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Beekeeping in Burkina Faso: A Survey on Local Knowledge and Practices in a Context of Global Decline in Honeybees

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Abstract

Like beekeeping worldwide, the sector in Burkina Faso is an income-generating activity. However, it faces many challenges: unsuitable practices, environmental degradation, declining bee populations, etc. Our aim is to contribute to the sustainable improvement of beekeeping by promoting local knowledge and expertise in this activity. To achieve this, we conducted a survey of 96 beekeepers and observed apiaries in three key beekeeping regions to analyze endogenous practices. We found that beekeepers in the regions studied are predominantly male (96.3%) and older (only 4.17% under 30), with a high illiteracy rate (56.25%). Most hives are of the traditional type. Their management involves precise know-how: selection of isolated sites rich in melliferous plants and water, north-south orientation to mitigate bad weather, and nocturnal harvesting of "ripe" honey (from capped cells). Bee attractants consist of various substances, notably plant-based materials and wax. Beekeepers perceive a worrying decline in bee populations (85% of respondents), which are attributed to several factors: pesticides, deforestation, the drying up of water sources and climate change. This perception is based on observed frequent bee mortality, fewer wild swarms and lower harvests. Beekeepers also face significant difficulties: limited access to modern equipment, insecurity (theft of hives), conflicts with residents due to bee stings (sometimes fatal, reported in 78.49% of reported cases), and the low economic value of honey. Despite these obstacles, beekeeping remains important to them, both for its products (honey for therapeutic and food uses) and for its ecological role (pollination). This study highlights potential avenues for concerted actions to preserve both bees and the communities that depend on them.

Keywords

Beekeeping, Local Knowledge, Endogenous Practices, Burkina Faso, West Africa

1. Introduction

Beekeeping, practiced in all regions of the globe, is the science and practice of maintaining bees to harvest their products [1] [2]. These products are essentially honey, wax, pollen and royal jelly. They hold significant food, nutritional, medicinal, cultural, social and economic value [3]-[7]. Beyond hive products, maintaining biodiversity and pollinating flowering plants are undoubtedly the most valuable ecosystem services provided by these insects [8]-[10]. Bee pollination promotes genetic diversity, enhancing floral diversity [11], and contributes approximately 9.5% of the total economic value of global agricultural production, (nearly $200 billion), by improving seed and fruit quality and yield [12] [13]. Thus, bees have profound ecological and economic impacts. In Africa, beekeeping is an ancestral activity that has evolved into a professional sector, becoming a key source of income for developing economies [14]. In West Africa, some beekeepers harvest honey from wild swarms in savannas or forests, while others trap swarms in hives made from local materials (e.g., hollowed tree trunks, straw). These hives are placed in trees after coating with a proprietary attractive paste. Honey harvesting is traditionally done at night, without protective gear, and often leads to colony destruction. Historically, efforts to modernize the sector have focused on importing techniques from industrialized countries [1] [14] [15]. In Burkina Faso, the sector has grown significantly in recent years: from 375 beekeepers in 1986 to over 16,000 in 2018 [15] [16]. Honey sales generated approximately three (3) billion CFA francs for the national economy in 2018 [16]. In addition to the local and sub-regional market, Burkina Faso honey now reaches the European market, serving 500 million consumers [17]. Globally, however, technical, environmental, chemical (e.g., pesticides) and biological (e.g., parasites, predators) constraints that hinder development and reduce productivity [15] [18]-[20]. This has led to an alarming decline in bee colonies, threatening the sector's sustainability and beekeeper's livelihoods [21]. In the context of Burkina Faso, scientific knowledge remains limited, but studies have documented some melliferous resources, practices and health challenges associated with beekeeping: plant species used to attract swarms were identified [22]; melliferous plant potential was assessed in Garango and Nazinga [23]; the annual biological cycle of colonies and honey flow periods have been described in western Burkina Faso [24], Research emphasized the need to align beekeeping projects with local dynamics [25]. In addition, several recent research studies have focused on colony health issues: Sankara *et al.* [26]

inventoried the entomofauna associated with hives. A more in-depth analysis confirmed *Varroa destructor* infestation in two phytogeographical zones [27]. A pilot survey assessed the prevalence of wax moth (*Galleria mellonella*) in the Center and Center-West regions [28]. Despite these efforts, no systematic study has documented local and endogenous beekeeping practices. Such practices, born from centuries of co-evolution between communities and their environment, could underpin more productive and sustainable beekeeping. This study seeks to fill that gap by analyzing local knowledge and practices, identifying their strengths and weaknesses to improve sustainable production. Against the backdrop of global bee decline, we address the central question: What are the local beekeeping knowledge and practices in Burkina Faso, and how can they help mitigate this crisis? This analysis will enable us to assess not only the shortcomings of local practices, but also the potential of endogenous knowledge to develop more resilient beekeeping strategies. The results could guide future research, inform both public policy and the actions of development organizations working in the beekeeping sector.

2. Materials and Methods

2.1. Study Area

Our study was conducted in the administrative regions of the East, Center-West and Center-South of Burkina Faso in January and February 2021 (**Table 1**). These three regions host nearly 41% of the country's individual beekeepers (defined as those not operating in associations), ranked as follows nationally: East (1st), Center-South (3rd), and Center-West (4th) [16]. Climatically, the study area lies in the Sudano-Sahelian zone [29] [30] and is the most agriculturally intensive region in Burkina Faso. Annual rainfall ranges from 700 to 900 mm. The landscape is predominantly savannah, featuring scattered large, stout trees (10 - 20 m tall), including *Faidherbia albida*, *Adansonia digitata*, *Vitellaria paradoxa*, *Lannea microcarpa*, *Parkia biglobosa* and *Tamarindus indica*. Shrubs include *Combretum micranthum*, *Combretum glutinosum*, *Combretum nigricans*, *Guiera senegalensis*,

Table 1. List of locations visited.

Region	Province	Town/Village
Center-West	Boulkiemdé	Noessin, Salbisgo-Dapoya
	Sanguié	Réo, Ténado
	Sissili	Léo, Tô, Zorro
	Ziro	Sapouy, Gallo
Center-South	Bazèga	Rakaye, Guidissi, Ipelcé, Guisma, Baguemnini, Komsilga, Saponé
	Zoundwéogo	Nobéré, Kougr-sinsé, Téwaka, Passintenga
	Nahouri	Pô, Tolem, Walem
East	Gourma	Dianga, Diapangou, Fada, Kouaré, Kikidéni, Momba, Nidounga, Tibga

Acacia dudgeonii, *Acacia gourmaensis*, *Acacia seyal*, *Bombax costatum* and *Sterculia setigera* are common. In some areas, there are patches of dense dry forest, remnants of ancient forest climaxes spared by clearing. These include: *Anogeissus leiocarpus*, *Diospyros mespiliformis*, *Celtis integrifolia*, *Acacia pennata* and *Pterocarpus erinaceus* among others.

2.2. Data Collection and Analysis

The present study consisted of semi-structured interviews and the data were directly entered on a smartphone using the KoBoCollect v1.28.0 application. The questionnaire covered the beekeeper's profile, the characteristics of his farm and beekeeping equipment, production and his knowledge of bees. It was previously tested with 15 respondents and adjusted after consultation with local experts, which enabled rigorous data collection that respected the realities on the ground. A total of 96 beekeepers were surveyed, including 35 in the Center-West, 34 in the Center-South and 27 in the East, with a confidence level of 95% and a margin of error of 5%. Beekeepers were selected by snowball sampling via local networks, retaining only those participants who had given their consent and shown a willingness to receive us. Qualitative data were presented in the form of descriptive text. They enable us to understand and explain beekeepers' opinions, choices, and practices. Quantitative data were used to calculate averages, count the frequency of certain responses, and divide the data into percentages. These results are presented in the form of tables and graphs. Calculations were made using Microsoft Excel 365.

3. Results

3.1. Profiles of Beekeepers

Of the beekeepers surveyed, 96.3% were men and only 3.7% women, with a low representation of young people (4.17% under 30) (**Table 2**). More than half (56.25%) were illiterate, and for 97.92%, beekeeping was a sideline activity, often practiced after agriculture or livestock farming. While two-thirds (66.67%) had inherited the practice, others had been motivated to take up beekeeping by relatives, the search for additional income, the enhancement of land, or the consumption of honey for its gustatory and therapeutic qualities. Only 27.66 % of the beekeepers surveyed were affiliated with a beekeeping association.

Table 2. Socio-demographic characteristics of beekeepers.

Variable	Modality	Frequency (%)
Sex	Male	96.30
	Female	3.70
Place of beekeeping	Primary activity	2.08
	Secondary activity	97.92

Continued

Source of motivation for beekeeping	Inherited from parents	66.67
	Personal initiative	33.33
Level of education	None	56.25
	Literate	28.13
	Primary	9.38
	Secondary	5.21
	University	1.04
Age group	20 - 29 years old	4.17
	30 - 39 years old	12.50
	40 - 49 years old	26.04
	50 and over	57.29
Participation in at least one beekeeping training course	Yes	63.54
	No	36.46
Membership of a beekeeping association	Yes	27.66
	No	72.34

Nearly two-thirds (63.54%) of beekeepers had already received beekeeping training at least once. The courses covered topics such as the ecological importance of bees, installing and managing hives, melliferous plants, the beekeeping calendar and harvesting techniques. These courses were organized and funded by beekeeping centers, NGOs or ministries responsible for vocational training and livestock.

3.2. Typology of Hives Used by Beekeepers

The beekeepers we surveyed had between 2 and 138 hives. These hives were of traditional and modern types (**Figure 1**). Traditional hives are in the majority in the Center-West (82.77%) and Center-South (63.19%) regions. In the East, on the other hand, modern hives predominated (64.42%). Traditional and modern hives coexisted in the same apiaries. The choices were based primarily on cost, but ease of design and handling were also considered.

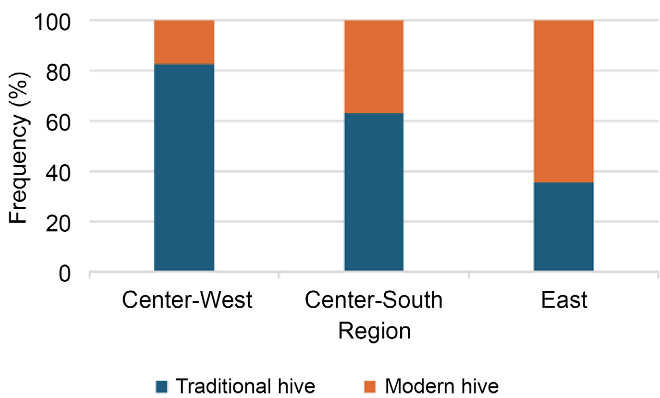

Figure 1. Hive typology by region.

3.2.1. Traditional Hives

Traditional hives are mainly self-built, with a single opening. Straw is the main raw material used to make hives (66%) (Figure 2 and Figure 3). This straw comes from wild herbaceous plants of the Andropogon genus and is woven using vegetable fibers or fastening irons. Unfortunately, it is becoming increasingly rare according to beekeepers. Large hives are preferred, but the small size of colonies and the scarcity of raw material force beekeepers to use small hives.

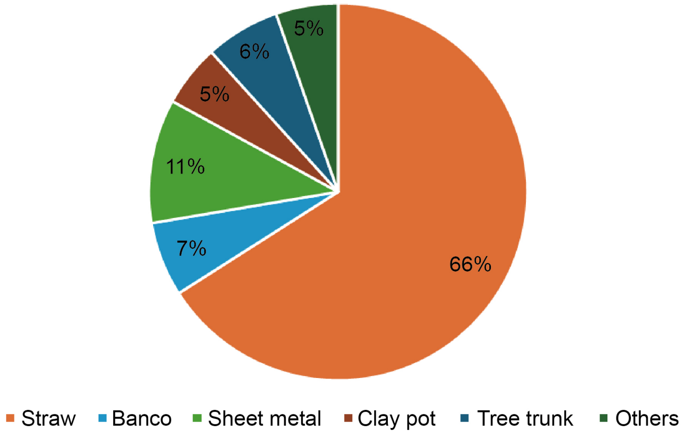

Figure 2. Distribution of traditional hive types in the three regions.

We have observed that clay hives are mostly reclaimed canaries. Wooden hives are made from hollowed-out trunks of large trees (dead or felled), with sheet metal or plastic lids. Traditional hives are mostly installed on tree branches, with no protection against predatory insects (Figure 3). The height at which they are installed depends on the tree. Some beekeepers prefer to place them higher up, so they can easily capture bee colonies and reduce the risk of aggression.

Figure 3. Photos of traditional hives. (a): Sheet metal hives; (b): Tin hive; (c): Tree trunk hives; (d): Straw hives.

3.2.2. Modern Hives

The Kenyan Top Bar Hive (KTBH) is the most widely used modern hive model (85%) followed by Dadant Hive (**Figure 4**). The KTBH is the type of hive used by all the women interviewed.

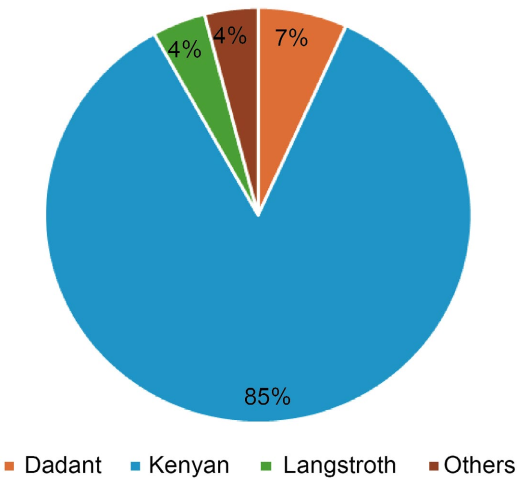

Figure 4. Distribution of modern hive types.

Modern hives are mostly acquired through projects and made from imported wood. They are usually placed on metal supports at ground level (**Figure 5**). However, they are considered too expensive and require a full set of beekeeping equipment to operate. The equipment that accompanies modern hives includes smokers, frame lifters, bee brushes, boots, overalls and harvesting buckets. But many beekeepers don't own any. Some resort to borrowing equipment from groups or individuals.

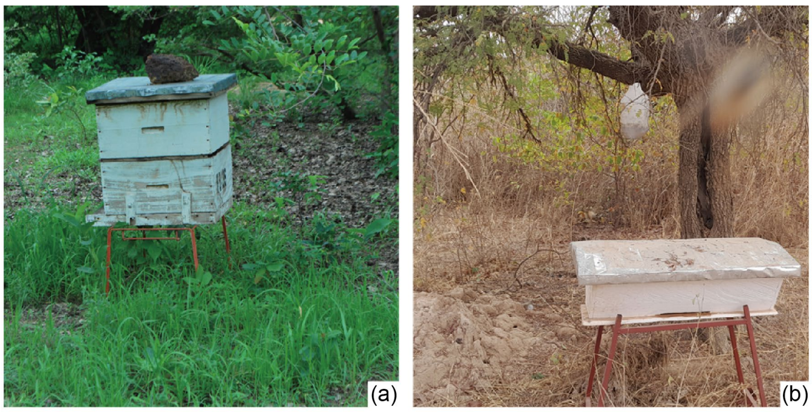

Figure 5. Photos of modern hives. (a): Dadant hive; (b): Kenyan Top Bar Hive.

3.3. Hive Preparation and Honeybee Colonization

Beekeepers use traditional techniques to optimize the attractiveness of their hives to bees. The process begins with selecting resistant and chemical-free building material. Traditional hives are coated with a mixture of clay, water, and fresh cow dung (the latter being a matter of debate, however, as some fear that it may alter honey's taste or attract termites). The hives are then smoked (sometimes for up to 24 hours), using carefully selected fuels: corn cobs, organs of local plants such as *Vitellaria paradoxa*, *Eucalyptus camaldulensis*, etc. Table 3 presents the botanical species reported as smoker fuels during this investigation. These materials are chosen for their dense smoke and attractive smell, but also and above all for their melliferous properties. In principle, all melliferous plants can be used as smokers. Some innovate with shea butter grains or animal bones, while others proscribe *Azadirachta indica* and *Khaya senegalensis* because of their bitterness. Wax application inside hives (modern or traditional) enhances their attractiveness, especially after smoking. Wax—whether embossed or raw, purchased or homemade—also guides comb construction.

Table 3. Plant substances used to smoke beehives in order to attract bee colonies.

Scientific Name	Part Used	Mode of Application	Vernacular Name (s)
Andropogon canaliculatus	Stems	Dry combustion	Yanta (m), yanga (gm) yandem (m)
Andropogon gayanus	Straw	Dry combustion	Kangré (m), Pita (m), Monpoaka (m), Monpoko (m)
Cassia sieberiana	Leafy stems, dried fruits	Fresh combustion	Kumbr-saka (m), Yanntiga (gm), Casia (fr)
Chrysanthellum indicum	Leafy stems	Fresh combustion	Sileg-nagninssé (m)
Combretum adenogonium	Leafy stems, roots	Fresh combustion	Kwig'nga (m), Kwig'ng daaga (m)
Combretum glutinosum	Leafy stems, roots	Fresh combustion	Kuign'ga (m), Kutr-wagle (m)
Crinum distichum	Bulb	Dry combustion	Pôonsé (m)
Cymbopogon citratus	Leaves	Fresh combustion	Lemongrass (eng)
Cymbopogon schoenanthus	Roots	Dry combustion	Sompiiga (m) ou Sõmpiissii (m), ou sõmpiri (m)
Daniellia oliveri	Leafy stems	Fresh combustion	Aoga (m) Anwga (m)
Detarium microcarpum	Roots, Leafy stems	Dry combustion	Kagdga (m)
Diospyros mespiliformis	Leafy stems	Fresh combustion	Gânka (m)
Eucalyptus camaldulensis	Leafy stems, Flowers	Fresh combustion	Eucalyptus (eng), Ti-woaka (m)
Guiera senegalensis	Leafy stems; fruits	Fresh combustion	Wiliwiga (m)
Leptedania hastata	Leafy stems	Fresh combustion	Lelongo (m), Lolongo (m)
Mangifera indica	Leafy stems, Flowers	Fresh combustion	Mango tree (eng), mango-tiiga (m)
Parkia biglobosa	Leafy stems, Bark, roots	Fresh combustion et sec	Roanga (m)
Piliostigma reticulatum	Leafy stems, dried fruits	Dry or fresh combustion	Bagana (m) ou bangdé (m)
Piliostigma thonningii	Leafy stems, dried fruits	Dry or fresh combustion	Bâguin-dâaga (m)
Sorghum bicolor	Empty cobs	Dry combustion	Sorgho (fr), Ki (m), kenda (m), kazinga (m)
Tapinanthus sp.	Leafy stems	Fresh combustion	Tapinanthus (eng), welba (m)
Vitellaria paradoxa	Leafy stems, Bark	Dry or fresh combustion	Shea tree (eng), Taanga (m)
Zea mays	Empty cobs	Dry combustion	Maize (eng), kamaana (m)

Langage: m = mooré, eng = english, gm = gourmantché, gr = gourunsi.

According to 68.89% of surveyed beekeepers, colonization generally takes less than one month. After a long period without colonization, they reheat hives over a flame, clean it of parasites or relocate it if needed, adapting methods based on season and experience.

Once the hives have been colonized, desertions can occur. These are mainly due to environmental factors (bad weather, improper hive size, poor harvesting or removal of reserves), biological factors (attacks by predators such as beetles, wax moth, lizards and rodents) or health factors (little-known diseases with observed symptoms such as diarrhea or immobilization of bees). About 80% of beekeepers clearly identify parasites as a major threat. Non-colonization and desertion often share similar causes.

3.4. Apiary Site Selection and Optimal Hive Installation Periods

Beekeepers believe that a suitable site for beehives should be far from populated areas and passageways, but still accessible, with abundant melliferous vegetation and a nearby water sources. Hives should be placed on stable supports, protected from predators and parasites (branches should not touch the hives). A north-south orientation is recommended to reduce weather exposure. When installing in agricultural areas, collaboration with landowners is essential.

According to the beekeepers, the best period to install hives is linked to the presence of flowers in the environment. In the Center-West and Center-South regions, the period from January to March is cited as the most favorable (47.61% and 55.55%). In the East, this period extends into June. The month of September is also favorable for the installation of new hives (Figure 6).

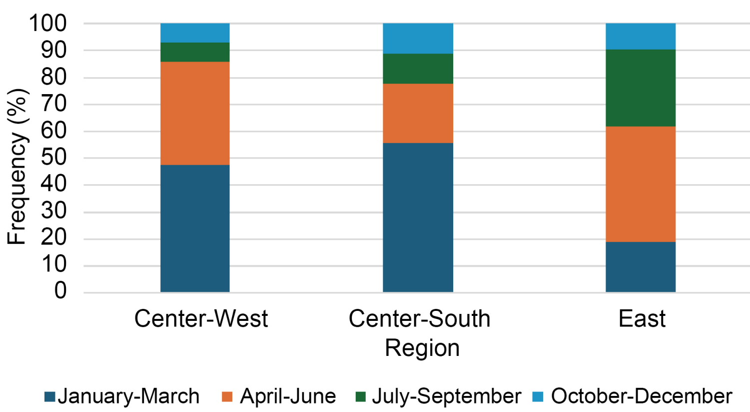

Figure 6. Suitable periods to set up beehives in the three regions.

3.5. Hive Monitoring and Honey Harvesting

The frequency of hive visits varies with the season, with 61.29% of beekeepers making weekly visits during honey flow periods. Visits are made mainly to check bee presence, harvest honey, or fill water troughs (sometimes with added sugar or flour). The troughs are homemade (using items like old tires or cut-up cans, etc.) (Figure 7). To prevent drowning, they place pebbles or wood pieces in the troughs. After bad weather, additional checks are performed. Some beekeepers leave honey in the hives as reserve or plant nectar-rich trees (mango, cashew) to preserve their colonies in times of shortage. Notably, no beekeepers (0%) provide veterinary care for their bees.

Figure 7. Photos of local bee troughs. (a): Recycled tire trough; (b): Recycled can trough.

Honey is the primary product sought by all beekeepers (100%), followed by wax (22.1%), pollen (14.73%), and propolis (5.26%). Royal jelly is harvested by only 1.05% of respondents. In addition to these products, brood is also collected by 3.16% of beekeepers.

Honey harvesting, which generally occurs at night (except for some Kenyan hives cases), conducted when the honey is "ripe" (evidence by capped cells and viscous texture), otherwise it is unfit for consumption. Beekeepers judge ripeness by various indicators: flowering of melliferous plants 3 - 4 weeks prior (cowpea and shea in dry season, cereals in rainy season), characteristic odor, agitated bee behavior, increased hive weight or dull sound when tapped. During the major honey flows (February-June), up to 3 harvests are possible in flowering areas, compared with a more liquid and less valued honey in minor honey flows (August-November) (**Figure 8**). Careful monitoring is crucial to harvest in good time before the bees consume their production, and to replace old combs before each new honey flow.

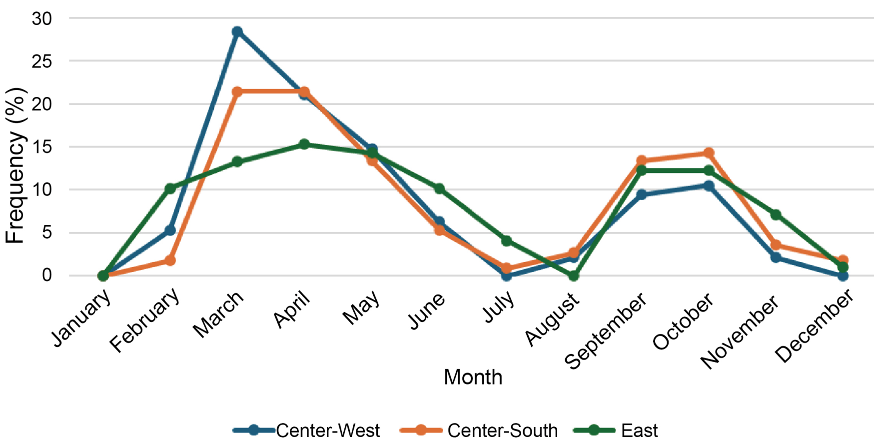

Figure 8. Periodicity of harvests in the year in the three regions.

Honey harvested is mainly intended for self-consumption and sale, generating an average annual income of 7,518.61 CFA francs per traditional hive and 15,775.99 CFA francs per modern (KTBH) hive, used to cover essential needs such as food, healthcare and schooling. Honey is also given as a gift and has many therapeutic virtues: it treats ulcers, stomach aches, heals wounds, fortifies the elderly and provides energy for agricultural work. It is also used as a memory aid for schoolchildren and in mystical practices. Its medicinal properties vary according to the flowers foraged by the bees.

3.6. Bee Aggression

Bee attacks are frequent: 89.13% of those surveyed have been victims or witnesses of such attacks. They mainly occur at harvest time and are caused by disturbance of the hives by humans, animals and bad weather; crushing of bees; or the use of odorous products (soaps, perfumes). Stings can cause a variety of reactions, from simple itching to death (78.49% of respondents had witnessed fatal cases directly or indirectly). Local remedies include decoctions of certain plant parts (*Solanum melongena*, *Solanum aethiopicum*, *Annona senegalensis*, *Cadaba farinosa*, *Maerua angolensis*, *Saba senegalensis*, *Securidaca longipedunculata*, *Tamarindus indica*, etc.). The application of ash, clay or shea butter is also recommended, although medical treatment remains the best option. To prevent conflicts, beekeepers set up hives away from houses, install drinking troughs in apiaries and inform residents when they plan to disturb bees.

3.7. Threats to Bees and Main Challenges Facing Beekeeping in Burkina Faso

More than 85% of beekeepers report a clear decline in bee populations, as evidenced by several alarming indicators: increased bee mortality, scarcity of wild swarms, slower hive colonization, reduced colony size and lower harvests. The main causes identified were the intensive use of pesticides (57.29%), deforestation (26.04%), the disappearance of watering holes (11.46%) and the proliferation of pests, predators and parasites (2.08%). A minority (16.67%) had no opinion on the subject. More generally, beekeepers point to global climate change. For them, rainfall is becoming scarce, the climate is warming up, water sources are drying up, the desert is advancing and, without being able to prove it, they believe that this is bound to have an impact on bees.

Beekeepers are facing several ecological, economic and social obstacles that are making the sector more fragile. These include the decline in bee colonies (leading to slow and weak colonization of hives), the scarcity of plants used to make traditional hives, and the lack of financial resources to acquire modern equipment (hives, protective clothing, etc.). Other problems include difficult access to land, conflicts with neighbors due to aggressive bees, theft of honey or hives, and a lack of knowledge about advanced beekeeping techniques. Finally, the low selling price of honey discourages efforts.

4. Discussion

This survey revealed that despite a timid involvement of women, beekeeping in Burkina Faso remains a male-dominated activity with a majority of practitioners aged over 50. This result aligns with the 2016 census by the Ministry of Animal and Fisheries Resources [16], which showed this masculine predominance with an average age of 48 years of actors. The predominance of older men could be explained by their social responsibilities, making them the providers of financial and nutritional resources for families. In honey, they find an alternative way of meeting these expectations without requiring strenuous physical effort. However, the low participation of young people and women may hinder the sector's development, limit innovation potential, and compromise long-term sustainability. Most beekeepers aim to diversify income sources, consistent with Olivier's findings [31] that honey production and sales remain the primary objective of African beekeeping. Youth, poorly represented in the sector, tend to prefer immediate income-generating activities. Additionally, as noted by STA [16], mystical considerations surrounding beekeeping contribute to its status as an activity dominated by older individuals. The women surveyed predominantly use KTBH. The current predominance of traditional hives may partially explain women's limited participation, as traditional methods requiring specific dressing norms and technical skills in hive construction favor men. However, promoting modern beekeeping techniques alongside awareness campaigns and addressing socio-anthropological barriers could enhance participation among women and youth. As a secondary activity compatible with other occupations, beekeeping holds potential for job creation and supplemental income [1] [32]. Traditionally, beekeeping know-how is acquired through contact with relatives or neighbors, but it is above all through motivation and personal experience that expertise is forged. However, the high proportion of illiterate people may impede adoption of modern techniques.

Traditional hives, constructed from local materials like tree bark, banco, pottery, and straw, dominate the apiaries and are common throughout West Africa [33]. Straw, the primary material for traditional hives, is becoming increasingly scarce. This is why, while seeking to produce beehives using local and sustainable alternative materials, these herbaceous plants should be the focus of conservation initiatives, as recommended by Yaméogo [34]. The challenge extends beyond hive construction materials to broader natural resource preservation. Modern hives, which are less widely used due to their high cost, are considered inaccessible and require training and modern equipment (harvesting gear, smoker, frame lifter, bee brush, etc.), which are also expensive. Yet they are appreciated for their ease of operation. But according to Paterson [35], hives need to be adapted to the beekeeper's situation. State-of-the-art beekeeping equipment does not always guarantee profitability. Honey production levels don't consistently correlate with hive type, a finding supported by Matsop *et al.* [36] in northwest Cameroon, who observed no significant differences in yield or profitability between traditional and modern methods. This shows that with techniques using local knowledge and local materials of more modest design and cost, beekeepers can achieve good yields both individually and in large-scale programs.

Colonization of hives occurs through attracting wild swarms using smoke and/or wax (raw or embossed), consistent with Nombré's findings [22]. Indeed, new hives benefit from colonies that have swarmed or deserted their nests. Desertions can be caused by weather conditions or poor hive management. Smoking techniques and materials vary regionally and colonization speed may depend on smoking effectiveness. While some beekeepers claim to use these products because they are traditional, others say they learned to do so during training programs. Beekeepers explain that the smoke produced by these products gives off a pleasant odor for bees. Further research should focus on developing affordable, eco-friendly swarm attractants to reduce reliance on wild plant harvesting and minimize costs in modern beekeeping initiatives.

Beekeepers have told us of the value of forests as the main source of food for bees. They also recognize the importance of bee pollination for these forests and their crops. This interdependence highlights the value of reforestation and sustainable beekeeping practices in natural resource conservation [37]. Getting beekeepers to understand their status as defenders of the environment should therefore be the leitmotif of any beekeeping project that is part of a sustainable development rationale.

Honey is harvested in two main periods. The first, or honey flow, takes place between February and June. The second occurs between August and November. According to Nombré [23] and Sawadogo [24], these periods coincide with the flowering peaks of ligneous and herbaceous plants, between February-April and July-September respectively. The presence of melliferous flowers indicates nutrient availability (nectar and pollen), enabling bees to store large honey quantities thus increasing hive weight. During shortage, bees consume more honey weekly than they store [24]. Honey flows are also ideal for establishing new hives, demonstrating the close link between floral and beekeeping calendars. However, the flowering period varies with climatic conditions [38].

Few beekeepers possess comprehensive knowledge of beekeeping and bees (their biology, pathologies, etc.). Except for a few who have the reflex to fill water troughs during droughts or when apiaries are far from watering holes, bees are left unattended. They are only visited when the beekeeper wants to harvest his honey, making it closer to gathering than true beekeeping. Awareness campaigns in this area would give beekeepers a real stake in their practices, providing them with additional motivation and the opportunity to feel that they are playing a part, in their own way, in the well-being of these insects.

The aggressiveness of the African bees is well-documented with reported cases of attacks that have led to human and animal deaths. Aggressiveness is one of the reasons why some people refrain from engaging in the activity. However, as Sawadogo [24] notes, aggression varies by colony and season, resulting from genetic and environmental factors (weather, resource availability). Within the local breed of *Apis mellifera*, there are (a small proportion) of "very gentle" colonies, workable without protective gear—while maintaining high productivity (active queens, low swarming) [24]. The selection of these queens could address aggression issues without importing non-native subspecies, with all the risks that this could entail. Interestingly, this defensive behavior (more accurate than "aggressiveness") may enhance survival against predators.

Beekeepers report an alarming colony decline, with various suspicions as to its origins, mirroring global trends [39] [40]. As Aebi [25] confirms for Burkina Faso, this stems from multiple factors: pathogens, habitat destruction, and agricultural practices. The confirmed presence of *Varroa destructor* since 2017 [25] necessitates ecological solutions like biopesticides within integrated pest management [41] [42].

Our results highlight several local practices that could help mitigate bee decline. Installing hives on tree branches optimizes their occupation by bees, thus reducing low colonization rates. This practice could be optimized by adding targeted protection against insect pests. The strategic planting of melliferous trees (mango, cashew) by some beekeepers is a sustainable solution to nectar shortages, creating essential ecological corridors in times of drought [43]. Similarly, artisanal water troughs (using recycled tires or cans), although rudimentary, represent low-cost solutions to water stress [44], adaptable with simple improvements (e.g. anti-drowning grids). Finally, the practice of leaving honey reserves in hives during critical periods reflects an empirical understanding of the nutritional needs of colonies—an approach that deserves to be systematized.

Some elements of traditional beekeeping appear to be counter-productive in the face of the current colony decline. Single-opening hives, for example, create conditions conducive to the development of disease, limit ventilation and encourage the accumulation of humidity [45]. It is also difficult to harvest in these hive models without killing the bees [46]. The total absence of protection against major parasites, particularly in traditional hives, leaves colonies vulnerable [47], while brood removal (practiced by 3.16% of beekeepers during harvest) directly compromises population renewal. Even more worrying, the complete absence of basic veterinary care prevents any management of emerging diseases. These practices call for targeted interventions: progressive adoption of improved double-opening hives, introduction of biological treatments against parasites, and training programs on beekeeping health—all while respecting local material and economic constraints.

5. Conclusions

The challenges facing beekeeping in Burkina Faso are complex. The sector demonstrates vulnerability to environmental and socio-economic upheavals. The data collected highlight three key findings: (1) a worrying decline in bee colonies (reported by 85% of beekeepers), primarily attributed to pesticides use (57.29%) and deforestation (26.04%); (2) the persistence of sophisticated traditional practices that are increasingly inadequate against emerging challenges; (3) structural constraints that hinder the sector's economic potential. Any initiative to develop the sector should be based on local knowledge, while integrating technical innovations through participatory approaches that fully involves beekeepers. This study therefore advocates formal recognition of beekeepers' key role in ecosystem preservation, and for the integration of their expertise into sustainable rural development policies. Safeguarding this ancestral activity appears to be an ecological, economic and cultural challenge for the communities concerned.

However, the data presented here relies principally on beekeepers' declarations, introducing potential subjectivity that requires verification through objective measurements. While conducted in high-density beekeeping areas, findings would benefit from nationwide extension to capture cultural variations and ecological diversity. These limitations present valuable opportunities for more comprehensive future research.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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