

Perspectives of honey production in Mato Grosso: an evaluation from the point of view of beekeepers

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Abstract: Beekeeping is characterized by the rational exploitation of Apis bees, based on the tripod of sustainability, integrating the social, economic, and environmental. The objective of this study was to evaluate what are the perspectives of honey production in Mato Grosso, based on the view of beekeepers from different regions of the state. In all, fifteen beekeepers were interviewed, representing twenty-seven apiaries, distributed in ten municipalities. The research was conducted through a structured questionnaire, containing twenty-three objective multiple-choice questions. The results show that 73.3% of beekeepers had a gain in production in the last five years. The increase in production makes 77.0% of beekeepers feel encouraged to continue in the sector. However, 73.3% stated that they do not receive technical assistance from the government. It is considered the need for greater encouragement by the government with beekeepers, including technical assistance, formalization of apiaries, records of apiary losses, and expansion of beekeeping pasture.

Keywords: Bees; Economy; Production; Sustainability; Family farming.

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São Paulo. Vol. 28, 2025

Original Article

DOI: <http://dx.doi.org/10.1590/1809-4422asoc01971vu28L4OA>



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Introduction

Beekeeping is an ancient practice that involves the proper management of bees (PEGORARO *et al.*, 2017), the preservation of colonies, and the sustainable use of the resources offered by these insects (COSTA *et al.*, 2017). Honey, the main product, is derived from the nectar of flowers or from secretions from the living parts of plants or from excretions of plant-sucking insects (MAPA, 2000). Currently, there are more than seven hundred genera, and twenty thousand species of bees described in the world, with prospects of expansion to more than forty thousand species (ZATTARA and AIZEN, 2021; CPT, 2023).

The importance of beekeeping is multifaceted. For small properties, the activity can represent a complementary source of income, especially for family farmers who seek to diversify their productive activities (EMBRAPA, 2018; PEREIRA *et al.*, 2020). Bee farming does not require large tracts of land and can be conducted in a sustainable way, using the natural resources available on the property (COSTA *et al.*, 2017; LONGO *et al.*, 2019).

From the point of view of human consumption, bee products have great nutritional and therapeutic value (GHRAMH *et al.*, 2019). Honey is considered a healthy food, rich in vitamins, minerals, and antioxidants (NASCIMENTO *et al.*, 2018), and bee products are used in the food and pharmaceutical industry, expanding their application possibilities (KERCKES *et al.*, 2013). From an environmental point of view, beekeeping can consider a key factor among ecosystem services in relation to pollination, which is fundamental for the maintenance of ecosystems and food production for humans (GIANNINI *et al.*, 2015). Studies show that bees pollinate 90% of flowering plants, with 35% for agriculture alone (KLEIN *et al.*, 2020).

In the State of Mato Grosso, beekeeping has gained prominence as a promising economic activity (LONGO *et al.*, 2019), characterized by large-scale bee farming and the production of honey and other by-products (FERREIRA *et al.*, 2016). The region has favorable conditions for the development of colonies, with a tropical climate and diversified vegetation, which provides an abundance of flowers and food resources for bees (FERREIRA *et al.*, 2016; PEREIRA *et al.*, 2020).

However, the socioeconomic development of Mato Grosso has a strong relationship with agribusiness (BAMPI *et al.*, 2017). Livestock and agriculture accounted for 10.19% of the GDP of the entire state, equivalent to R\$238 billion in 2021 (CEPEA, 2022). However, the beekeeping sector has been expanding its participation in the economy of Mato Grosso, including an increase in producers. The 2017 Agricultural Census registered 502 beekeepers, who moved more than R\$5,500,000.00 that year (IBGE, 2017). In 2022, 565 rural establishments with beekeeping work were registered, totaling 17,818 colonies (INDEA, 2022). In 2021, the value of honey production was R\$14,055,000.00 (IBGE, 2021), with exports of 436 tons in 2022 (ABEMEL, 2022).

However, contemporary challenges are posed to the beekeeping sector, including the lack of technical and administrative assistance to producers; the non-formalization of production with the State and the responsible secretariats; the lack of incentive for

the consumption of honey, which in Brazil is, on average, 60 g per capita/year, while the world average is close to 200 g per capita/year; in addition to the need for harmonious relationships between beekeepers and property owners (ABELHA, 2024).

Another major challenge is associated with the large-scale use and occupation of the land, caused by the planting of *commodities* (soybeans, corn and cotton), and, consequently, the greater use of pesticides applied to crops, generating the expansion of the entire production chain linked to the sector, including the installation of mills, increase in urban limits on forest remnants, in addition to enabling the advancement of the mining sector and an increase in fires, which intensify the decrease and contamination of bee colonies (POTTS *et al.*, 2016).

These factors, in addition to the damage caused to the environment, directly impact beekeeping, especially due to the change in the natural state of the environment, which can contribute to the “Colony Collapse Disorder” CCD syndrome (VANENGELSDORP *et al.*, 2009), which is the disorder of colony collapse or decline of bee populations. This is a problem that is accentuated worldwide, which has direct negative effects on pollination rates, ecosystem diversity, food production and, consequently, on the expansion of the beekeeping market (PIRES *et al.*, 2016; GIROTTI *et al.*, 2020).

The production of honey and bee products can be boosted in Mato Grosso through incentives and improved technical assistance to producers, an increase in the number of boxes in existing apiaries and the installation of new apiaries in Conservation Units, for example (BORLACHENCO 2017; PEREIRA *et al.*, 2020). The use of these areas is regulated by the New Forest Code nº 12.651/2012 (BRASIL, 2012).

Another relevant aspect is the expansion of technical-scientific studies that seek to associate the difficulties encountered by producers with mechanisms of public management, commercial management, and management of colonies, to meet the existing deficiencies in the means of production. For Mato Grosso, as well as for other regions, one of the first steps to achieve these goals is to know the basis of the sector, considering the socioeconomic and environmental relevance of beekeeping. However, specifically for Mato Grosso, there is no official and forceful database of the competent state bodies regarding the current census, so that from this data, it is possible to formulate proposals that can contribute to the expansion of the activity (e.g., BALBINO *et al.*, 2015). In this context, the surveys contribute with information and support to associations and cooperatives, in view of the great existing demand.

Among the few studies addressing beekeeping in Mato Grosso, the research carried out by Ferreira *et al.* (2016), which analyzed honey production between 2002 and 2011, recording the decrease in production and the number of beekeepers caused by the agricultural expansion of the region, however, among the municipalities located in the Pantanal obtained higher honey production. Longo *et al.* (2019) that carried out the socioeconomic diagnosis in six municipalities of the Baixada Cuiabana, as well as the use of the land with emphasis on beekeeping activity in the region, characterizing beekeeping as a complementary activity, which can be a source of income in places with a level of extreme poverty and, Pereira *et al.* (2020) who evaluated this activity in Territories of

Citizenship of the Lower Araguaia and the Portal da Amazônia, noting that the increase in activity favors employability and increased income of producers.

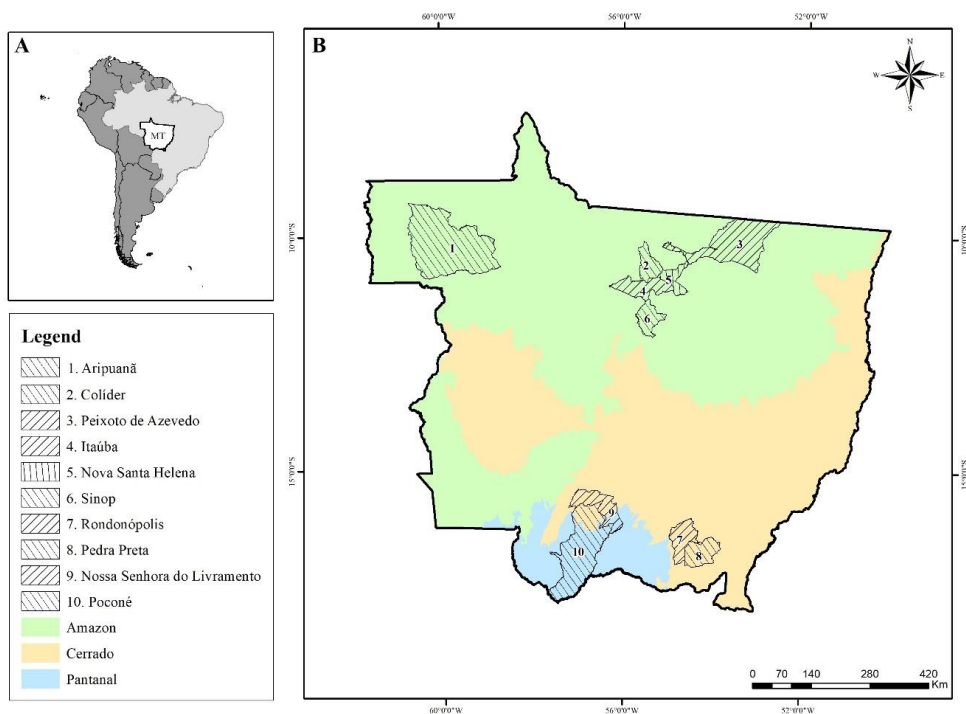
Thus, it is observed that beekeeping is an economic activity with high potential in Mato Grosso, especially in municipalities with lower per capita income and HDI, considering the promising domestic and foreign market for bee products. In addition, it constitutes a relevant implement for the maintenance of small properties and family farming, in the face of the reality of the expansion of land use and occupation, caused by the growing demand of national agribusiness. Thus, this study has as its main problem to be addressed: What are the perspectives of honey production in Mato Grosso, from the point of view of the beekeepers themselves, working in different regions of the state? Based on this questioning, the objective is to provide information that can support decision-making and investments in public policies aimed at contributing to the sustainability and expansion of beekeeping production in the region.

Material and Methods

Study area

The study was conducted in different municipalities of Mato Grosso. The state has a territorial area of 903.207 km², covering three major phytogeographic domains, Amazon, Cerrado and Pantanal (IBGE, 2022). In the present study, we sought to contemplate apiaries present in these three phytogeographic domains, totaling twenty-seven apiaries in ten locations, with fifteen beekeepers interviewed (Figure 1).

Figure 1 - Geographic location of the collection areas. A – South America, with emphasis on Brazil and Mato Grosso; B – State of Mato Grosso, with emphasis on the ten municipalities and phytogeographic domains present in the state.



Source: Authors, 2023.

Six municipalities are in the northern region, specifically in the Mato Grosso Amazon. This region, according to the Köppen classification, has a tropical monsoon climate (Am) (ALVARES *et al.*, 2014), altitude between 300-400 m, with average temperature between 24 and 25 °C, and annual rainfall varies from 2,000 to 2,300 mm (CORSINI, 2018). Two municipalities are in the Cerrado domain, characterized by a tropical climate, with a rainy summer and dry winter. The average annual temperatures in this biome range from 18 to 27 °C, with the minimum temperature reaching 8 °C and the maximum temperature reaching 34 °C (EMBRAPA, 2023). Two other localities are inserted in the Pantanal domain, with an Aw climate - humid tropical, average annual precipitation of 1,200 mm, with an average temperature of 22 to 32 °C, and 100 to 150 meters of altitude (HASENACK *et al.*, 2003).

These locations were defined for the study, considering the distribution of the municipalities among the economic macro-regions, and the contrast of the surrounding matrix between apiaries, crops, urban centers, and mining, as well as the phytogeographic domain of the region (Table 1).

Table 1 - Demographic data of the ten municipalities of Mato Grosso sampled to evaluate the perspective of honey production (*HDI – Human Development Index).

Phytogeographic domain	Municipality	Nº. of apiaries	Area (km ²)	Population (hab.)	IDH
Amazon	Aripuanã	3	24.678,135	24,499	0,675
	Colíder	3	3.112,091	30,768	0,713
	Peixoto de Azevedo	3	14.433,77	34,403	0,649
	Itaúba	3	4.521,790	5,273	0,690
	Nova Santa Helena	3	2.385,611	4,281	0,714
	Sinop	3	3.990,870	199,698	0,754
Cerrado	Rondonópolis	2	4.824,020	253,388	0,755
	Pedra Preta	1	3.841,672	19,559	0,679
Pantanal	Nossa Senhora do Livramento	3	5.537,413	12,455	0,638
	Poconé	3	17.156,759	30,278	0,652

Fonte: IBGE (2020-2022).

Methodology

The methodology applied has the exploratory diagnostic characteristic. For data collection, a printed questionnaire was applied containing 23 objective questions, formulated based on the Beekeeping/Meliponiculture Registration Form, and the Property Registration Form with Beekeeping/Meliponiculture of the Institute of Agricultural Defense of Mato Grosso (INDEA, 2022), approved by the Research Ethics Committee (CEP) of the Federal University of Mato Grosso – UFMT/Sinop – according to Consolidated Opinion no 5.484.928 of June 23, 2022. Data collection took place between July and November 2022, in person. The Informed Consent Form (ICF), in two copies of the same content, was read by the beekeepers, signed, and dated by the parties, each one having possession of one copy. The questionnaire was answered in his own hand, given the time needed to fill it out, and later, the questionnaire was collected and remained in the custody of the researcher.

For the selection of apiaries and producers in the same region, the Snowball methodology was used (BIERNARCK and WALDORF, 1981). In this methodology, the first known beekeeper, called “seed” did not participate in the research. However, after the indication of another beekeeper in the region made by the “seed”, he was offered the Consent Form to participate in data collection. In this way, a total of fifteen beekeepers fully participated in the process.

Among the eligibility criteria used to carry out the research, the following stand out: (i) distance of at least three kilometers between the apiaries selected for the study; (ii) the apiary's period of operation is longer than three months; (iii) that the apiary had at least five hives of *Apis* bees; and, (iv) that they had not suffered severe damage, caused by fires, pesticides, climatic factors or pest attacks in a period of less than three months. All participants were at least 18 years old and literate. These criteria aimed at isonomy regarding the eligibility of the participants, maintaining the impartiality of the analyses on the socioeconomic and cultural characteristics of the beekeeper. The data obtained are presented and analyzed in a descriptive manner.

Results

Among the fifteen beekeepers interviewed, it was observed that most have been working for less than 10 years in this economic activity (66.7%; ten beekeepers), while 33.3% of them have been working in the sector for more than 16 years. It is possible to identify that beekeeping in Mato Grosso is an activity linked to small properties, since 40.7% of the apiaries are in properties with less than 20 hectares. Only seven apiaries are located on properties with more than 101 hectares.

Regarding the area, it was observed that most of them are in private properties (37.0%), however, other forms of economic activity viability were recorded, such as the use of borrowed (33.3%) or leased areas (14.8%). It was also observed that only nine apiaries are located on properties where this is the only source of production and income generation (33.3%), therefore, it was evident that beekeeping is developed concomitantly with other economic activities, including livestock (44.5%), farming (18.5%) and mining (3.7%). Among the fifteen beekeepers, 73.3% declared that beekeeping does not generate direct jobs in their apiaries, however, it was observed that there is the employment of family labor (13.3%) and the hiring of daily rates or division of production (6.7% each).

Regarding the technical information about the apiaries maintained by the fifteen beekeepers interviewed, it was possible to record that all of them produce honey from *A. mellifera* (100.0%). No beekeeper indicated the use of stingless bees (*Meliponini*). The hives are kept in Langstroth boxes and are fixed in a place specifically intended for beekeeping, most of them in forest area (51.9%) and forest edge (37.0%). Considering that most of the properties are small, it is observed that the number of hives is also small. Most apiaries have between 11 and 30 hives (51.9%), followed by those with between 5 and 10 hives (33.3%). None of the evaluated apiaries has more than fifty hives (Table 2).

Regarding honey processing, most beekeepers extract the combs using centrifugation (81.5%), while (14.8%) use the decantation technique, and the smallest part (3.1%) use the draining process to separate the honey from the denser particles. The formation and expansion of the number of hives is carried out using both the capture of swarms and the division of existing hives in all properties (100.0%). Only four beekeepers stated that they

received some type of specialized technical assistance (26.7%), citing two entities, the National Rural Learning Service (SENAR) and the Mato Grosso Company for Research, Assistance and Rural Extension (EMPAER). Another eleven beekeepers stated that they did not receive any assistance (Table 2).

Table 2 - Information on the characteristics of the apiaries evaluated in the study on their perspectives in relation to honey production in Mato Grosso.

Characteristics	Nº	%
Type of bee in the apiary		
<i>Apis mellifera</i> (Africanized)	27	100.0
Meliponíneos (Stingless bees)	-	-
Type of box used in the apiary		
Langstroth (original)	17	63
Langstroth (handcrafted)	10	37
Kenya	-	-
Other	-	-
Type of apiary (location)		
Fixed	27	100
Migratory (mobile)	-	-
Mixed (fixed part, movable part)	-	-
Positioning of hives on the property		
Forest forest area	14	51.9
Forest edge area	10	37.0
Open Field Area	-	-
Orchard area	02	7.4
Other	01	3.7
Number of hives in the apiary		
Between 5 and 10 hives	09	33.3
Between 11 and 30 hives	14	51.9
Between 31 and 50 hives	04	14.8
Above 51 hives	-	-
Honeycomb Extraction Method		
Run	01	3.7
Pressing	-	-
Spin	22	81.5
Decanted	04	14.8

Existence of technical assistance		
Yes, I receive technical assistance	04	26.7
I do not receive technical assistance	11	73.3
Institution that offers technical assistance		
SENAR	2	13.5
EMPAER	2	13.5
Method of hive formation in the apiary		
Swarm capture	27	100
Division of boxes	27	100
Other	-	-

Source: Authors (Field research, 2022).

The beekeepers interviewed were encouraged by the production of honey. It was observed that 46.7% say they are very stimulated with the area, followed by another 20.0% who say they are extremely stimulated, making a total of 66.7% of the beekeepers interviewed. Only 13.3% were indifferent when asked if they were stimulated with the sector, as well as 20.0% who showed to be little stimulated.

Among the factors considered fundamental for the increase in honey production by beekeepers, the need for technical assistance for production and administration (cited by 53.3% of the interviewees) stood out, followed by the need for genetic improvement of queens and hives (46.7%), availability of physical space (33.3%), logistical conditions for marketing, transportation and sales (26.7%) and greater public incentive for the consumption of the product (26.7%). The existence of financing and the creation of cooperatives were the items least mentioned by beekeepers (Table 3).

Also in general terms, the main points that reduce honey production according to the opinion of beekeepers are the reduction of flowering (cited by 80.0% of the interviewees), followed by climatic factors (60.0%), such as prolongation of dry periods and anticipation of rainy periods (40.0%). Deforestation, fires, bee diseases, pest attacks, the existence of mining and garbage dumps were issues rarely mentioned by the interviewees.

Most of the honey produced by the interviewees is sold locally (66.7%), followed by apiaries that currently maintain the commercialization on a regional and state scale (26.7%). The honey trade at the national level is maintained by only one beekeeper (6.6%), while none of them uses the export of the product. Even with local commercialization, most of the interviewees recorded an increase in production between the last five years (73.3%). The increase in 36.4% of the apiaries was more than 150 kg of honey per year (Table 3).

Table 3 - Information related to the profile of honey production in apiaries evaluated in the study on the perspectives of beekeepers in relation to production in Mato Grosso.

Information	Nº	%
Factors that increase honey production (multiple choice))		
Production and administration technical assistance	08	53.3
Genetic improvement of queens and hives	07	46.7
Availability of physical space	05	33.3
Marketing, transportation, and sales planning	04	26.7
Greater public incentive as a menu for the population	04	26.7
Existence of funding	03	20.0
Creation of cooperatives	03	20.0
Factors that decrease honey production (multiple choice)		
Decreased flowering	12	80.0
Climatic factors	09	60.0
Extension of the dry season or anticipation of rainfall	06	40.0
Forest Deforestation	05	33.3
Prague attack	04	26.7
Burned	04	26.7
Use of pesticides in crops near hives	03	20.0
Existence of mining near the hives	01	6.6
Breadth of marketing of honey		
Local marketing	10	66.7
Regional/state marketing	04	26.7
National marketing	01	6.6
On increased production in recent years		
Yes, there was an increase in production	11	73.3
There was no increase in production	04	26.7
What is the increase recorded?		
Between 10 and 50 kg	03	27.3
Between 51 and 100 kg	02	18.2
Between 101 and 150 kg	02	18.2
Above 151 kg	04	36.4

Source: Authors (Field research, 2022).

The beekeepers who obtained an increase in production indicated that the main factors that contributed to this growth were the increase in flowering (72.7%), favorable climatic factors (54.5%), as well as a reduction in deforestation rates (36.4%) and a reduction in the use of pesticides in areas close to the apiaries (36.4%) (Table 4).

Specifically, in relation to the quality of honey, most beekeepers did not observe

changes in color, smell, texture, flavor, and density (80.0%). Reports on changes in color were made by 20.0% of the interviewees. Regarding the behavior of bees in the hives, changes were not recorded in most apiaries (77.8%). However, specific situations were evidenced in two apiaries deserve due attention, such as the occurrence of excess dead bees near the hive, excess dead bees far from the hives, decrease in the reproduction rate, mortality and malformation of the offspring, as well as disorganization of the hive, both apiaries located in Legal Reserves.

It is observed that a considerable portion of the apiaries are located close to the areas of mining exploration (37.0%), most of them less than 5 km away (91.7%). The same is observed in relation to the proximity of apiaries and crop areas that use pesticides, since 66.7% are in agricultural production areas, and 88.9% of this total is located less than 5 km from the crops (Table 4).

Table 4 - Information related to the profile of honey production in apiaries evaluated in the study on the perspectives of beekeepers in relation to production in Mato Grosso.

Factors that influenced the increase in production at the apiary	Nº	%
Increased flowering	08	72.7
Climatic factors	06	54.5
Decrease in forest deforestation	04	36.4
Absence of the use of pesticides in nearby crops	04	36.4
Absence of pest attack	02	18.2
Absence of disease in bees	02	18.2
Extension of the dry season or anticipation of rainfall	01	9.1
Dump far from the apiary	01	9.1
Reduction or absence of fires	01	9.1
Observation of physical changes in honey		
Color change	03	20.0
No changes were observed	12	80.0
Observation on the behavior of bees		
Excess dead bees near the hive	02	7.4%
Excess dead bees away from the hive	01	3.7
Decreased reproduction rate	01	3.7
Offspring mortality or larval malformation	01	3.7
Hive disorganization	01	3.7
No changes observed	21	77.8
Existence of gold mines near the apiary		
Yes, there are mines nearby	12	37.0
There are no mines nearby	15	63.0

Distance from the mines		
Less than 5 km	11	91.7
Between 6 and 10 km	01	8.3
Existence of crops with the use of pesticides near the apiary		
Yes, there are crops	18	66.7
There are no crops	09	33.3
Distance from crops		
Less than 5 km	16	88.9
Between 11 and 15 km	02	11.1
As for the encouragement to continue working in beekeeping		
Little stimulated	03	20.0
Indifferent	02	13.3
Very stimulated	07	46.7
Extremely stimulated	03	20.0

Source: Authors (Field research, 2022).

Discussion

Beekeeping in Mato Grosso is an activity in full expansion that needs specialized technical support and stimulus through public policies, aspects also observed by (FERREIRA *et al.*, 2016; LONGO *et al.*, 2019; PEREIRA *et al.*, 2020). Based on the information collected, it is observed that honey production occurs in small private properties or leased spaces, partly associated with family farming, with numbers of hives ranging between 10 and 50, with beekeepers encouraged to remain in the area, however, facing common problems, such as long periods of drought, similar to the Brazilian northeast (VIDAL, 2021), southeastern Paraná (NUNES and HEINDRICKSON, 2019), and Baixada Cuibana (LONGO *et al.*, 2019). It is known that the base of Brazilian beekeeping is made up of small producers with up to fifty hives, which results in 60% of the national honey production (CBA, 2019).

Regarding the place where this economic activity is developed, the problem of the use of non-private areas was observed, since most are installed on third-party properties (62.9%). A fact that raises concern in relation to regularization, registration, and necessary technical assistance. Basso (2022) characterizes the importance of formalizing apiaries to have security in the enterprise, given the environmental, economic, and social losses that may occur, as provided for in the Land Statute, Law nº 4.504/64 (BRASIL, 1964), and Law nº 4.497/66 (BRASIL, 1966), which establishes the rules for agrarian contracts. It is evaluated that the formalization of apiaries is essential to strengthen the fight against the clandestine trade of bee products, since, when formalized, the products start to receive the seal of guarantee of production and quality, offering the consumer products with sanitary inspection.

The formalization of apiaries in Mato Grosso is established by Law nº 12.387/2024, which regulates the general rules regarding the registration of establishments and edible products of animal origin from family or small agribusiness. However, according to Balbino *et al.* (2015) and Basso (2022), it is necessary to encourage this practice beyond the legislation, and to advance to the reach of beekeepers through cooperatives and associations.

Associated with the non-registration of the apiary, another extremely relevant point observed is the non-communication of the loss of the apiaries to the responsible agencies, due to the fear of beekeepers of losing the production space, ceded, or rented by owners of the area and who develop another economic activity. The lack of recording of these occurrences makes it difficult to control and mitigate the impacts on production, in addition to making it difficult for the government to define and implement policies aimed at the sector, due to the lack of official data (PIRES *et al.*, 2016). In this sense, it is necessary to expand the fieldwork with beekeepers so that the total production can be measured, and even enhance sustainable development, the fixation of man in the field, increase in family income and formal jobs (BALBINO *et al.*, 2015; EMBRAPA, 2018).

Regarding the size of the areas used for the installation of the apiaries, it was observed that 40.7% of the apiaries are in areas smaller than twenty hectares. At this point, it should be noted that 53.3% of beekeepers live only from beekeeping, and 73.3% say they do not generate direct jobs, data that are peculiar to family farming (COSTA *et al.*, 2017). Beekeeping is an important means of livelihood for many families in the state, and considering that most municipalities have economies in consolidation, the expansion of the beekeeping market will contribute to the generation of employment and income (BALBINO *et al.*, 2015). For this, it is necessary to have affordable financing, and to stimulate the consumption of products by the population.

Another proposal that is feasible is the implementation of apiaries in Sustainable Use Conservation Units (UCs/US), enhancing the increase in honey production in Mato Grosso (BORLACHENCO, 2017; PEREIRA *et al.*, 2020). The conditions and forms of use of these areas are provided for in Law Nº. 9,985/2000 (BRASIL, 2000), the Law of the National System of Conservation Units (SNUC), and the New Forest Code, Law nº 12.651/2012 (BRASIL, 2012).

Conservation areas are characterized by great beekeeping potential and are protected from those threatened with degradation by anthropic action. From this perspective, when analyzing the protected areas of Mato Grosso, it is found that there are seven federal UCs/HUs and 12 areas of state UCs/HUs (SEMA, 2023), which together add up to more than 2 million ha, a large beekeeping pasture distributed among all regions of the state. According to the State Secretariat of Family Agriculture of Mato Grosso, the state occupies 0.3% of the beekeeping capacity (SEAF, 2022). In this sense, it is necessary to conduct a survey of the areas with this potential, observing the rules for the installation of apiaries. From this information, measure the total production capacity of honey and other bee products, considering the cost-benefit ratio and its sustainability.

Regarding the beekeeping pasture and apiary structure, 59.3% of the beekeepers interviewed keep the apiaries inside the forest areas, and 37% on the edge of the forest.

This result highlights the importance of forests and legal reserves in the sustainability of beekeeping (CAMPOS, 2018). According to the interviewees, this practice allows more honey harvests in less time, reaching three harvests considered “good” in a year of prolonged drought, linked to the variety of floral resources and water available to the bees. There is a close relationship between beekeeping production and the diversity of ecosystem services, specifically pollination (BARBOSA *et al.*, 2021; ROGERS *et al.*, 2014), considering the flowering periods of the plants and the floral visitation by bees, as well as the intercropping with plant production. Studies relate the increase in the production of crops such as avocados, watermelons, melons, pears, peaches, among others, to the presence of bees as the main pollinating agents (KLEIN *et al.*, 2007; GIANNINI *et al.*, 2015).

In Mato Grosso, it is observed that monoculture is predominant in most regions, especially soybeans, using 10.598.769 ha and approximately 529.500 ha only in the municipalities surveyed in the 2022/2023 harvest (INDEA, 2023). It was found that 66.7% of the apiaries evaluated in our study are in the middle of these crops. Studies under development by EMBRAPA/soybean and its collaborators have shown gains in soybean and honey productivity, due to the interaction between soybeans and visiting bees (EMBRAPA, 2024). In this perspective, in addition to the gain in the ecosystem service provided by bees, beekeepers expand their production due to the increase in the available beekeeping field and crop flowering (EMBRAPA, 2024).

However, according to the data collected, 73.3% of beekeepers reported the absence of government and/or private technical support. The perception is that a greater approximation of the State could influence the increase in production, a situation also pointed out by Pires *et al.* (2016). The discussion of the representatives of the beekeeping productive sector with the government about what demands would be necessary to support the producer is essential. Aveni *et al.* (2018), described that one of the ways to overcome these challenges is through the formation of associations. Even under the allegation of non-assistance to beekeepers, it is evident that the sector does not stop producing. This shortage, in practice, is made up for by the dialogue between the producers themselves. This is based on training and information obtained through conversations and exchanges of experiences with the most experienced producers.

In general data, the growth of the sector and honey production in Mato Grosso is notorious. In 2021, 440.216 kg of honey were produced, with an increase in production value of 29% compared to 2019 (IBGE, 2021). These data are compatible with those observed in this study, in which 73.3% of beekeepers reported an increase in production in the last five years, an average of 18.5 kg per apiary. The production in Mato Grosso positions it as the 14th largest honey producer in the country, a position well below the state's potential, considering the available areas with potential beekeeping pasture, including the UCs.

In the same proportion as the possibility of expanding beekeeping in the state, the challenges to be faced are also accentuated. According to beekeepers, the decrease in flowering and climatic factors are the conditions that most negatively influence the sector, with 80 and 60%, respectively. Both situations are related to anthropogenic actions,

the main source of changes in the ecosystem (GIROTTI *et al.*, 2020).

This information can be verified through environmental monitoring indexes, including fire outbreaks in Mato Grosso, which in 2022 culminated in more than ten thousand records (INPE, 2023). Fires, in addition to destroying habitats, emit polluting gases and heavy metals into the environment, such as mercury (Hg), which, once volatilized, undergoes different chemical changes and can sediment on forests, water, soil, and fauna (NATASHA *et al.*, 2020), including bees, which can even die (ORSI *et al.*, 2017).

Another index that shows the conditions pointed out by beekeepers is the occupation and use of the soil in Mato Grosso for the planting of commodities. The increase in the planting area also causes an increase in the demand for pesticides. Data from IBAMA indicated the sale of more than 133.290 tons of active ingredients of pesticides in Mato Grosso, including more than 2.800 tons of Fipronil, Imidacloprid and Thiamethoxam (IBAMA, 2020).

These substances are extremely toxic to bees and can cause changes in reproduction with the birth of malformed larvae and changes in glandular physiological structures, which impair the production of enzymes and proteins necessary to produce honey and wax (ORSI *et al.*, 2017; GOMES *et al.*, 2020). However, although most of the apiaries participating in this study were close to the areas of crops and mining, few changes were reported in the management process or in the physical characteristics of the honey or behavioral characteristics of the bees, considered within the normal range by the beekeepers.

Although the reports presented by the interviewees do not foresee chemical, physical or biological changes in bees, including an increase in honey production, it is necessary to broaden and deepen the levels of research on environmental contamination, including heavy metals such as Pb, Hg, Cr, among others, in order to diagnose whether these factors contribute to the “Colony Collapse Disorder” CCD (VAN ENGELSDORP *et al.*, 2009).

Cases of bee decline occurring in Brazil were recorded in the southeastern region in 2007 and 2010, in both cases, there was no evidence of a relationship with CCD (PIRES *et al.*, 2016). Recently in the city of Sorriso/MT, and region, cotton crops were sprayed with Fipronil, resulting in the death of thousands of *Apis* bees (INDEA, 2023), native and solitary bees, generating economic, social, and environmental losses, also without defined characterization to the CCD. However, under threats, beekeeping can occur in harmony with other economic activities such as mining and agriculture, if the legislation is respected, and the use of inputs is conducted correctly (EMBRAPA, 2015).

Combined with a sustainable socio-environmental economy, the investment of public policies in the beekeeping sector can generate revenues for the state, economic development, and sustainability of pollinators, natural resources, fauna and flora (QUEIROZ ROLIM *et al.*, 2018), and consequently greater production and variety of food (GIANNINI *et al.*, 2015), considering that 77% of beekeepers continue to be encouraged to remain in the sector, driven by the enthusiasm they have developed for the activity.

Final considerations and future perspectives

The low rate of assistance from the government is notorious for most beekeepers. It is up to the public agent to enable discussions and training that promote the policy of expanding beekeeping in the region. It is also important that beekeepers organize themselves and seek the necessary support in the face of day-to-day demands and difficulties, whether technical or administrative.

Considering that many apiaries are located in ceded, borrowed or leased areas, and considering the losses of the most diverse orders that they may suffer, it is essential that this point be clarified for the beekeeper and the landowner, safeguarding the rights of both, in the form of registration and/or contracts, promoting the integration of areas used for farming, livestock, extractivism, and mining, along with the beekeeping production sector.

Due to the constant anthropogenic threats to apiaries, such as the use of pesticides irregularly, criminal fires, and deforestation, the creation of an accessible and objective reporting channel is essential, so that the damage caused is recorded, and that the appropriate measures by the responsible agencies are applied to the person who caused the damage.

The promotion of beekeeping as the basis of the local economy is a relevant factor, which increases the income of families that survive only from this economic activity. It is important for the government to encourage the increase in the consumption of bee products on the population's table, through the insertion of the food in school menus, public events, advertising materials and in the service of the social sector itself.

Advancing policies on the use of UCs/Us (APP and RL), expand the possibilities of increasing honey production, and encourage the owners of forest areas to keep them standing, in addition to a legal obligation, it becomes an action of social responsibility, adding the values of the forest, pollination and honey production. In attention to the beekeepers who contributed to this research, we hope that our work will contribute significantly to the economy of the beekeeping sector, exposing the needs and at the same time the determination of the sector that contributes so much to the maintenance and sustainability of the environment, and stimulating the increase of beekeepers in the state, considering the extensive areas of beekeeping pasture potentially available to improve socioeconomic development.

Acknowledgements

To the Graduate Program in Biotechnology and Biodiversity at the Federal University of Mato Grosso. To the Arachnida and Myriapoda Laboratory of the Federal University of Mato Grosso, Sinop University Campus. To the beekeepers participating in the research.

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Submitted on: 26/11/2024

Accepted on: 16/06/2025

2025;28:e001971

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Data Availability Statement:

The entire dataset supporting the results of this study was published within the article itself.

Perspectivas da produção de mel em Mato Grosso: uma avaliação sob a visão dos apicultores

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Resumo: Apicultura é caracterizada pela exploração racional das abelhas Apis, com base no tripé da sustentabilidade, integrando o social, econômico e ambiental. O objetivo deste estudo foi avaliar quais as perspectivas da produção de mel em Mato Grosso, tendo como base a visão dos apicultores de diferentes regiões do Estado? Ao todo, foram entrevistados 15 apicultores, representando 27 apiários, distribuídos em 10 municípios. A pesquisa ocorreu por meio de questionário estruturado, contendo 23 questões objetivas de múltipla escolha. Os resultados evidenciam que 73,3% dos apicultores tiveram ganho de produção nos últimos cinco anos. O aumento de produção faz com que 77,0% dos apicultores se sintam estimulados em continuar no setor. Entretanto, 73,3% afirmaram que não recebem assistência técnica do poder público. Considera-se, a necessidade de maior estímulo pelo poder público junto aos apicultores, incluindo assistência técnica, formalização dos apiários, registros de perdas de apiários, e ampliação de pasto apícola.

São Paulo. Vol. 28, 2025

Artigo Original

Palavras-chave: Abelhas; Economia; Produção; Sustentabilidade; Agricultura familiar.

Perspectivas de la producción de miel en Mato Grosso: una evaluación desde el punto de vista de los apicultores

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Resumen: La apicultura se caracteriza por la explotación racional de las abejas *Apis*, basada en el trípode de la sostenibilidad, integrando lo social, económico y ambiental. El objetivo de este estudio fue evaluar cuáles son las perspectivas de la producción de miel en Mato Grosso, a partir de la visión de apicultores de diferentes regiones del Estado. En total, se entrevistó a 15 apicultores, en representación de 27 apiarios, distribuidos en 10 municipios. La investigación se llevó a cabo a través de un cuestionario estructurado, que contenía 23 preguntas objetivas de opción múltiple. Los resultados muestran que el 73,3% de los apicultores tuvieron un aumento en la producción en los últimos cinco años. El aumento de la producción hace que el 77,0% de los apicultores se sientan animados a continuar en el sector. Sin embargo, el 73,3% afirmó que no recibe asistencia técnica del gobierno. Se considera la necesidad de un mayor impulso por parte del gobierno a los apicultores, incluyendo asistencia técnica, formalización de apiarios, registros de pérdidas de apiarios y expansión de pastos apícolas.

São Paulo. Vol. 28, 2025

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