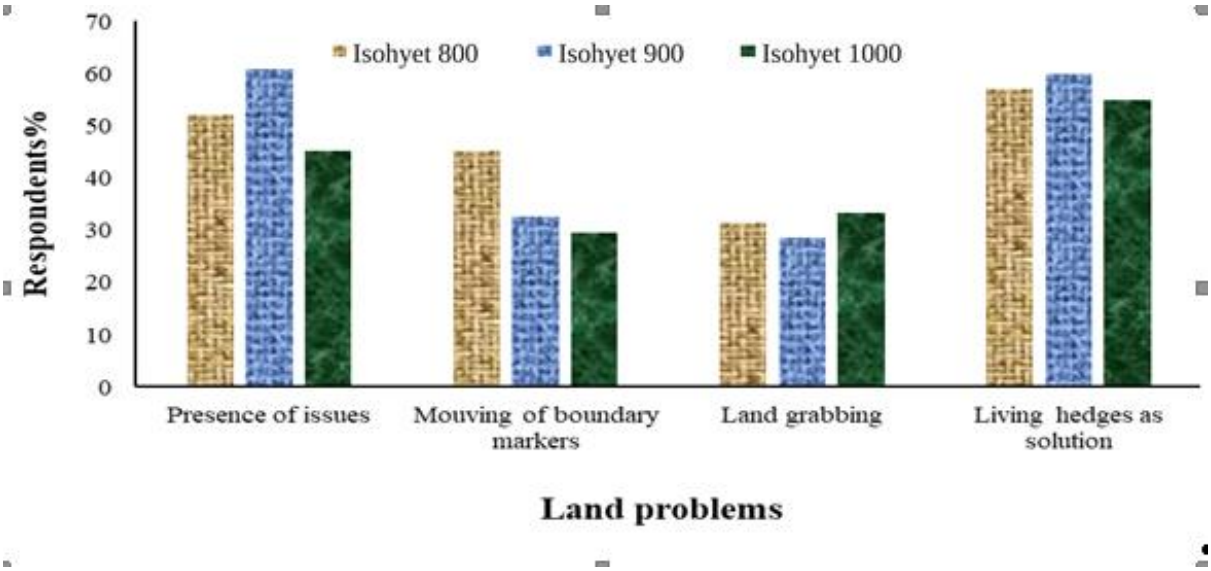


Figure 14: Causes of land conflicts

Live fences can be established using herbaceous, perennial, or woody species (Fig. 15). Those composed of **woody species** are generally more durable than those based on herbaceous species.

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Figure 15. Land demarcation using live fences: (1) *Andropogon gayanus* and (2) *Azadirachta indica*

Causes of Conflicts

Normally, during the rainy season, all livestock are kept in enclosures to prevent them from destroying crops; however, this is not always the case. As a result, respondents indicated that agropastoral conflicts are unavoidable in the study area. These conflicts sometimes lead to the death of animals or humans. Crop damage caused by livestock is the primary trigger of agropastoral conflicts. This is compounded by several structural constraints, including insufficient farmland, encroachment of grazing areas by crop fields, lack of designated cattle corridors (stock routes), and the occupation of farmland and grazing areas by human settlements due to population growth (Fig. 16).

Farmers report being overwhelmed by this situation, as most of these factors are beyond their direct control. They emphasize the need for intervention by administrative authorities.

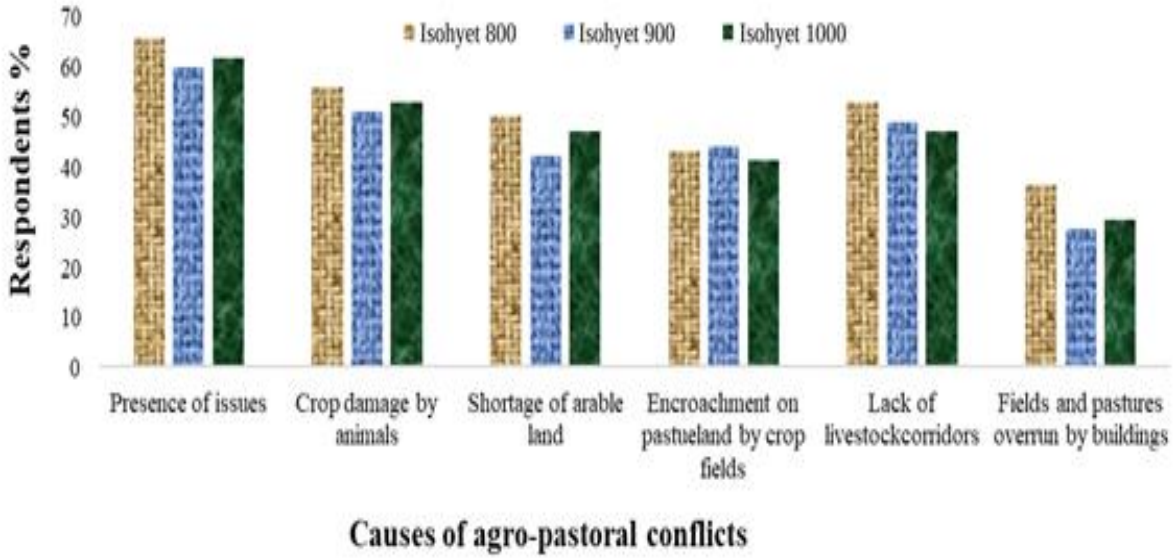


Figure 16. Causes of agropastoral conflicts in the study area.

Cameroon is a country characterized by strong agropastoral activities. The northern part, in particular, is a major livestock-rearing zone. Despite the suitability of agropastoral production, there is still no clear spatial planning that separates agricultural land from pastoral areas. In this context, live fences emerge as an alternative solution, as previously indicated by respondents.

Solutions to agropastoral conflicts

The solutions proposed by respondents to address agropastoral conflicts include: crop protection through live

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fences, the creation of clearly designated grazing areas, and the establishment of well-defined cattle corridors (stock routes). It is essential that the allocation and use of land resources be properly organized and respected (Fig. 17). Among these measures, only the establishment of live fences depends directly on farmers. This makes it an easily implementable, individual-level solution, which explains why live fences are considered the most suitable option by farmers.

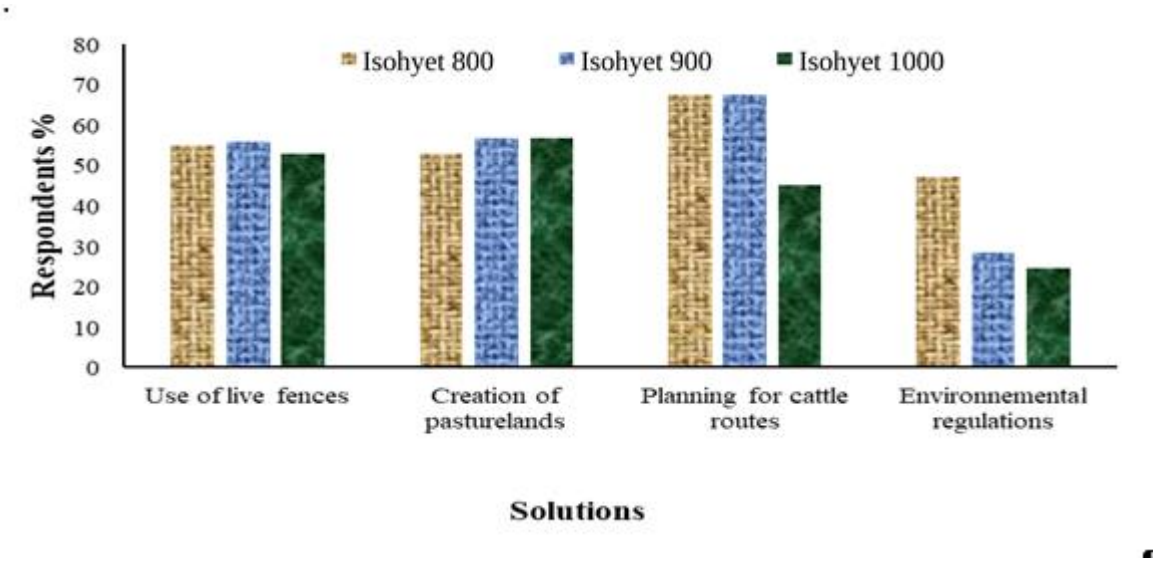


Figure 17: Solutions to agropastoral conflicts

DISCUSSION

Several windbreak hedges were established to reduce soil erosion, create wildlife habitats, and integrating native shrub species that produce non-timber forest products (NTFPs), such as fruits and vegetables, thereby improving the profitability of otherwise lost cropland (Marjolaine, 2007). Indeed, Hedgerows have long been an integral component of agricultural economies. Farmers have empirically derived multiple benefits from live fences established to enclose fields and pastures (Dorst, 1981; Yossi *et al*., 2000, 2006). Research conducted by CIRAD (2013) shows that live hedges are primarily established around agricultural fields, orchards, and homesteads.

Seven types of live hedges have been identified: defensive, land boundary, windbreak, anti-erosion, fodder, multifunctional, and ornamental hedges (Depommier, 1991, 1993; Louppe and Yossi, 1999, 2006). These categories are generally based on their primary functions within agroecosystems.

In their study on timber and carbon stocks in French hedgerows, Dassot *et al*. (2022) emphasized the need for planned management to ensure that wood harvesting does not compromise the hydrological and climate-regulating ecosystem services provided by hedgerows.

Thibaut (2026) analyzed how the diversity of tree species found in French live hedges supports 16 officially recognized woodworking crafts, including wood sculptors and marquetry artisans. The study highlights that hedgerows contain valuable and rare timber species particularly suited for the production of high-quality artistic objects. The use of woody plants in agroforestry is incorporated into construction and various other services (Jagoret *et al*., 2014).

Surveyed agropastoralists prune trees and shrubs from live fences and transport the cut branches to livestock enclosures to feed their animals. Agroforestry enhances both crop and livestock productivity through positive interactions among trees, crops, and livestock (Trouillard *et al*., 2024). Guerin *et al*., (2011) emphasized that trees growing in live hedges function as a fodder reserve, providing livestock feed when herbaceous resources become depleted. Tunde *et al*. (2022) reported that woody species in live hedges play a vital role as emergency feed banks for livestock during the dry season.

The deliberate introduction of hardy or wild fruit trees into live hedges provides both agronomic and economic benefits (Barjou, 2023).

Integrating woody structures, particularly live hedges composed of *Ziziphus mauritiana*, exerts a positive impact on the protection and yields of traditional millet and cowpea crops (Guimbo *et al*., 2021).

Live hedges offer permanent and sustainable protection for off-season crops, which are essential for food security

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and rural livelihoods but are frequently threatened by stray livestock (Levasseur *et al*., 2009).

The branched architecture of live hedges serves as a support structure for climbing plants. These hedges protect the fragile stems of climbing vines against strong winds (Vega-valdez, 2018).

Trees and shrubs supply numerous ecological services to communities in the Sudano–Sahelian zone. In particular, trees play a crucial role in soil protection and the maintenance of soil fertility (Depommier, 1991; Jennifer, 2008; Yossi *et al*., 2006).

Productive live fences play an important role in generating rural income through the commercialization of timber and non-timber forest products (Yossi *et al*., 2025). These findings align with those reported by Baye-Niwah (2015).

Agroforestry trees perform multiple functions in farming systems, including soil fertility enhancement, biomass production, and the diversification of farm income (Jagoret *et al*., 2014). Agroforestry systems integrating trees and hedgerows contribute to long-term improvements in soil fertility and carbon sequestration (Chevallier et al., 2015). According to Boukeng *et al*. (2023), live fences in the Cameroonian Sudano-Sahelian zone play a major role in maintaining agricultural ecosystem services and improving cultivated soils. Leaf litter and other plant residues from live fences increase soil organic matter and reduce soil degradation. Woody species integrated into agricultural systems significantly improve the productivity of agroecosystems in semi-arid Africa through their protective effects on soils and crops (Félix *et al*., 2018).

Land acquisition can be defined as "a legal act by which a person lawfully acquires ownership of land in exchange for a sum of money, in accordance with land and civil law regulations" (Ordonnance, 1974). In civil law, Capitant (1936) defines inheritance as the legal mechanism through which heirs acquire the property of a deceased person, including land, dwellings, debts, and other proprietary rights. According to Capitant's legal vocabulary (1936), a donation is defined as "a legal act by which a person (the donor) transfers ownership of property free of charge and irrevocably to another person (the donee), who accepts it." According to Carbonnier (1959), a lease (tenancy) is "a contract by which one party agrees to allow another to enjoy property for a specified period in exchange for consideration." In a land context, this implies that the landowner retains title to the land while the tenant holds only a temporary usufruct right. According to the Cameroonian Civil Code, inspired by the OHADA uniform act on securities, a pledge (*gage*) is defined as "a contract by which movable property is delivered to a creditor or an agreed third party to secure debt repayment." According to Gautier (1992), traditional hedgerows in Cameroon directly contribute to the organization of agricultural production systems and the management of rural holdings. This finding is consistent with that of Levasseur *et al*. (2007), who studied improved live fences in the Ségou district of Mali. These results are also in agreement with those of Dangai (2022), who investigated indigenous knowledge and agroforestry parklands of *Daniellia oliveri* in the Sudano-Sahelian zone of Cameroon.

Savannah regions in northern areas are characterized by intense agropastoral activities that frequently cause substantial damage to crops and property. Such livestock-related damage not only leads to agricultural losses but also occasionally results in violent conflicts between farmers and pastoralists (N'Guessam, 2018).

Solutions were proposed by the Project Supporting the Equitable and Sustainable Management of Agropastoral Land (2014) in the North and Far North regions of Cameroon. Abdul-Rahaman *et al*. (2020) described live hedges as a crucial socio-ecological tool functioning as a permanent physical boundary that secures crops while clearly demarcating property limits. These structures also foster social cohesion by mitigating conflicts and structuring transhumance corridors, thereby facilitating mutually beneficial exchanges between farmers and agropastoralists, such as the exchange of livestock manure for crop residues.

CONCLUSION

The findings of this study demonstrate that live fences play a vital role in the production systems of the Sudano–Sahelian zone by providing important ecological, economic, and social functions. They supply a wide range of products for household use, harvested by 70.6% of the respondents, including fuelwood, leafy vegetables, fruits, fodder, medicinal plants, and timber. Fuelwood (65.3%) and leafy vegetables (60.3%) were the most frequently utilized products, while fodder species such as *Leucaena leucocephala*, *Ziziphus mauritiana*, *Afzelia africana*, and *Prosopis africana* provide valuable livestock feed during periods of pasture scarcity.

Live fences primarily protect croplands, homesteads, and orchards, thereby enhancing agricultural production. They reduce the adverse effects of wind (48%), erosion and flooding (33%), predators (48.3%), and theft (40.2%), while improving soil fertility (38.5%) through the addition of organic matter and, in the case of certain species such as *Faidherbia albida*, through atmospheric nitrogen fixation. They also serve as support structures for climbing plants (19.2%), provide shade, and contribute to climate change mitigation. Cotton and groundnut were the crops most frequently protected by live fences, while dry-season vegetable production also occupied a prominent place.

Beyond their ecological functions, live fences constitute an important source of household income. Products derived from their exploitation, including fence posts, fuelwood, vegetables, thorny branches, and timber, are marketed and contribute significantly to meeting household needs. In addition, twenty medicinal plant species were identified, with *Jatropha curcas* being the most frequently cited (98.08%) for the treatment of various ailments, including

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malaria, stomach disorders, eye infections, measles, influenza, gastric ulcers, hypertension, dental caries, ringworm, diabetes, amoebiasis, and poultry epidemics.

Finally, live fences play a key role in land tenure security and the management of agropastoral conflicts. They clearly demarcate farm boundaries, strengthen landowners' property rights, and help reduce disputes related to land occupation. In the context of increasing population pressure, limited agricultural land and grazing areas, and the growing incidence of conflicts between farmers and pastoralists, the promotion of live fences represents a sustainable solution. The expansion of live fences, combined with improved planning of agricultural and pastoral landscapes, constitutes a major strategy for enhancing the resilience of production systems and promoting the sustainable management of natural resources in the Sudano–Sahelian zone of Cameroon.

Authors' Contributions

All authors contributed to the conception of the methodological framework, supervision of socio-economic data collection, and manuscript drafting. In addition, they participated in quantitative data analysis and contributed to the discussion of the results. Finally, they ensured the critical revision of the article and approved the final submitted version.

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Conflict of Interest

There are no conflicts of interest declared by the authors.

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