

Socioeconomic and technical characterization of beekeeping in Burkina Faso: case of the Center-West Region

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Apiculture, hive management, bee plants, farm income, Burkina Faso

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Summary

Beekeeping is a potential source of income for rural populations. Once viewed as a minor agrosylvopastoral activity, beekeeping is now considered a promising activity. However, data to guide interventions are insufficient. The objective of this study was to carry out a technical and socioeconomic characterization of beekeeping in the Center-West Region of Burkina Faso. A cross-sectional survey using a pretested questionnaire enabled to collect information on the socioeconomic and demographic characteristics of beekeepers ($n = 113$), and the characteristics of apiaries and beekeeping practices. The results showed that the majority of beekeepers were male (64.3%), educated (71.4%), with an average age of 42.8 ± 10.4 years, belonging mainly to the Mossi ethnic group (76.9%). Practiced as a secondary activity, the main attraction of beekeeping was its profitability for 69.0% of those interviewed. With a dominance of modern Kenyan-type hives, the typology identified three production systems: the modern system, the traditional system and the mixed system. Average production was 6.9 ± 2.9 and 11.5 ± 2.8 liters per year for the traditional and modern hives, respectively. The profitability of the apiaries reached 10,504 and 24,620 CFA francs annual net margin for the traditional and modern hives, respectively. The main constraints revealed by the study were the lack of modern equipment and financial resources, insufficient technical supervision, and pests/predators.

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■ INTRODUCTION

In Burkina Faso, beekeeping is an age-old activity (Nombré, 2011) practiced almost everywhere, and mainly in the East, West and South regions; only the North and Sahel regions do not have intensified beekeeping practices (Ouédraogo, 2013). Beekeeping contributes to the

preservation of biodiversity and is an effective means to improve farmers' incomes. The average annual production of honey was estimated at 565 tons by the Department of Animal Resources and Fisheries (MRAH, 2019), far behind the 3150 tons produced in Senegal, leader in West Africa (Barry and Mbahin, 2018). Most of this production is consumed locally and reflects the existence of an expanding national market because of the rapid increase in supply, which stood at 55 tons in 2007 (MRAH, 2015). However, few research activities are conducted on beekeeping for a better orientation of interventions in this sector. Indeed, most research activities have focused on bee plants (Nombré et al., 2009), physicochemical aspects, medicinal uses of honey and recently the entomofauna living with bees (Nombré, 2003; 2011; Nombré et al., 2009; Sankara et al., 2015; Kientega, 2011). Few research has been devoted to socioeconomic and technical aspects. As a result, data and information on beekeepers and their apiaries in terms of production, practices or profitability are scarce and disparate. The integration of beekeeping in State programs through the creation in 2016 of a Technical Secretariat for Beekeeping at MRAH constitutes an important paradigm shift that requires factual data on the honey value chain for the development strategy of this sector.

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This work therefore focuses on production and questions the conditions of beekeeping in Burkina Faso and its economic performance.

■ MATERIALS AND METHODS

Study area

The study was carried out in the Center-West Region of Burkina Faso (Figure 1) from October to December 2016. The climate is North Sudanese (annual rainfall: 700 to 1000 mm) in the major part of the provinces of Boulkiemdé and Sanguié, and South Sudanese (annual rainfall: 1000 to 1200 mm) in the provinces of Sissili and Ziro.

Methods

Data on socioeconomic characteristics and apiarian practices were collected from 113 beekeepers by direct interview with a questionnaire containing closed and open questions. The main headings of the questionnaire focused on beekeepers' socioeconomic and demographic characteristics, farm characteristics (e.g. size, equipment, vegetation), and practices (e.g. colonization, nutrition, health, harvesting), economic parameters (equipment cost and life span, production quantities, products sold and selling prices) and constraints. Interviews were carried out in Mooré (national language) and in French. A non-probabilistic snowball sampling was performed. For the sample size, in the absence of official statistics on the number of beekeepers in Burkina Faso and in the target region in particular, the objective was to question as many beekeepers as possible.

Data analysis

Field work data was recorded in Sphinx Plus 5.0 then in Excel 2016 to make graphs, tables and descriptive statistics such as frequency, means. We also used R 2.13.0 and XLSTAT 2015.4 for statistical analysis. Descriptive statistics were applied to data to determine means and standard deviations, frequencies, and maximum and minimum values. Then with R, nonparametric tests were used to study the relationships between the study variables with a significance threshold of 5%.

We adopted an exploratory structural typology based on beekeepers' socioprofessional characteristics (ethnicity, sex, age, marital status, education level, occupation, experience, motivation, membership in

an association, training), the hive type and apiary size. After coding of variables, a multiple correspondence analysis was first used. Then, this method only transmits part of the information and viewing is sometimes too complex to be interpreted, a hierarchical ascending classification, which is an automatic classification method, was carried out with XLSTAT. In order to study the profitability of beekeeping during the study, the operating account method was used to determine costs and generate margins on the data stated by the beekeepers.

■ RESULTS

Beekeepers' sociodemographic and organizational characteristics

The study revealed that the majority of beekeepers were men (64.3%), aged on average 42.8 ± 10.4 years, and almost all of them were married (95.2%). In this region they were mainly of the Mossi (76.9%) ethnic group, followed by the Gourounsi (15.4%), the Gouin (3.8%) and the Nouni (3.8%). Regarding schooling, 28.6% had never attended school, 50%, 16.4% and 4.8% had primary school, high school and university levels, respectively.

Regarding socioeconomic activities, 66.7% of them practiced mixed farming against 7.1% who practiced beekeeping only. Thus, their motivations for practicing beekeeping included profitability (69.0%), income diversification (45.2%), hive inheritance (21.4%), passion (9.5%), therapeutic virtues (4.8%), and promotion of the activity (2.4%).

The beekeepers had an average experience of 8.1 ± 7.1 years. The farms were operated under different statuses: individual (45.7%), familial (23.9%), associative (23.9%) or as small informal groups (6.5%). To finance their activities, the actors initially counted on their own funds (41.6%), non-governmental (NGO) subsidies and/or projects (29.6%), support from the family (19.2%), and to a lesser extent official subsidies (3.2%), inheritance (3.2%), or financial credit (1.6%). Nearly 71% of beekeepers received training in techniques of modern beekeeping. Nevertheless, it was mainly an initial training on the techniques of apiary management from setting up to hives' harvesting.

Technical characteristics of apiaries

Among the beekeepers 56.1% used modern hives, 36.6% traditional hives, and 7.3% both types. Among the modern hives, the Kenyan type (57.2%) prevailed, and the Dadant and Langstroth types were in equal proportions (21.4%). The number of hives used varied from 2 to 127 with an average of 25 ± 4.8 ; it varied significantly depending on the main activity of the surveyed people (Table I) ($p < 0.05$).

Table I: Variation in the number of hives according to the beekeepers' status and main activities in Burkina Faso // *Variation du nombre de ruches en fonction du statut et des activités principales des apiculteurs au Burkina Faso*

	Average num. of hives	P
Beekeeping	57	Reference
Crop/livestock	15 ***	$2.10^{-6} *$
Trade	11 ***	$4.10^{-4} *$
Sewing	7 **	$0.002 *$
Civil servant	7 ***	$0.001 *$
Masonry	25 **	$0.01 *$
Employee	13 *	$0.04 *$

The number of hives is significantly higher in interviewees who had beekeeping as main activity: * 0.05; ** 0.01; *** 0.001 // *Le nombre de ruches est significativement plus élevé chez les répondants ayant l'apiculture comme activité principale : * 0,05 ; ** 0,01 ; *** 0,001*



Figure 1: Location of the study area // *Localisation de la zone d'étude*

Apiarian resources

In the study area, there was a diversity of plants identified as dominant in the different apiaries. Figure 2 shows the most dominant trees in the apiaries according to the respondents. In addition, all beekeepers harvested wild bee hives while setting up their first hives. To extend apiaries, 95.2 % of beekeepers used wild swarms *versus* 4.8% who used the colony division technique. Thus, 85.5% of farms were sedentary, whereas 4.5% of them sometimes moved their colonies.

Nutrition, problems and health management

More than half (60.5%) of beekeepers stated that they fed their bees. However, they mainly used water (56.7%), honey from apiary (16.7%), sweetened water (13.3%) and leftover/rotten fruits (13.3%). Pests/predators (37.9%) and desertion from colonies (33.9%) constituted serious problems encountered in the apiaries (Table II). Concerning health management, 37.9% of beekeepers did not apply any care and 31% regularly cleaned their hives or used traditional care to protect bees against pests/predators. They seldom had recourse to animal health agents such as veterinarians (3.4%).

Harvesting and use of hive products

Eight months divided in two periods were identified as production periods (Figure 3): i) from February to June when honeydew is present in large quantities with harvesting in March through June, and ii) harvesting in September through November when honeydew is present in small quantities. On average, the beekeepers collected products twice a year. Among the products present in a hive, only honey and wax were collected by 100% and 19% of beekeepers, respectively. In

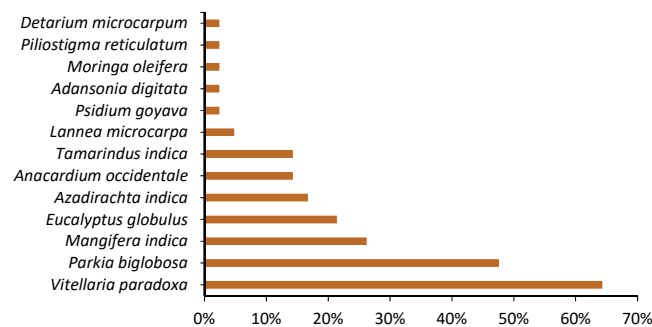


Figure 2: Dominant honey plants in the apiaries of the Center-West Region of Burkina Faso // *Plantes mellifères dominantes dans les ruchers de la région Centre-Ouest du Burkina Faso*

Table II: Problems and health management strategies in apiaries in Burkina Faso // *Problèmes et stratégies de gestion sanitaire des ruchers au Burkina Faso*

Most frequent problems (%)	Pests/predators	37.3
	Desertion of the colonies	33.9
	Mortalities	13.6
	Falling hives	6.8
	Diseases	5.1
	Hives damaged by xylophagous insects	3.4
Bee health management (%)	No health monitoring	37.9
	Cleaning	31.0
	Traditional care	13.0
	Destruction of infected hives	10.3
	Use of water and forest agent services	3.4
	Use of veterinarian services	3.4

traditional and modern hives, respectively, harvests reached on average 6.9 ± 2.9 liters (about 10.4 ± 4.4 kg) and 11.5 ± 2.8 liters (about 17.3 ± 4.2 kg) of honey per year. One liter is the unit usually used by beekeepers in rural areas to measure their production, and it weighs about 1.5 kg. After harvesting, honey was transported for treatment or sale by various means (Table III). It could be sold (85.7%), self-consumed (85.7%), used as gifts (81%), for health care (42.9%) (Figure 4), or cosmetics (4.8%).

Sales could be retail (52%), wholesale (17%), both (31%), on local markets (34%), residences (31%), apiarian centers (21%), or at producing/processing locations (15%). Prices were set according to various criteria such as expected profits (43%), agreements between actors (24%), the market price (24%), or at sellers' discretion (9%). The beekeepers' main customers were households (65%), collectors (19%) and tradespeople (16%). Honey from traditional and modern hives was sold on average 1640 francs of the Financial Community of Africa (CFAF) and 2450 CFAF per liter, respectively.

Typology of apiaries

For the typology, we performed a multiple correspondence analysis which projected the variables on two axes carrying 39.4% of the information (Figure 5). To complete viewing the projections a hierarchical ascending classification was performed (Figure 6). Class 1 (63.7%) comprised traditional hives (> 75 hives) and belonged to men. Beekeepers had the primary education level but were not trained in

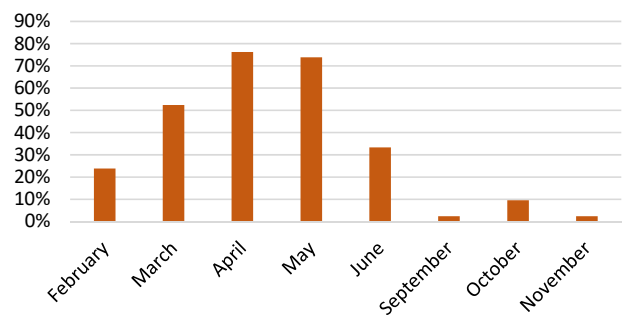


Figure 3: Honey harvesting periods in the Center-West Region of Burkina Faso // *Périodes de récolte du miel dans la région Centre-Ouest du Burkina Faso*

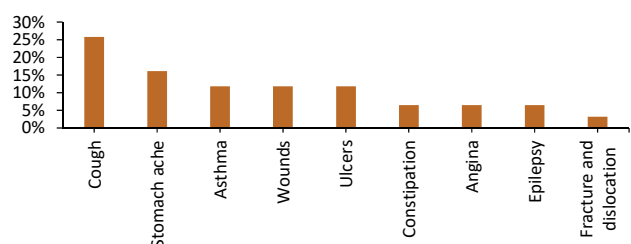


Figure 4: Honey medicinal uses in the Center-West Region of Burkina Faso // *Usages médicinaux du miel dans la région Centre-Ouest du Burkina Faso*

Table III: Transport of bee products in Burkina Faso // *Transport des produits apicoles au Burkina Faso*

Means	%	Means	%
Bicycle	50	Cart	10
Motorcycle	31	Tricycle	10
By foot	17	Car	7

beekeeping techniques. This description corresponded to the traditional beekeeping system. Class 2 (18.6%) included both traditional and modern hives of average sizes (31–75 hives), mostly managed by men, single, with secondary or higher education. This class corresponded to a mixed beekeeping system. Class 3 (17.7%) contained only modern apiaries of small size (< 30 hives) that belonged to women with the primary school level. Beekeepers were organized in associations and benefited from training. This class represented a modern type of farm.

Profitability of apiaries

For the profitability study, estimates were based only on beekeepers who provided complete technical and economic data. The analysis of the operating accounts showed that the net or gross profit could double according to whether the beekeeper used traditional or modern hives (Table IV). The average annual profit reached 231,093 CFAF and 640,142 CFAF per year of production for traditional and modern hives, respectively.

■ DISCUSSION

Beekeepers' socioeconomic characteristics

The study revealed that beekeeping in Burkina Faso was mainly practiced by adult, male and married people. The results were similar to those of Fotso et al. (2014). This trend may be explained by the fact that this category of people faces many family responsibilities that

lead them to diversify their sources of income. We found a proportion of female beekeepers (35.7%) higher than that reported by Kientega in 2011 (17%). Our finding may be explained by the continuous process of women joining the activity of beekeeping, especially as women's empowerment has been encouraged and facilitated in recent years.

Regarding the education level, it ended at elementary school for most of the respondents (71.6%). This high frequency of primary level could be explained by the low rate of enrollment and admission to post-primary education (INSD, 2020). The study also revealed that beekeeping was a secondary activity. These observations corroborate those of Paterson (2008) and may be caused by lack of competition between beekeeping and other rural activities.

The beekeepers' experience was good and matched on average that described by Tchoumboue et al. (2001). This observation could reflect the presence of an ancient practice of beekeeping in our societies (Paterson, 2008) as many beekeepers had inherited their hives. Regarding the apiaries' status, the majority belonged to beekeepers' associations, especially since these associations benefited from aid and subsidies from NGOs and projects. The aim of these structures would be to train and accompany rural populations in the fight against poverty and food insecurity through secondary activities such as beekeeping. However, 41.6% of the surveyed beekeepers relied primarily on their own funds to finance their activities. Self-financing the activities could be explained by the difficult access to financial services in rural areas (Inter-réseaux, 2016).

Technical characteristics of apiaries

Beekeepers mainly managed movable comb hives (56.1%), mostly Kenyan hives (57.1%) with an average of 25 hives per apiary. This average was lower than the 42 hives reported by Tchoumboue et al. (2001) in Cameroon. Thus, beekeepers in the study were family producers who did not aim at intensive production. The high cost of equipment could also explain this situation, especially since access to agricultural credit is difficult in some areas (Inter-réseaux, 2016).

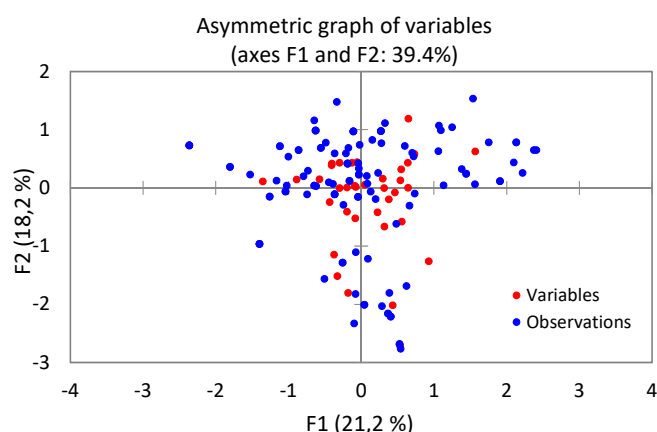


Figure 5: Distribution of the modalities of the variables defining the beekeeping systems on the first two axes in the Center-West Region of Burkina Faso // Répartition des modalités des variables définissant les systèmes apicoles sur les deux premiers axes dans la région Centre-Ouest du Burkina Faso

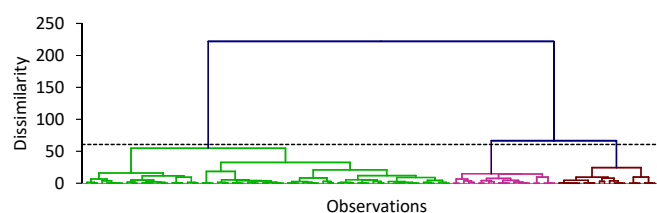


Figure 6: Variables defining the beekeeping systems in the Center-West Region of Burkina Faso: traditional beekeeping (green), modern beekeeping (red), mixed beekeeping (purple) // Variables définissant les systèmes apicoles de la région Centre-Ouest du Burkina Faso : apiculture traditionnelle (vert), apiculture moderne (rouge), apiculture mixte (violet)

Table IV: Operating statements (in CFAF) of apiaries over the apiarian season period (one year) // Relevés d'exploitation (en FCFA) des ruchers sur la période d'une saison apicole (un an)

Expenses and profits	Traditional hive	Modern hive
Receipts		
Honey	11,316	28,175
Wax	NA	NA
Total receipts	11,316	28,175
Variable expenses		
Food	110	215
Transport	215	318
Total variable expenses	325	533
Fixed expenses		
Humidify hives	409	2,925
Humidify equipment	77	96
Total fixed expenses	486	3,021
Margin		
Gross margin / hive	10,991	27,642
Net margin / hive	10,504	24,620
One liter of honey production cost	117	136

NA: not available // NA : données non disponibles

The predominance of Kenyan hives can be explained by their promotion by Wendpuié NGO which oversees beekeepers and Kenyan-hive equipment via the bee rescue project (Wendpuié, 2017). In addition, the diversity of the cited plant resources and the use of wild bee colonies observed in this study were similar to data reported by Nombé (2003) in the East-Center and South-Center regions, and by Kientega (2011) in the Hauts-Bassins Region, highlighting the melliferous potentialities in the country.

With regard to bee health, we found that bees faced a greater danger from predators (37.3%) than they did from diseases, as observed by Villières (1987) who reports that in tropical Africa the importance of bee diseases hides the importance of predators. This is probably one of the reasons for the lack of health care in apiaries. This deficiency and the rare use of animal health workers' services are probably explained by an underestimation of the impact of diseases and predators on production.

In spite of the lack of rigor in the sanitary management of the apiaries, harvesting took place on average twice a year. This may be because, in Burkina Faso, the period of great honey flow corresponds to that in West Africa in general, where the honey season takes place during the long dry and hot season (Villières, 1987; Barry and Mbahin, 2018) with flowering of perennial plants.

The average annual production in traditional and modern hives reported in this paper was higher than that found in West Africa estimated at 4 to 6 liters (Villières, 1987). This level of production would reflect the fact that in Burkina Faso there is an important natural multispecies flora which constitutes an abundant nutritional resource for bees (Nombé et al., 2009). Thus, in order to promote better the production of honey and other bee products, it is useful to describe the existing production systems with a view to their improvement.

Typology of apiaries

The typological analysis showed a diversity of beekeeping practices in the Center-West Region. Our results were different from those obtained by Adam (2012) who distinguishes four groups; the author went beyond technical criteria by considering anthropological factors and the scale of the production system. The categories of farms identified in our study would be related to the structural and organizational transformations of the sector. Factors such as the hive type, education level, beekeeping training, gender, and to a lesser extent marital status were the most determining factors.

Thus, on the basis of endogenous knowledge and know-how, and probably because of the lack of financial means, beekeepers chose to practice the activity in a traditional way and were sometimes resistant to change and the introduction of modern practices. The use of both hive types would be part of a process, with the objective to evolve toward exclusively modern beekeeping and become more professional (Fotso et al., 2014). This group would play a key role in the policies of modernization of beekeeping in Burkina Faso. The modern type of farms would be the result of the support of development structures to the rural populations who then have access to modern hives which generally benefit from heavy investment. The characteristics of the different classes would also be related to the choices of beekeepers according to their main activities. The significant presence of women in beekeeping and more specifically in modern beekeeping may reflect the results of policies to empower women through income-generating activities.

Beekeeping profitability and constraints

The identification of three types of customers from the analysis of honey marketing did not agree with the results of Ouédraogo (2013) who also identified hotels and restaurants of high standing, buyers/

exporters. The higher price of modern beekeeping honey than that of traditional beekeeping is that honey from modern beekeeping, with improved harvesting and processing conditions, better meets the requirements sought by customers. The annual gross margins found were lower than those obtained by Fotso et al. (2014). The difference may be related to the apiary size; this level of profitability could be improved by taking into account the difficulties encountered by beekeepers at the technical, financial and sanitary levels. These constraints have been reported by Fotso et al. (2014) in Cameroon. They could be explained by the lack of real promotion of beekeeping and the slow pace of actors' professionalization.

CONCLUSION

In the Center-West Region of Burkina Faso, beekeeping is an activity with varied profiles. Apiaries and beekeepers' characteristics highlight three production systems. The study of profitability reveals the importance of beekeeping in the fight against poverty. Nevertheless, the lack of financial means for the heavy investments needed in the modern system, the lack of training and of beekeeping equipment, and the health problems related to bee parasites or predators are some of the constraints that hinder the development of beekeeping. This study provides data that can help in particular to improve organizing the sector, provide beekeepers with technical support or access to financing, conduct research on bee health and, more generally, develop beekeeping.

Conflicts of interest

The authors declare that there is no competing interest in this study.

Author contributions statement

BAK, LDD, WO designed the study; BAK collected field data, carried out statistical analyses and wrote the draft of the manuscript; LDD, WO reviewed the manuscript according to authors' guidelines; WO, NSB, AT, AMGB supervised the study and made observations on the manuscript before submission.

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Résumé

Kaboré B.A., Dahourou L.D., Ossebi W., Bakou N.S., Traoré A., Belem A.M.G. Caractérisation socioéconomique et technique de l'apiculture au Burkina Faso : cas de la région Centre-Ouest

L'apiculture constitue une source potentielle de revenu pour les populations rurales. Autrefois reléguée au second plan des activités agrosylvopastorales, l'apiculture est aujourd'hui considérée comme une activité prometteuse. Cependant, les données permettant d'orienter les interventions sont insuffisantes. Cette étude a ainsi eu pour objectif de réaliser une caractérisation technique et socioéconomique de l'apiculture dans la région Centre-Ouest au Burkina Faso. Une enquête transversale au moyen d'un questionnaire préalablement testé a permis la collecte d'informations sur les caractéristiques socioéconomiques et démographiques des apiculteurs (n = 113), et celles des ruchers et des pratiques apicoles. Les résultats ont montré que la majorité des apiculteurs étaient des hommes (64,3 %), scolarisés (71,4 %), âgés en moyenne de 42,8 ± 10,4 ans, appartenant principalement au groupe ethnique Mossi (76,9 %). Pratiquée comme activité secondaire, le principal attrait de l'apiculture était sa rentabilité pour 69,0 % des personnes interviewées. Avec une dominance de ruches modernes de type kenyan, la typologie a permis d'identifier trois systèmes de production : le système moderne, le système traditionnel et le système mixte. La production moyenne a été de 6,9 ± 2,9 et de 11,5 ± 2,8 litres par an respectivement pour la ruche traditionnelle et la ruche moderne. La rentabilité des ruchers a atteint 10 504 et 24 620 francs CFA de marge nette annuelle respectivement pour la ruche traditionnelle et la ruche moderne. Les principales contraintes révélées par l'étude ont été le manque d'équipements modernes et de ressources financières, l'insuffisance de l'encadrement technique, et les ravageurs/prédateurs.

Mots-clés : apiculture, conduite de la ruche, plante mellifère, revenu de l'exploitation, Burkina Faso

Resumen

Kaboré B.A., Dahourou L.D., Ossebi W., Bakou N.S., Traoré A., Belem A.M.G. Caracterización socioeconómica y técnica de la apicultura en Burkina Faso: el caso de la región Centro-Oeste

La apicultura constituye una fuente potencial de ingresos económicos para las poblaciones rurales. La apicultura, antes relegada a un segundo plano en las actividades agrosilvopastorales, se considera actualmente una actividad prometedora. Sin embargo, los datos para orientar las intervenciones son insuficientes. El objetivo de este estudio es realizar una caracterización técnica y socioeconómica de la apicultura en la región Centro-Oeste de Burkina Faso. Una encuesta transversal mediante un cuestionario previamente probado permitió recopilar información sobre las características socioeconómicas y demográficas de los apicultores (n = 113), así como de los colmenares y las prácticas apícolas. Los resultados mostraron que la mayoría de los apicultores eran hombres (64,3 %), con estudios (71,4 %), de una media de edad de 42,8 ± 10,4 años, pertenecientes principalmente al grupo étnico Mossi (76,9 %). El principal atractivo de la apicultura, practicada como actividad secundaria, es su rentabilidad para el 69,0 % de los entrevistados. Con un predominio de las colmenas modernas de tipo keniano, se pudieron identificar tres tipos de sistemas de producción: el sistema moderno, el sistema tradicional y el sistema mixto. La producción media fue de 6,9 ± 2,9 y de 11,5 ± 2,8 litros al año para las colmenas tradicionales y modernas, respectivamente. La rentabilidad de los colmenares alcanzó los 10 504 y 24 620 francos CFA de margen neto anual respectivamente para las colmenas tradicionales y las modernas. Las principales limitaciones reveladas por el estudio fueron la falta de equipos modernos y de recursos financieros, la insuficiente supervisión técnica y las plagas/depredadores.

Palabras clave: apicultura, manejo del apiario, plantas melíferas, renta de la explotación, Burkina Faso