



Productive and health diagnosis of beekeeping in the state of Tabasco in the period 2015-2018



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Abstract:

This study analyzes the spatial, productive, and health dynamics of beekeeping in Tabasco during the period 2015-2018 through the analysis of georeferenced data and *Varroa destructor* incidence records. GIS tools were used to identify spatial patterns and priority regions of attention. Despite the 13.68 % decrease in the number of apiaries and 10.18 % in hives, honey production increased by 15 %, evidencing an improvement in production efficiency. The Chontalpa region concentrated the largest beekeeping infrastructure and production volume, whereas other regions, such as Centro, showed low development. Most beekeepers were small producers, with fewer than three apiaries, limiting the state's productive capacity. The average incidence of *Varroa destructor* remained low (≤ 1.26 %); however, critical foci were identified in municipalities such as Jalapa and Teapa, associated with significant reductions in production. The technical management of the hives was a factor that possibly contributed to maintaining a low average incidence of varroa and to maintaining and even improving yields in honey production. The study shows the importance of

strengthening sanitary surveillance, producer training, and infrastructure development as key strategies to exploit the state's beekeeping potential; likewise, it shows the need for differentiated policies that promote resilient, sustainable, and competitive beekeeping in the regional and national context.

Keywords: Beekeeping, Honey production, Beekeeping health, *Varroa destructor*.

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Beekeeping plays a fundamental role in agroecological systems and in the maintenance of biodiversity through pollination, in addition to having an economic impact on rural communities⁽¹⁾. In Mexico, although the states of the Yucatán Peninsula concentrate most of the national honey production, states such as Tabasco have underutilized potential, conditioned by productive, health, and structural factors^(2,3). In this context, one of the main beekeeping health challenges is the infestation of *Varroa destructor*, a mite that can reduce the productivity and viability of colonies⁽⁴⁾.

Tabasco, despite its favorable agroclimatic conditions for beekeeping and its rich botanical diversity, has shown low indicators for beekeeping density, infrastructure, and yields per unit area⁽⁵⁾. This shows the need for new studies that contribute to the identification of factors that influence the state's beekeeping activity. This study aimed to evaluate the spatial, productive, and health dynamics of beekeeping in Tabasco during the period 2015-2018, through the analysis of georeferenced data and *Varroa destructor* incidence records. The results can help identify spatial patterns, critical infestation areas, productive trends, factors that influence the performance of the beekeeping sector in the state, and priority areas for strengthening activity in the state. Likewise, they can establish a base that contributes to the formulation of strategies aimed at strengthening the state's beekeeping sector, with emphasis on sanitary surveillance, integrated pest management, and producer training⁽⁶⁾. Identifying factors that limit or favor beekeeping development in tropical regions is key to promoting more resilient and competitive beekeeping in the context of climate change and food security.

The study was carried out in Tabasco, located in southeastern Mexico and bordered to the north by the Gulf of Mexico, to the northeast by Campeche, to the southeast by Guatemala, to the west by Veracruz, and to the south by Chiapas. The state has an area of 24,730.9 km² and is divided into 17 municipalities⁽⁷⁾. The regionalization used in this study was based on their physical characteristics.

Data from the National Program for the Control of the African Bee provided by the state’s Livestock Association were used. The database included information on producers, apiaries (location, number of hives, units sampled, diagnosis, and date of last treatment), and the degree of infestation recorded from 2015 to 2018. The geographical location was obtained by georeferencing from the catalog of localities of INEGI⁽⁷⁾. These data were processed to generate a distribution map of apiaries and hives in Tabasco using ArcGIS 10.8.

The data were organized by year, region, and municipality for analysis and interpretation. Incomplete records were eliminated, leaving 1,106 records for the study. The number of apiaries and hives per producer was determined and classified in frequency tables. To analyze the spatial distribution of apiaries and the presence of varroa, the records were grouped by municipality, region, and year. The database had 1,106 records, of which 986 were georeferenced: 267 corresponding to 2015, 254 to 2016, 235 to 2017, and 230 to 2018.

In 2015, Tabasco registered 122 beekeeping producers distributed in four regions and 13 municipalities. By 2018, this number increased by 12.2 %, reaching 137 producers distributed across 16 of the 17 municipalities. The Chontalpa region had the highest concentration of beekeepers, followed by Sierra and Ríos, whereas the Centro region only registered 15 producers. The municipalities with the most beekeepers were Huimanguillo and Tacotalpa (Table 1).

Table 1: Distribution of the number of beekeepers, apiaries, and average number of apiaries per beekeeper, municipality, and region for the state of Tabasco in 2018

	Municipality	BEEK	APIA	Average		Municipio	BEEK	APIA	Average
Ríos	Balancán	6	12	6.0	Centro	Centro	8	9	1.1
	Centla	8	20	2.5		Jalpa			
	E. Zapata	0	0	0.0		de Méndez	7	11	1.5
	Jonuta	0	0	0.0		Nacajuca	0	0	0
	Tenosique	11	19	1.7		Cárdenas	4	8	2.0
Sierra	Jalapa	3	5	1.7	Chontalpa	Comalcalco	13	22	1.7
	Macuspana	5	5	1.0		Cunduacán	8	12	1.5
	Tacotalpa	26	39	1.5		Huimanguillo	31	88	2.8
	Teapa	0	0	0.0		Paraíso	7	15	2.1

BEEK= beekeepers; APIA= apiaries.

Beekeepers were classified into three categories according to the number of apiaries: small⁽⁸⁾, with 3 or fewer apiaries (83.6 %); medium, with 4 to 10 apiaries (13.9 %); and large, with 11 to 40 apiaries (2.4 %). Sixty-six point three (66.3) percent of the small beekeepers had only one apiary. In 2015, the average number of apiaries per producer was 2.5, falling to 1.9 in 2018 (Table 1). These values are lower than the average of 2.7 apiaries per producer reported in the Yucatán Peninsula^(9,10), where the largest number of apiaries and hives in the country

are concentrated, but they are similar to the average of 1.4 apiaries per producer recorded in the Humid Tropics of Mexico⁽¹¹⁾.

The low number of producers and the low average number of apiaries in 2015 explain the low honey production in Tabasco, which accounted for only 0.55 % of national production, ranking 25th in the national classification of honey producers. In contrast, Yucatán and Campeche, with a higher average number of apiaries per producer, together contributed 31.3 %⁽¹¹⁾. According to data from the Agrifood and Fisheries Information Service (SIAP, for its acronym in Spanish), honey production per unit area was 0.01 t/km² in Tabasco, compared to 0.18 t/km² in Yucatán and 0.1 t/km² in Campeche⁽¹²⁾. At the end of the period studied, Tabasco ranked 21st in the national classification of honey producers, contributing 0.60 % of the national volume. In contrast, Yucatán and Campeche ranked second and fourth, with production of 0.298 t/km² and 0.143 t/km², respectively⁽¹²⁾.

Although Tabasco was not among the leading national producers and despite the reduction in the number of apiaries and hives detected in this study, producers improved their yields. In 2015, the state produced a total of 340.92 tonnes of honey. By 2018, this figure increased to 391.2 t, reaching a yield of 0.019 t/km². This volume of production has shown sustained growth in the following years. In 2022, Tabasco reached a production of 413 t, representing 0.64 % of national production, and by 2023, this share amounted to 0.71 %⁽¹²⁾. Although state production is still below the national average of 2,010 t, the steady increase over the last eight years highlights the beekeeping potential of Tabasco, whose botanical diversity and good management practices can improve yields⁽⁵⁾.

Regarding beekeeping infrastructure, it was observed that the Chontalpa region had the highest concentration of hives in the state during the period analyzed. In 2015, Tabasco had 5,108 hives distributed across four regions and 13 municipalities, but by 2018, it decreased by 10.18 % (Table 2), possibly due to climatic factors, lack of food, swarming, and competition with other species⁽¹³⁾.

Table 2: Number of hives by region and municipality for the state of Tabasco, period 2015-2018

	Municipality	Years				Municipality	Years				
		2015	2016	2017	2018		2015	2016	2017	2018	
Ríos	Balancán	55	41	93	186	Cárdenas	150	93	23	204	
	Centla	656	473	317	323	Chontalpa	Comalcalco	296	320	514	422
	E. Zapata	0	0	25	0	Cunduacán	378	235	235	160	
	Jonuta	0	0	0	0	Huimanguillo	2119	1093	1412	1574	
	Tenosique	496	183	360	434	Paraíso	369	378	239	296	
	Subtotal	1207	697	795	943	Subtotal	3312	2119	2423	2656	
Centro	Centro	88	435	234	86	Jalapa	17	27	28	49	
	Jalpa de Méndez	17	195	143	125	Macuspana	64	120	78	62	
	Nacajuca	0	30	0	0	Tacotalpa	403	765	697	667	
	Sierra	Teapa	0	11	0	0					
	Subtotal	105	660	377	211	Subtotal	484	923	803	778	
Total	5108	4399	4398	4588							

The most significant loss of hives (13.88 %) occurred between 2015 and 2016, especially in Chontalpa and Ríos, with drops of 36 and 42.2 %, respectively. In Chontalpa, Huimanguillo registered a 25.7 % loss in 2018 compared to 2015 (Table 2). In Los Ríos, Centla lost 50.7 % of its hives between 2015 and 2018, and Tenosique had a 63 % drop, recovering to reach 434 hives, with a final loss of 12.5 %. On the other hand, Sierra and Centro showed a positive trend, especially in 2016, when Sierra increased by 90.7 % in hives and Centro by 528.57 %. Both regions subsequently declined, but maintained higher numbers than in 2015. In Sierra, Tacotalpa was the municipality with the highest growth, with a 65.5 % increase.

As for apiaries, by 2015, Tabasco had 307 apiaries distributed in four regions and 13 municipalities. Sixty-three point eight (63.8) percent were located in Chontalpa and 23.6 % in Los Ríos. In the following two years, the Sierra region doubled its production units and ranked second, whereas the Chontalpa region maintained its leadership during the four years analyzed. The Centro region recorded the lowest values, with only 2.9 % of apiaries in 2015 and 7.5 % in 2018 (Table 2).

In 2016, the number of apiaries in the state decreased by 11.4 %, a trend that continued until 2017, when the lowest number of units (262) was reached, which represented a drop of 3.68 % compared to the previous year and of 14.65 % compared to 2015. The most significant reductions occurred in Chontalpa and Ríos in 2016, and in Centro and Sierra in the last two years. In 2018, the recovery was minimal (1.14 %), with 265 apiaries; 54.7 % were in Chontalpa and 19.2 % in Los Ríos. In general, from 2015 to 2018, beekeeping production units in Tabasco decreased by 13.68 %.

Within the regions, Huimanguillo had the highest number of apiaries (88) during the period studied. In 2015, it was home to 58 % of the apiaries in the Chontalpa region and 37 % of the state's apiaries. Although this percentage decreased to 33.2 % at the end of the period, its share in Chontalpa increased to 60.7 %. This is reflected in its honey production, which was the highest from 2015 to 2018. Its contribution to state production exceeded 25 % in the first two years and was 22 % in the following years. Tacotalpa ranked second in honey production with 20 %, and Tenosique ranked third with 10 %, during the entire period analyzed.

Although beekeeping is common in Tabasco, it is mainly carried out in Chontalpa, followed by Sierra and Ríos, which compete for second place. Despite the decrease in apiaries and hives, particularly in Chontalpa and Ríos, where the most considerable reductions are observed, honey production in the state increased by 15 %, from 340 t in 2015 to 391 t in 2018⁽¹⁴⁾, with Chontalpa and Ríos as the largest producers.

This increase in production could be explained by the size of the production units, measured in the number of hives^(8,11,15), especially in Chontalpa and Ríos, which maintained the most extensive beekeeping infrastructure. In 2015, Chontalpa was home to almost 65 % of the hives and 63.9 % of the state's apiaries, and in 2018, it concentrated 57.89 % of the hives and 54.7 % of the apiaries (Table 2). This infrastructure contributed to maintaining constant production and increasing honey volumes from 148.57 t in 2015 to 164.93 t in 2018⁽¹²⁾.

Despite the challenges, the increase in honey production can also be attributed to factors that significantly affect the capacity of the production unit, such as feeding, genetics, technification, and pest and disease control, especially the low incidence of varroa in the state^(8,16). These factors, together with botanical diversity⁽¹⁷⁾ and beekeeping infrastructure, would have compensated for the reduction in production units. The data suggest that physiographic factors do not significantly influence the beekeeping distribution in Tabasco.

In 2015, the average amount of hives per producer in the state was 41.86, decreasing to 33.48 in 2018. In this last year, the municipalities with the highest average amount of hives per apiary were Cárdenas with 25.5, Tenosique with 22.84, and Paraíso and Comalcalco with an average slightly higher than 19 hives per apiary. Those with the lowest average were Centro (9.6), Jalapa (9.8), and Jalpa de Méndez (11.4). The average number of hives per apiary in 2018 was 17.3, similar to that of small beekeepers in Brazil (10-50 hives), slightly lower than that of Yucatán and Campeche with an average of 20 hives per apiary^(9,10), and below Veracruz with averages of between 101 and 300 hives⁽¹⁸⁾. In Latin America, the average for small producers was 25 to 35 hives per apiary^(19,20).

The density of hives for the state was very low, as the average for the period was 0.18 hives per km², which contrasts with recommendations for crops of 4-6 hives per hectare⁽²¹⁾. Other authors report an average of 3 to 3.5 hives per hectare at the national level⁽¹³⁾. In 2018, the

municipalities with the lowest density of hives were Macuspana, Balancán, Centro, Jalapa, and Cárdenas, with values below 0.1 hives per km², while those with the highest density were Tacotalpa with 0.9, Paraíso with 0.72, and Comalcalco with 0.55 hives per km².

The state incidence rate of varroa in 2015 was 1.05 %, with slight fluctuations until reaching 0.96 % in 2018. In 2016, the Sierra region reached the highest rate, mainly due to a peak in the municipality of Jalapa, which exceeded the average values, along with the Teapa rates (Table 3). By 2016, Teapa only registered two apiaries, both with high incidence rates, suggesting inappropriate apiary management. The literature indicates that inadequate practices, poor monitoring, lack of treatments, and little experience of the beekeeper favor the proliferation of *Varroa destructor* and other mites, resulting in dangerously high levels of infestation^(8,22,23).

These two municipalities were the most affected during the study; the incidence rate presented by both in 2016 was problematic for the health of their apiaries^(20,24). When comparing the production of the years 2016, 2017, and 2018^(12,14), a drop of more than 50 % was observed in both municipalities: Jalapa lost 52.66 % in 2017 and 54.63 % in 2018 compared to 2016; in contrast, Teapa lost 54.11 % in 2017 and 28.87 % in 2018. This decrease could be related to high incidence rates, since, in the humid tropics, beekeeping health significantly affects the volume and quality of honey^(9,11,25).

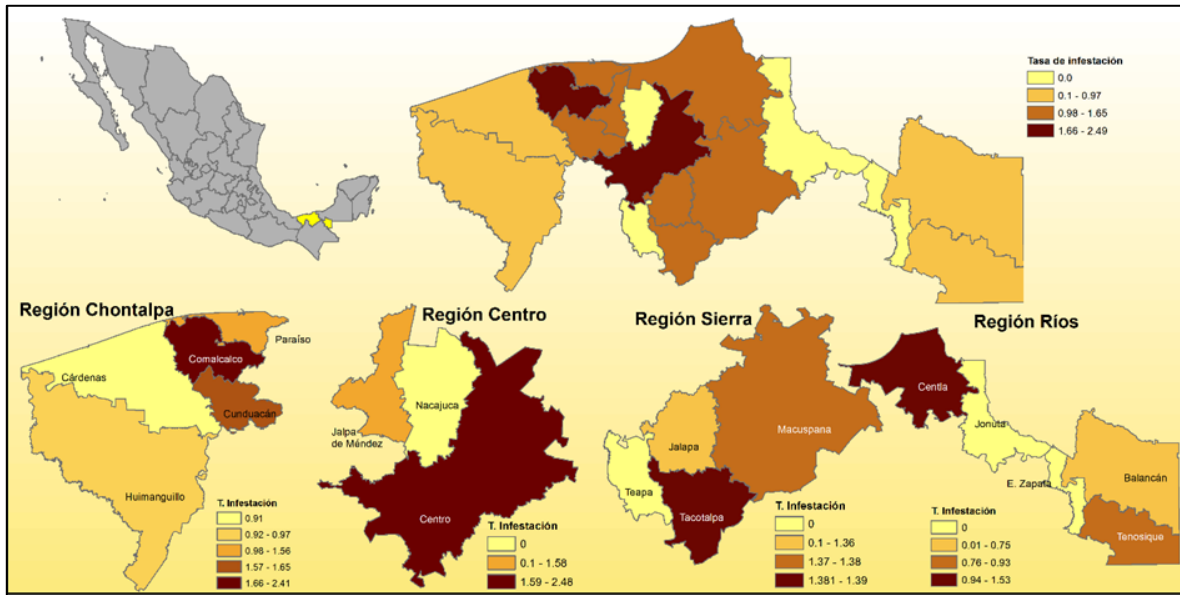
Table 3: Varroa incidence rate by region in the state of Tabasco, period 2015-2018

	Municipality	2015	2016	2017	2018		Municipality	2015	2016	2017	2018
Ríos	Balancán	1.17	0.48	2.02	1.70	Chontalpa	Cárdenas	1.31	1.19	1.74	0.91
	Centla	0.97	1.28	1.37	1.70		Comalcalco	1.17	1.27	1.81	1.38
	E. Zapata	0	0.00	3.37	0.00		Cunduacán	1.23	1.37	3.22	1.19
	Jonuta	0	0.00	0.00	0.00		Huimanguillo	1.49	1.16	1.66	1.16
	Tenosique	2.20	1.15	1.48	1.81		Paraíso	0.91	1.23	1.08	1.68
	Average	0.87	0.58	1.65	1.04		Average	1.22	1.24	1.90	1.26
Centro	Centro	1.55	2.85	1.87	0.66	Sierra	Jalapa	1.66	14.20	0.77	1.51
	Jalpa de						Macuspana	1.45	1.78	1.38	0.90
	Méndez	1.64	1.04	0.92	1.01		Tacotalpa	1.10	1.41	1.11	1.50
	Nacajuca	0	0.48	0.00	0.00		Teapa	0	5.33	0.00	0.00
	Average	1.06	1.46	0.93	0.56			1.05	5.68	0.82	0.98
General average		1.05	2.24	1.32	0.96						

Other municipalities with high incidence rates were Emiliano Zapata and Cunduacán in 2017, and Tenosique in 2015 (Table 3). At the regional level, the lowest incidence was recorded in Los Ríos in 2016 and in Centro in 2018. The municipalities with the lowest rates were Balancán and Nacajuca, with levels below 0.5 % in 2016, and Centro in 2018.

The four regions of the state maintained an average incidence rate of up to 1.26 % in 2018. Figure 1 shows the distribution of incidence by region and municipality for this year. This figure is considered low since values below 4.5 % are not a beekeeping health problem^(20,24). This coincides with the levels of parasitism between 2 and 4 % reported for adult bees in Mexico⁽²⁶⁾. In tropical and subtropical climates, adequate apiary management and monitoring help maintain low infestation rates^(9,24).

Figure 1: Varroa incidence rate in the state of Tabasco by regions and municipalities in 2018



Although the average of 1.26 % is low, there are specific infestation foci in the state that affect incidence rates and, consequently, the yield of beekeeping production units⁽⁹⁾. This highlights the importance of monitoring, good practices, and training in apiary management. The participation of more producers in control programs makes it easier to provide access to training that improves beekeeping practices and to the monitoring of units to keep them free of varroa and other diseases, or to properly evaluate and treat infestations, thus strengthening beekeeping production⁽²⁷⁾.

In conclusion, the expansion of beekeeping was identified, along with a 15 % improvement in honey production in the state of Tabasco, despite the reduction in the number of apiaries and hives, suggesting greater efficiency in the productive units, possibly associated with good management practices, low incidence of *Varroa destructor*, and the utilization of local botanical diversity. La Chontalpa stood out as the main beekeeping center of the state, concentrating the most extensive infrastructure and production, whereas other regions, such as Centro, showed low development. The activity is dominated by small producers with limited infrastructure, which represents a challenge for their growth. Although the average

incidence of varroa was low, municipalities such as Jalapa and Teapa presented foci of infestation that require constant monitoring. The study underscores the need to strengthen producers' technical and health capacities, professionalize the sector, and apply regionalized policies, highlighting Tabasco's beekeeping potential to consolidate itself as a competitive and sustainable activity.

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