Chapter 7

Beekeeping in Jalisco, México

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Abstract

The purpose of this study was to analyze the socioeconomic factors that influence the beekeeping process and describe the current situation in beekeeping technology development in the south and southeast regions of Jalisco. The study was conducted by reviewing secondary sources of documentary information and the primary information was obtained by means of a survey, analyzing demographic, social, technological, and economic variables. From January to April 2011, a stratified sampling was conducted of six strata of beekeepers, with a final sampling of 183 beekeepers. We applied a frequency analysis, ANOVA (Waller-Duncan), and contingency tables (χ^2). The average age observed for the beekeepers was 47 years, with fewer women participating in the activity, and an above national average level of education. The majority keep their apiaries in rented premises, a high percentage outside the municipality where they live. The honey obtained is multiflora and the main harvest is in the autumn, with a honey yield per hive below the national average. A number of problems affect the production sector including environmental factors, production costs, and varroa. We observed little diversification; in addition to honey only beeswax is recovered, and only a minority keep a record of production costs. There is wide participation in beekeeping associations and in training provided by different public and private bodies. There is a willingness to adopt new technologies and equipment for honey production with good practice standards.

Keywords: beekeepers, management, innovation, technology, socioeconomic aspects

1. Introduction

Apiculture is a production area that has been carried out under a broad mosaic of systems and vertical and horizontal integration of the production process. It is an important activity in Mexico

within the food, economic, social, and ecological areas and has developed in different parts of the country, through small and medium producers with an important share of the international market and local consumption of 190 grams per capita during the nineties, increasing to 320 grams in 2010. This increase is because of its use as a raw material in the preparation of foods such as yoghurt, cereals, confectionery, baked goods, and cosmetic products.[1] In 2010, Mexico was the sixth largest honey producer in the world with 1.8 million hives producing 56,883 tons a year, and the third largest exporter, exporting 25,000 tons that same year, mainly to the European market,[2] positioning apiculture among the top three sources of foreign currency in the national livestock field.[3] More than 2,400 tons of beeswax and close to 8 tons of royal jelly are produced each year.[4] Apiculture directly benefits 400,000 people who form part of the beekeeping production chain by constructing beekeeping equipment and packaging and marketing honey and other bee products. In addition to benefiting agricultural crops through pollination, with an estimated value of 2 billion dollars a year, beekeeping also helps to maintain the ecological balance in various ecosystems, through the pollination of wild plants.[5]

The state of Jalisco is one of the main honey producers in Mexico, with a census of 157,827 hives producing an average of 5,698 tons of honey per year between 2005 and 2009 and a 10% market share positioning it in third place nationally behind only Yucatán with close to 10,000 tons (15%) and Campeche with 7,500 tons (12.9%). There are almost 1,000 beekeepers in the state, of whom 50% are in the south and southeast, the main regions in this productive environment; the activity is mainly a sideline to agriculture and livestock.[1,6,7]

In recent decades, the beekeeping sector has faced substantial changes, the result of urbanization, globalization, and population growth, thus developing a new environment in itself.[8, 9] Actions have been taken to improve production, increase diversity in the end product, and try new schemes of organization, giving rise to new commercial dynamics and methods of insertion into the world market.[1] Government actions have focused on promoting productive restructuring, diversification of traditional crops, technological assessment, and the generation of infrastructure and technology innovation.[9,10]

Several studies have drawn attention to the fact that national apiculture is affected by a wide range of issues, including Africanized bees, global climate change (encompassing factors such as erratic rainy seasons, drought and extreme heat, and freezing temperatures), in addition to the lack of training and organization of beekeepers, and not least diseases such as varroa and foulbrood. Middlemen and competition on the international market have also contributed to a worrying instability.[3,6,11]

Honey was already shaping up with major annual sales projections until 2007.[12] This positive forecast has a growing international honey market as current production does not satisfy total demand.[13] However, marketing is another of the core problems within this production sector. In terms of product development, there need to be changes in the collection process, presentation, and business dynamic for it to be considered a primary activity and not just an additional source of income. In general, honey in Mexico is considered a by-product and few producers and companies have invested in research and development, conservation, and quality improvement, as well as differentiated forms of sale and marketing strategies and channels.[14]

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Within Mexican apiculture, more than 75% of beekeepers are low-income farmers who see apiculture as a means of boosting their income; they have on average fewer than 100 hives,[6] numbers that are declining because of the problems already mentioned. The way these small producers carry out the activity does not follow business logistics, making it difficult to obtain reliable data regarding the income they perceive; they keep no records of production, spending, or income.

Given the economic and social importance of apiculture in the south and southeast regions of Jalisco as already described, and a scenario of constant change, it is important to characterize beekeepers and agents of innovation taking into account socioeconomic, technological, and productive variables. Thus the aim of this work was to identify the influential socioeconomic factors within the beekeeping process and describe the current situation in the technological development of beekeepers in the south and southeast regions of Jalisco, to have an updated, objective view of the situation of the apiculture sector that allows the development of a frame of reference, a fundamental decision-making tool within government support programs for the benefit of beekeepers.

2. Materials and methods

The documentary information was obtained from secondary sources to get a frame of reference about aspects of production and commercial statistical behavior of the apiculture production chain, as well as the methodological framework.

The study design is exploratory and quantitative. Exploratory investigation is used to define the study problem and its context through the analysis of secondary data. The quantitative investigation was descriptive and cross-sectional, applying a person-to-person nominal scale survey and a single sampling. The primary information was obtained by means of a survey using a structured questionnaire (See Appendix 1).[15,16] We analyzed demographic, social, technological, and economic variables, which included questions such as gender, age, how often hives were inspected, treatments for varroa, price of honey per kilo, apiculture products, type of extraction equipment, labeling, and marketing the honey, main diseases and their treatments, type of feed and frequency, extraction equipment and production costs, among others.[17]

A pilot survey was applied beforehand to 30 people to make adjustments to the final questionnaire. A stratified sampling of beekeepers was made in six strata: 1 to 25 hives, 25 to 50 hives, 50 to 100 hives, 100 to 500 hives, 500 to 1,000 hives, and over 1,000 hives. From a population of 1,000 beekeepers in Jalisco, 50% live in the study zones, resulting in a population of 500 beekeepers. The final sampling was of 183 beekeepers surveyed, with a 95% confidence level, 3% accuracy, 5% participation, and sample size adjusted to 15% losses. For the data analysis we used a descriptive and quantitative method to identify, understand, correlate, and prove the hypothesis of the study. To analyze the information collected, it was processed using SPSS version 19® statistics software. We applied frequency analysis, ANOVA (Waller-

Duncan), and contingency tables (χ^2) to find whether or not there is an association between the social, economic, and technological profile variables in the apiculture production chain.

3. Results and discussion

3.1. Demographic aspects

The majority (59%) of beekeepers in the study region manage fewer than 100 hives, although some were observed to have more than 1,000 hives ([**Figure 1**). The average age of the beekeepers in the study zone was 47 years for men and 45 years for women. Only 3% were younger than 20 years, and the beekeepers with most hives were also the oldest, evidence of the lack of interest in beekeeping among young people. In the peninsula of Yucatán, the average age is 47 years,18] unlike Michoacán where a 2004 study mentioned 43 years.[19,20] In contrast, on the island of Tenerife, Spain, the average age is reported as 59 years.[21] Age is an important factor to consider in terms of the present and future management skills of beekeepers; older beekeepers are less willing to change their traditional production methods and learn new production or management techniques. Likewise, working on projects with young beekeepers under 25–30 years increases instability because of temporary or definitive migration because of a lack of sources of work in the field or perhaps for reasons of study.[22]

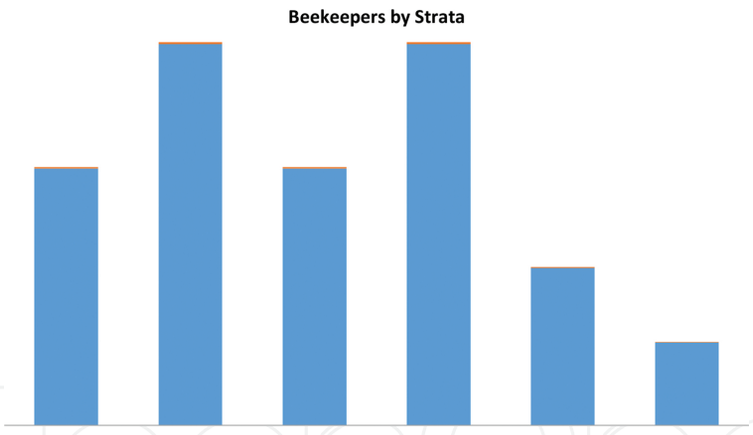

Figure 1. Distribution of beekeepers by strata. (Livestock Research Laboratory, Department of Agriculture Production, CUCSUR, University of Guadalajara).

3.2. Location of apiaries

As far as access to land for beekeeping, there is a significant difference ($p = 0.046$, χ^2) where 61.2% of beekeepers rent the premises where they have their apiaries and the rest use small-holdings and, to a lesser extent, *ejido* or common ground. Beekeepers with 101 to 500 hives are more likely to rent, a similar situation to that reported in communities in Michoacán, where the majority of beekeepers do not own the premises where they set up their apiaries.[23] This situation limits apiculture development as producers must pay, either in cash or kind, for the lease of the lands, and also limits the assurance of the availability of the space to maintain the

apiaries; this, in addition to competition for better spaces not only among beekeepers but also farmers and other branches of livestock. In Turkey, 90.59% of beekeepers have their apiaries installed on private property.[20]

Some 60% of beekeepers installed their apiaries in the municipalities where they were born and the rest look elsewhere for suitable flowering spaces, showing a significant difference ($p = 0.000$, χ^2) where beekeepers with more than 100 hives have greater mobility in search of better yields. They also mention a wide saturation of hives in their municipalities, this being another of the main issues raised within the beekeeping production system. This is related to the average distance of 25 km they have to travel to inspect the apiaries (in a range from 1 to 200 km), where a significant difference ($p = 0.000$, χ^2) was observed, beekeepers with less than 50 hives traveling less than 10 kilometers to install their apiaries, while those with over 500 hives travel distances in excess of 60 kilometers. Such a situation is unique to this region; a study in Chile describes a high concentration of apiaries in certain zones,[22] a fact that goes against the environmental management requirements for good farming practices. A different situation exists in Yucatán, where close to 50% of beekeepers travel more than 10 kilometers to reach the apiary, while 22.2% travel less than 2 kilometers, which leads to strong competition among the bees to obtain food, since 88.9% have apiaries at a distance of less than the recommended 3 kilometers.[24]

3.3. Months of honey production

About 100% of the beekeepers refer to honey harvested is multiflora origin, since flowering of the area is varied in the area, and production depends on environmental conditions and the availability of floral resources producing pollen and nectar. The main honey harvest occurs in autumn; 30.1% of the beekeepers in the study area harvest in October, 74.5% harvest in November, the strongest month, and 48.1% in December. The secondary harvest, with less production, is done in the spring starting in March with 12%, rising to 27.9% in April, with a significant reduction in the activity in May with 11.5%.

The seasonality of honey production is marked at two different times of the year in most of the country, in the southeast and coastal regions it is obtained from March to May (spring-summer), generating 40% of production. The second harvest is obtained in the Altiplano and north of the country between September and November (autumn-winter), obtaining the remaining 60% of production. Honey production in the Yucatán Peninsula occurs during winter and spring from December to June and comes from toothleaf goldeneye (*Viguiera dentata*), tzitzilché (*Gymnopodium floribundum*), and some vines (1, 25). In Michoacán, most beekeeping activity takes place in spring and summer (August and September), with the most significant peak during June. This variation in seasonality by zone around the country allows honey to be available throughout the year.

3.4. Problems in honey production

There is a significant difference ($p = .000$, χ^2) among the complaints of beekeepers where those with more than 500 hives express the lack of available spaces for placing the apiaries; in recent

years, new beekeepers have emerged who establish their apiaries less than 2 kilometers away, thus invading flowering spaces, which decreases production. Meanwhile, beekeepers with less than 500 hives give priority to environmental factors, mentioning situations of high deforestation and fires, reduced and erratic seasons, the indiscriminate use of pesticides with the resulting damage to bee populations; followed by production costs, which have increased because of the high cost of sugar, one of the basic inputs, the purchase and exchange of queens because of Africanization, as well as the cost of the treatment of diseases, lack of support for the purchase of extraction equipment and hive management, and roads and tracks in poor condition, which affects the beekeeper going to inspect the hives, and the fact that where support does exist it is insufficient (**Figure 2**).

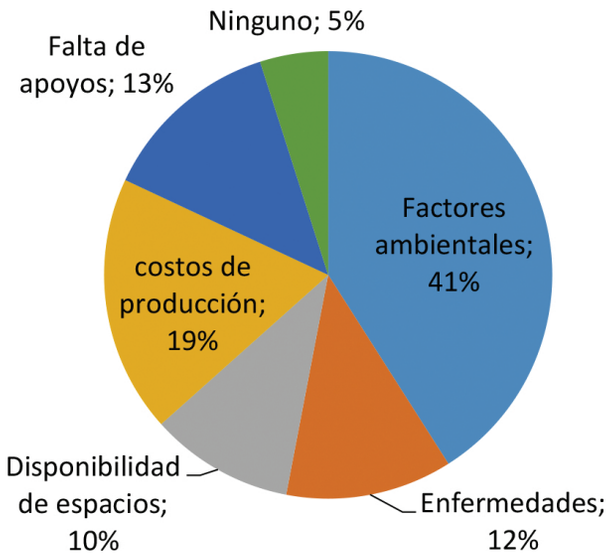

Figure 2. Problems facing beekeepers for honey production (Livestock Research Laboratory, Department of Agriculture Production, CUCSUR, University of Guadalajara).

As far as disease, attention is focused on the varroa mite to control the health problem. A similar situation is found in Yucatán, where beekeepers also complain of lack of training and unfavorable market conditions, not unlike the situation in the study zone. This is in contrast to the problems described in Nigeria, where beekeepers are affected by theft of the hives, fires, abandonment of hives, lack of better technology, lack of technical assistance, and the aggressiveness of the bees.[25]

3.5. Bee products

In the productive field, all (100%) beekeepers obtain conventional honey; in first place as an alternative product is beeswax, produced by 58.6%. This is followed in second place by nucleus colonies and propolis, and to a lesser extent, royal jelly, queens, and pollen, with little or no participation in the pollination process (**Table 1**). Although pollination is not a product but a service provided by apiculture, in many parts of the country it is an alternative source of income. In fact, in the states of Sinaloa, Chihuahua, and Coahuila, it is the main purpose of bee

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exploitation, honey production being a secondary activity,1] and in Michoacán pollination generates important economic income for 32.4% of beekeepers. In contrast, only 29.1% of beekeepers in Michoacán recover beeswax, whereas in the study zone this figure is more than double (58.5%).[19]

Alternative product	Frequency	Percentage
Beeswax	107	58.5
Nucleus	52	28.4
Propolis	33	18
Queens	25	13.7
Royal jelly	23	12.6
Pollen	18	9.8

Table 1. Products other than honey obtained by beekeepers in the south and southeast regions of Jalisco (Livestock Research Laboratory, Department of Agriculture Production, CUCSUR, University of Guadalajara).

Although obtaining organic honey generates higher economic profits, it implies additional costs both for equipment and the necessary certification processes as well as the application of different production protocols to guarantee a product free of chemical substances. Organic bee farming also presents strategic technical challenges in training to obtain quality products and resource management for the acquisition of processing equipment and physicochemical product analyses which, when done professionally, make the activity more competitive. Organic honey is an area of opportunity for beekeepers in the study zone; the best price for organic honey may be 30% more than the price of conventional honey.[1,19] The obtaining of other products and pollination could improve the producers' income; however, these activities require the investment of more time and as this is not the main economic activity of more than 50% of the beekeepers in the study regions, further diversification is stifled and they remain within traditional exploitation with the production of primarily honey, beeswax, and bee nucleus colonies, which is contrary to the so-called integral exploitation.

3.6. Economic aspects

No differentiation is made in the management of the honey whether sold by the bottle or by the bucket as only 14% of beekeepers sell their products with a label. However, a 2012 study mentions that in Jalisco, sales of private label bottled honey are less than 1% of the production sold by those producers, an action that represents an important step toward the end consumer and the added value of the product.[26]

This form of commercialization has facilitated the sale of adulterated honey and even high-fructose corn syrup as if it were honey, thus deceiving many people who purchase it believing it to be real honey at a very low price.[1] Limited classification of the product by color and/or flowering, bulk sale, and the lack of technology to enable value-added export position the honey industry as a commodity.[27]

In terms of the sale price per kilo of honey, a significant difference is observed in the analysis of variance Waller-Duncan of 0.000; beekeepers in strata 1 with up to 25 hives receive an average of 52.71 pesos while those in strata 5 with 501 to 1,000 hives receive 37.42 to 40 pesos. The trend observed is that the fewer the hives, the higher the sales price, which is because of the sale being made directly to the consumer while big producers sell their product wholesale and often receive a price close to 40 pesos per kilo (**Table 2**). In 2008, however, Jalisco was considered the best paid state, in that year receiving a price of 30.57 pesos per kilo, above the national average of 24.52 pesos. It should be noted that the price quadrupled in the decades from the nineties to 2008 going from 5.86 to 24.54 pesos nationally, which is attributed to the issues this production sector faces.19]

Variable		*N*	Average	Sig.
Sale price of honey in 2011 (kg)	1–25	31	52.71	0.000
	26–50	46	48.00	
	51–100	30	43.50	
	101–500	46	40.26	
	501–1,000	19	37.42	
	1,001 o more	10	40.10	
	Total	182	44.57	

Table 2. Sales price of honey per strata in the south and southeast regions of Jalisco (Livestock Research Laboratory, Department of Agriculture Production, CUCSUR, University of Guadalajara).

As far as the export of honey, only 6.55% of beekeepers mention exporting honey to Germany. The beekeepers in strata 6 with more than 1,000 hives are the ones who export the most, there being a significant difference ($p < 0.001$ using χ^2) compared with strata 2 with 26 to 50 hives. One of the problems observed in the states in the study is that the production is bought by intermediaries who often pay for the harvest in advance and are responsible for positioning the product on the European market. This is a situation that prevails in countries such as Argentina, where it is reported that more than 95% of honey production is for exportation, and which is handled by only a few actors (three or four companies); the crucial points applied to exportation, such as quality control, storage, transport, and retail outlets form part of the marketing and supply strategies of the exporting companies in the area.[27]

Only around 30% of beekeepers know the quality standards required on the international market. Beekeepers in strata 4, 5, and 6 (more than 100 hives) are better trained in these aspects ($p < 0.66$, χ^2) compared with beekeepers with fewer hives, who also show little interest in the export process considering it to involve too much bureaucracy. Producers need to know the quality standards required by the international market, as well as packaging, packing, and prices be competitive.[28]

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3.7. Honey marketing problems

Close to 40% of beekeepers interviewed expressed problems in marketing the honey, and among the problems they face are low prices, mentioning that sometimes they recover only the production costs. Likewise, street vendors (carts) of adulterated honey at low prices have become unfair competition for beekeepers, as consumers have no knowledge of the quality and purity of the honey. A similar problem occurs in Argentina, where adulterated honey is rife on the local market. In addition, the abundance of red tape for exporting and the need for intermediaries demotivates producers from exploring the international market. In strata 1, 2, and 3 beekeepers express their concern about the low per capita consumption of honey, which only reaches 320 grams per year.[27]

Within the production process, 43.7% of those interviewed keep a record of production costs. It is mostly the beekeepers in strata 4, 5, and 6 (more than 100 hives) who carry out this activity to a significant extent ($p < .028$, χ^2). Similarly, Torres[22] observed in Chile that 50% of those interviewed said they did not maintain written accounts or sales records.

Of those beekeepers who do maintain records, not all were able to provide complete information, hence only 38.25% (70) of those interviewed were considered in the calculation of production costs, which include containers, treatments, gas, electricity, equipment repair and maintenance, vehicle maintenance, queen bees, beeswax, labor, feed (sugar, and others), protection equipment, and hive management equipment. In this area, there were significant differences ($p < 0.43$, Waller-Duncan) between the strata, observing that beekeepers with more than 500 hives (strata 5 and 6) have lower production costs (16.43 and 19.62 pesos, respectively), while beekeepers with less than 50 hives (strata 1 and 2) have higher production costs at 46.87 and 34.47 pesos, respectively. Lower production costs in strata with more hives may be directly related to the high volumes of inputs purchased to carry out the beekeeping activity and to group purchases to obtain better prices by buying wholesale.

The exploitation of bees that are more defensive, swarming, and evasive leads beekeepers to make changes in the way they are managed, such as relocating apiaries to more distant locations, thereby increasing the costs of transportation and labor (each worker manages fewer hives per day than when working with European bees), and also the protective equipment required against more defensive bees (coveralls and gloves),[29] and the purchase of queens, which before Africanization was minimal. In addition to this is the cost of bee feed, which in recent years has become one of the major costs, given the excessive increase in the price per kilo of sugar. It is estimated that production costs in managed colonies have increased around 30% in comparison with European bees[4] and because of treatments, particularly for the varroa mite. In spite of this, 66.6% of beekeepers believe bee farming is profitable. However, profit margins vary widely in a range from 5% to 200% as a consequence of such great differences between beekeepers.

3.8. Social aspects

About 90% of beekeepers are members of a beekeepers association; 52% belong to 4 of the 11 associations registered in the study regions (Table 3).

Local livestock association of beekeepers (municipality)	Frequency	Percentage
Sayula	26	14.2
Apiteca	17	9.3
Asociación de Tamazula	22	12.0
Gómez Farías	9	4.9
Atoyac	4	2.2
Asociación San Gabriel	19	10.4
Asociación de Zapotiltic	23	12.6
Asociación de Tapalpa	6	3.3
Zapotlán	24	13.1
Zacoalco	9	4.9
Atemajac de Brizuela	6	3.3
Does not belong to any association	18	9.8
Total	183	100.0

Table 3. Participation in beekeeper associations in the south and southeast regions of Jalisco (Livestock Research Laboratory, Department of Agriculture Production, CUCSUR, University of Guadalajara).

A strategic challenge in the technology field is for small beekeepers to communicate clearly with research bodies, to generate a greater degree of professionalism and scientific rigor to meet the competitive challenges emerging in the industry; such communication is more feasible with producers who participate in organizational bodies. This is an important factor to push the competitive development of apiculture production units toward higher levels of social engagement for economic and productive purposes. It is also important to carry out coordinated actions to achieve a common goal, through the identification and planning of collective actions, and confront the control exerted by intermediaries, which would allow better prices for bee products and lead to the activity no longer being considered as merely for subsistence.[19,30]

Associated beekeepers in the study zones indicate that the support they have received from the association to which they belong consists of guidance for obtaining technical resources and training. Through the producers' alliance, they have been able to obtain government economic resources for the construction and equipping of extraction rooms based on the safety requirements within the honey production process. Beekeepers have opted to associate in various ways to deal with their lack of resources and knowledge; however, the way in which they have become associated has often been linked to obtaining government support, as in the Yucatán

Peninsula, beekeeping organizations and cooperatives facilitate the adoption of technology, equipment acquisition, storage, and sale of better quality honey, and are promoted by public institutions and civil organizations.[24]

Associative schemes, whether for productive or commercial purposes, are a valuable tool for beekeepers to achieve their objectives; however, these alone are no guarantee of success; any tool has advantages and disadvantages and being aware of these and analyzing them will avoid any false expectations.

Among the associated beekeepers, 26% think it is unnecessary to make any changes within the operation of the association; however, others mention that changes are required, such as better organization and integration among the members of the associations, referring to greater responsible participation of the assemblies. They also express the need for more resource management and technical support. Nevertheless, they recognize that they have obtained an important benefit by participating in the organization, namely training, and they believe that the honey they produce is recognized for its excellent quality because of their training in best practices in apiary management.

Regarding participation in programs or institutions for support management, close to 80% of beekeepers mention having obtained support from the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación*, SAGARPA), followed by the Secretariat of Rural Development (*Secretaría de Desarrollo Rural,* SEDER), with 13.1%. In addition, 6.6% have received support from the Livestock Productivity Incentive Program (*Programa de Estímulos a la Productividad Ganadera*, PROGAN), which provided economic resources, support for hive identification and payment for technical assistance and training, as well as direct support of 75 pesos per hive to beekeepers of 10 to 175 hives and 75 pesos per hive from 175 to 1,500 hives. This contrasts to the participation in the Secretariat of Social Development (*Secretaría de desarrollo Social*, SEDESOL) program, with 2.7%, which unlike the others promotes social and micro business development. Of the 26% who have not received support from any institution, the majority have less than 50 hives (Table 4).

Institution	Frequency (beekeepers)	Percentage
SAGARPA	146	79.8
SEDER	24	13.1
PROGAN	12	6.6
FIRA	6	3.3
SEDESOL	5	2.7
DIF	3	1.6
None	26	14.20

Table 4. Institutions that have provided support to beekeepers in the south and southeast regions of Jalisco (Livestock Research Laboratory, Department of Agriculture Production, CUCSUR, University of Guadalajara).

Similar participation in support programs is observed in Michoacán and Yucatán, which beekeepers consider is mainly because of there being no requirement for guarantees.[19,24]

3.9. Technological aspects

Of the beekeepers interviewed, 84% have access to training including support by the SEDER through PSP technicians. Of these, 80% say they have put into practice the knowledge obtained both in congresses and during training with technicians, mainly in disease control, feeding, and honey production with good practices. This is interesting as the percentage of beekeepers with technical or higher education is very low. This coincides with what happens in the Alhué commune in Chile, where 70% are interested in training on beekeeping topics, as indicated by Torres,[22] who reports that 80% of beekeepers mention having attended training courses and the rest consider themselves self-taught.[31] This is in contrast to what happens in Santa Catarina in Brazil, where beekeepers do not put into practice knowledge obtained in different forums because the majority engage in beekeeping as a secondary activity, in addition to financial difficulties.[32] It should be mentioned that in the study zones, 47% engage in beekeeping as a primary activity, which is perhaps why they are more likely to put innovation into practice.

Of those interviewed, 94.5% carry out pest and disease control in January, February, June, and August ([Table 5). Varroa is the main problem affecting 91% of their bees, with foulbrood to a lesser extent at 24%, and chalkbrood at 16%. Yucatán presents similar figures for Varroa but with chalkbrood at 44.4%.30] In India, treatment is provided to 86.7% of hives, mainly against varroa and moths.[33] Similarly, in Canada it has been reported that varroa is the main cause of death for bee colonies during winter, being associated with 85% of cases of mortality.[34] Furthermore, in the United States, Europe, and Japan bee colony deaths have also often reported (*Apis mellifera* L.). The *Varroa destructor* mite and the combination of some viruses have been implicated in recent disappearances of bee colonies, making it a particularly serious threat to the health of bees.[35]

MONTHS	Bee feeding		Disease treatment	
	Frequency	% Beekeepers	Frequency	%Beekeepers
January	25	13.7	94	51.4
February	27	14.8	39	31.3
March	21	11.5	25	13.7
April	31	16.9	21	11.5
May	74	40.4	33	18
June	139	76	80	43.7
July	145	79.2	49	26.8
August	139	78	54	29.5
September	89	48.6	25	13.7

MONTHS	Bee feeding		Disease treatment	
	Frequency	% Beekeepers	Frequency	%Beekeepers
October	19	10.4	4	2.2
November	1	0.5	4	2.2
December	6	3.3	18	9.8

Table 5. Feeding and disease control by month in the south and southeast regions of Jalisco (Livestock Research Laboratory, Dept. of Agriculture Production, CUCSUR, University of Guadalajara).

Given that varroa is the main pathological problem in the study zones, 45% of producers have focused on controlling mite infestation in bee colonies using mainly Bayvarol®, 28.4% use natural products, and 16% use Apivar®. Only 7.7% did not apply any treatment. There are few studies in Mexico that show the detrimental effect of varroa on honey production; however, in Valle de Bravo in Mexico State, colonies treated with an acaricide against *V. destructor* were observed to produce significantly more honey than untreated colonies,[36] but it should be noted that environmental conditions and the type of bee may influence the effect of varroa on the productivity of the bees.[37]

3.10. Feeding frequency and feed type

Of the beekeepers interviewed, 96.7% provide maintenance feed to their bees; 81% of these provide energy feed mainly in syrup, and only 33% provide protein feed, unlike Brazil, where 63.6% provide maintenance feed and only 9% protein feed.[38] The use of fructose and confectionery waste is an uncommon practice. In Yucatán, 77.8% feed their bees with a sugar syrup, while only 14.8% feed them with honey, the rest use granulated sugar.[28] In California, the use of honey and sugar syrup is described,[39] and in Chile feeding with honey is also practiced;[31] however, this practice endangers the health of the colonies if the honey does not come from safe sources.

The frequency of feeding is from 7 to 10 days (36.1%), 11 to 15 days (45.4%), and 16 to 30 days (17.5%). Various types of feeders are used to feed, the most popular being a plastic bag (close to 27%), followed by a 1-liter tub (25.7%), the Doolittle feeder (18.6%), and less frequently the Miller feeder (14.2%) and plastic soda bottle (13.7%). Feeding and feeding frequency is a management practice that guarantees vigorous colonies when the nectar is flowing, which translates into higher production levels. Feeding is one of the main production costs and beekeepers indicate that in recent years bees need to be fed for longer periods because of changes in rainfall cycles and lack of flowering. In this respect, the practice of migratory beekeeping, which is negligible in these regions, could reduce feeding costs, however, the costs of moving the hives and the wide competition for spaces to place apiaries would have to be considered.

The majority of the beekeepers in the study manage modern jumbo or Langstroth hives. In contrast, beekeepers in Ethiopia use predominantly rustic hives even though they mention having adopted technological innovation (86%) and notice production increases; nevertheless the modern hive has not gained popularity because of its high cost and lack of awareness.[40]

In the north of Ethiopia, an average of 33 and 16 kg of honey per colony was observed in modern and traditional hives, respectively; production is more than doubled with just the transition to a modern hive.[41]

3.11. Quality control

As far as the implementation of a quality system, 66% carry out some practice for this purpose, mainly maintaining hygiene in the equipment, harvest and post-harvest, and avoiding the use of pollutant fuels and to a lesser extent using vegetable oil instead of paint to protect the hives.

Within the honey harvesting process, 82% of beekeepers interviewed use a smoker to remove the bees from the racks, either alone or in combination with shaking or brushing. The fuel they use is wood chips and corn cobs. This is consistent with the authorized physical means to repel the bees from combs for harvesting (air, shaking, brushing, and smoke through the use of clean fuels). Only a few (4.9%) use chemical repellents (carbolic acid, propionic anhydride, and benzaldehyde), which are restricted because of their residual action on honey and because they are considered carcinogenic. It is also inadvisable to use hydrocarbons and their derivatives (diesel or liquid gas) or materials impregnated with chemicals, paints, resins, or organic waste such as manure as fuels.[9] These are important aspects to consider in the honey production process to preserve and even improve Mexico's privileged position on the international market.

Among honey processing equipment, 60% of beekeepers said they had an extraction room, and the rest mention having a prepared space or resorting to the rental or loan of a room to carry out the extraction: 66% of the beekeepers say the rooms in which they work are equipped with running water. Close to 70.5% of the beekeepers in the study have stainless steel equipment (extractor and settling tank), an indispensable requirement within the good practices of honey production. In addition, 16.4% of beekeepers claim to have galvanized metal extractors and 11% mention other types of materials, among which some are made by the beekeepers themselves; 64.5% of the beekeepers use drip trays in the honey harvesting process in the field, with which they protect the supers from possible field contamination; and 66. 7% of beekeepers in Michoacán have an extractor and only 39.5% a settling tank, but the kind of materials these are made from are not described, and although they have incorporated technology, they have not updated it in accordance with current demands for safe food products.[19]

About 63.4% of beekeepers sieve or strain the honey as part of the process once it is extracted, while the rest mention only letting it settle for a period of 48 hours in the tank, and bottling it from there. On the other hand, it was observed that 87% of Michoacán producers filter the honey.[19] The technological level is a competitive factor intended to speed up the production process.[38] This leads to an increased volume of honey and reduces costs by improving equipment and tools with the innovation of the beekeeping production system.

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4. Conclusions

In the south and southeast regions of Jalisco, beekeeping is practiced by older people, with little appeal to the young and few women participants. Small and large producers with over 1,000 hives participate in the activity, although the majority are small producers who do not have enough hives to justify a full-time commitment. This is reflected in a considerable reduction in honey production that is below the national average, due mainly to environmental factors, high production costs and health problems in which varroa is the producers' major challenge. There is little diversification and differentiation between bee products, so it is necessary to work on strategies to differentiate the quality of honey to maintain their position as global exporters. The beekeepers in general are unaware of the destination of the production, and only have general references of those who buy large quantities, the destination being simply exportation. Similarly, there is little knowledge of the quality standards demanded by export markets. The level of education of producers has encouraged them to attend various training and technical assistance forums, as well as the assimilation of technological innovation both in hive management and harvest and post-harvest of honey and derivatives, through the incorporation of stainless steel equipment in the extraction rooms.

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Appendices

Appendix 1

Survey

Beekeepers of the South and Southeast Regions of Jalisco, Mexico.

Universidad de Guadalajara, Universidad Popular Autónoma del Estado de Puebla

Date:_____Interviewer_____

Name of respondent_____

E-mail_____ Telephone_____

Address_____

Age: **_____Sex _____ Education _____**

Type of Tenure

☐ Common land ☐ Smallholding ☐ Co-ownership ☐ Rented

Town and municipality _____

Length of time as a beekeeper _____

Primary economic activity _____

a. GENERAL INFORMATION ABOUT THE ACTIVITY

1. How many hives do you have?

a) 1 to 25 b) 26 to 50 c) 51 to 100 d) 101 to 500 e) 501 to 1000

2. What is the average distance from your apiary to your home?

_____

3. Geographical location of the apiaries (Municipality)

_____

4. During which months is honey produced?

_____

5. What is the average yield per hive? (Indicate unit of measurement)

_____

6. What are the problems you face in producing honey? (In order of importance)

_____

7. Indicate the bee products you currently produce:

Pollen ☐ Royal jelly ☐ Beeswax ☐ Propolis ☐ Queens ☐ Nucleus ☐ Others (specify)

_____

c) ECONOMIC ASPECTS

8. Where do you sell honey?

☐ Local market (neighbors, friends, nearby communities)

☐ National market: Intermediary ☐ Bottler ☐ Other ☐

☐ Industry Which?

_____

9. Do you sell the honey? ☐ **Bottled** ☐ **In bulk** ☐ **Both**

10. At what price have you sold honey in the last 5 years?

_____

11. Do you label your products?

Yes ☐ No ☐

12. ***Do you export honey?***

Yes ☐ *No* ☐ ***To which countries***? _____

13. **What quality standards does the international market demand?**

_____

_

14. Mention the problems you face to market honey**?**

_____

15. Do you keep a record of production costs? Yes ☐ No ☐
Why? _____

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Inputs	Unit cost	Amount	Total Value
Containers:			
Drum			
Tub			
Jar			
Treatment per hive for			
Nosemosis			
Foulbrood,			
Varroa			
others			
Gas (kg)			
Electricity (Kw.)			
Repair and maintenance of extraction and field equipment (nails, vegetable oil, etc.)			
Gas, vehicle repair and maintenance. (Km)			
Queen replacement			
Stamped beeswax (kg)			
Paid labor ($ / working day)			
Feed (kg sugar per hive per year) and other feeds			
Protective equipment (veil, overall and gloves)			
Hive management equipment (hive tool, smoker, brush)			
Others			

16. Indicate under each heading your expenses for producing honey (per year)

_____

17. Has the activity been profitable in the last 5 years?

Yes ☐ No ☐ What is your profit margin? _____%

b. SOCIAL ASPECTS

18. Do you belong to a beekeepers association?

Yes ☐ Which? _____

No ☐ Why not? _____

19. What type of support do you receive from the beekeepers association?

_____

20. What changes do you think are necessary to improve the functioning of beekeepers associations?

_____

21. Which organizations or government programs have given you support? a) SAGARPA b) Local livestock associations c) FIRA d) Other (Specify)

_____

C. TECHNOLOGICAL ASPECTS

22. Do you have access to beekeeping training courses? Yes ☐ No ☐

23. What institutions offer training courses?

_____

24. How often do you attend beekeeping courses or conferences?

a) Once a year b) Twice a year c) 3 or more times a year d) Never

25. What training events do you attend regularly?

_____

26. Have you implemented any of the knowledge you obtained in the training courses in your apiaries?

Yes ☐ No ☐ Which?

_____

27. Do you carry out any bee disease control?

Yes ☐ No ☐ Which? _____

28. In which months do you carry out disease control?

_____

29. Which medicines do you use for disease control?

_____

30. How do you administer the medicines?

_____

31 Do you feed the bee colonies? Yes ☐ No ☐

32. In which months do you feed the bees?

_____

33. How often do you feed the bees?

a) Every 7 to 10 days b) Every 11 to 15 days c) Every 16 to 30 days

34 What kind of feed do you give the bees?

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a) Energy b) Protein c) Both

35. What kind of energy feed do you give the bees?

a) Sugar b) Fructose c) Confectionery waste d) Other

36. What kind of feeder do you use?

_____

37. What variety of honey do you produce?

_____

38. Do you use any quality control system in the honey production?

Yes ☐ No ☐ Which?_____

39. What technique do you use to remove the bees from the honeycombs?

a) Smoke b) Air c) Strong blow d) Repellents e) Brush f) Other

40. Do you have an extraction room?

Yes ☐ No ☐

41. Do you use drip trays to transfer the harvested supers?

Yes ☐ No ☐ Other

42. Do you have running water in the extraction room?

Yes ☐ No ☐

43. What kind of material are your extractor and settling tank made of?

_____

44. Do you sieve or filter the honey?

Yes ☐ No ☐

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