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Article

Cognitive dissonance in the face of climate change in beekeepers: A case study in Mexico

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Abstract:

Climate change in beekeeping is perceived as a relational phenomenon, and it is necessary to adopt adaptation strategies to maintain economic activity. Festinger's theory of Cognitive Dissonance helps understand the constraints to the adoption of climate change adaptation strategies. For this purpose, a survey was applied to explore the relationship between the perception, attitude, and behavior of beekeepers in the face of climate change in Mexican territory. It was noted that: 1) Beekeepers identified climate change as the main problem for beekeeping; 2) They exhibit dissonance between their attitude and their behavior regarding adaptation strategies, and 3) Cognitive dissonance is reduced through justifications for their behavior. Thus, the present state of dissonance is a limitation for adopting climate change adaptation actions, evidencing the need to modify the behavior of beekeepers, through training to inform and explain the nature of climate change and its impacts; to place the beekeepers within this context, where they can contribute technical elements that may allow them to reorient their work, promoting an objective and constructive perception, which will generate a positive attitude in the face of the challenges that climate change represents, so that they may modify their behavior as much as necessary in order to keep the activity profitable in Mexico.

Key words: Adaptation, Perception, Attitude, Beekeepers, *Apis mellifera*.

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Introduction

Climate change is the greatest challenge for humankind in the 21st century. The greenhouse effect associated with the phenomenon causes negative environmental, social and economic effects in the various productive sectors[1]. Therefore, maintaining optimal development of the primary sector in rainfed systems poses a challenge for Latin American countries in the face of the negative effects of climate change[2].

Beekeeping is an important activity and an option for the growth of the primary sector in developing countries[3]. Worldwide, Mexico ranks sixth in honey production and, on average, third as an exporter of this product, generating foreign exchange for $93,725 million dollars[4].

Beekeeping depends on a range of stable climatic conditions for its optimal development[5]. The impacts of climate change on beekeeping occur as a relational phenomenon within a local context[6]. Therefore, both a potential direct impact on this activity (considering the intra- and interspecific response of the flora and the honey bees), through the space-time mobility of melliferous blooms[7], and an indirect impact on the socio-economic factors of beekeepers are to be expected[8].

Beekeepers have empirical and technical knowledge regarding the bees and their environment, as well as local climate variability[9], which defines their perception of climate change and the generation of ideas that can influence the acceptance of adaptation strategies and their behavior[10].

Leon Festinger's Cognitive Dissonance Theory (CDT) helps explain the individual and societal incongruity that climate change generates in people, as well as the justification for such an attitude or behavior. According to this theory, the ideal state is the cognitive congruence or harmony and, therefore, the internal incongruence of the system of ideas or cognitions that are generated in an individual arises in the face of simultaneous contradiction between two of them or of a behavior contrary to their beliefs[11].

When dissonance occurs, the stress generated thereby makes the individuals uncomfortable and, therefore, these try, unconsciously, to reduce their own discomfort or stress in various ways, e.g., a) through thoughts that justify their behavior, whereby the individual accepts that the action taken is the right one; b) through modification of behavior, and c) by living with the internal conflict, although this generates other states in the mental health of the individual[12,13].

Research in this area has shown that there is cognitive dissonance between the perception of climate change (according to the belief system of the individual) and its influence on the adoption of adaptation strategies in the agricultural sector[14,15].

Hence, there is a need for beekeepers to distinguish their perception of climate change from the cognitive dissonance generated in them between their perception, their attitude and their behavior in relation to the adaptation strategies in the face of climate change, as well as to determine the manner in which this incongruence of cognitions can be reduced, so that they may understand those ideas that limit the adoption of adaptation strategies and propose these actions themselves[16].

Material and methods

The state of Veracruz is the fifth largest producer of honey and the first producer of beeswax in Mexico. Within the state, the central beekeeping region (97° 27' 0" N, 95° 26' 41.9" N, 18°31' W), of which has approximately 244.86 km^2 are forests, 1.37 km^2 is jungle, 101.88 km^2 (1.72 %) is shrubbery, and 2,698.68 km^2 are agro-ecosystems, and which contributes over 35% of the state’s production of honey and beeswax, was selected[17].

Sample and procedure

In order to obtain the information, a survey was designed and applied to 88 beekeepers, so as to explore the cognitive relationship, based on Festinger's CDT[18], between perception, attitude and behavior in the face of climate change, as well as the adaptation strategies that are practiced or that can be implemented.

Because there was no official beekeeping census in the central region, the list of beekeepers who were issued a *Varroa destructor* infestation certificate (which was not considered as an indicator or selection parameter) by the national governing body in the state delegation of the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) during the 2012-2013 period, was considered as the sample population, being the only information available to obtain a list of beekeepers.

The sample size was estimated by means of William Scheaffer's formula[19], $n= N\sigma 2 /[(N-1)D+\sigma 2]$, considering as the sample population the list of beekeepers described above. The values utilized were: n= 247, standard deviation of the number of beehives (σ)= 200.6 and B= 34.4. With the information collected, an exploratory analysis was carried out with the Statistica© 7 software, using univariate methods, for the cognition forms perception, attitude and behavior. Finally, these three cognition forms were associated through a bivariate analysis in order to explore the presence of dissonance among them.

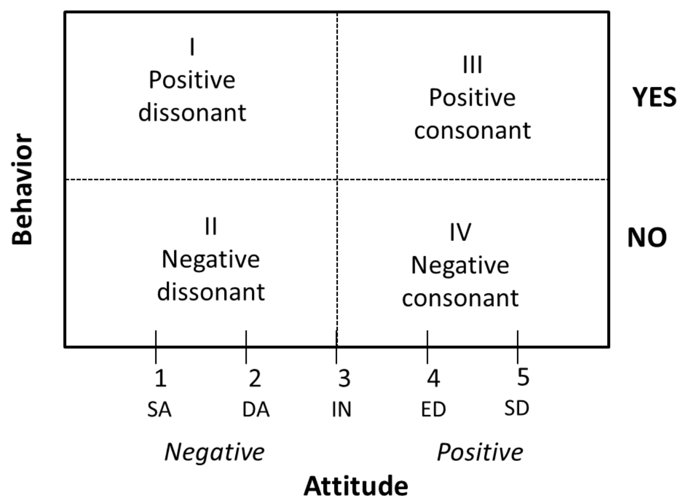
Questionnaire

A questionnaire with 10 open questions for the perception and behavior cognitions, categorized according to the answers of the beekeepers, was designed and applied; a content analysis was carried out[20] to identify emerging analytical categories.

The attitude questions considered the willingness of beekeepers to adopt nine climate change adaptation strategies; for this purpose, each item was arranged in a Lickert scale, in which the categories and their values were: (5) Strongly Agree (SA), (4) Agree (AG), (3) Neutral (IN), (2) Disagree (DG), (1) Strongly Disagree (SD) Considering the response value (3) as a low positive attitude, and the response (5), as a very high positive attitude. The Lickert formula was defined as: LI=TS/TNOS, where LI (Lickert index); TS (total score), and TNOS (total number of statements).

The cognitive dissonant elements were explored by analyzing bivariate histograms delimited by a matrix for interpreting the inconsistent state[21]. Four quadrants were used, each of which represents a potential cognitive status of the beekeepers, in a positive or negative way as follows (Figure 1): Quadrant I, positive dissonant: (1) and (2) has a negative attitude towards adaptation strategies but carries them out. Quadrant II, positive consonant: (1), (2) and (3), has a positive attitude towards adaptive strategies and carries them out. Quadrant III, negative consonant: (1) and (2) has a negative attitude towards adaptive strategies and does not carry them out. And Quadrant IV, negative consonant: (1), (2) and (3) has a positive attitude towards adaptive strategies but does not carry them out.

Figure 1: Attitude versus behavior cognitive status decision matrix

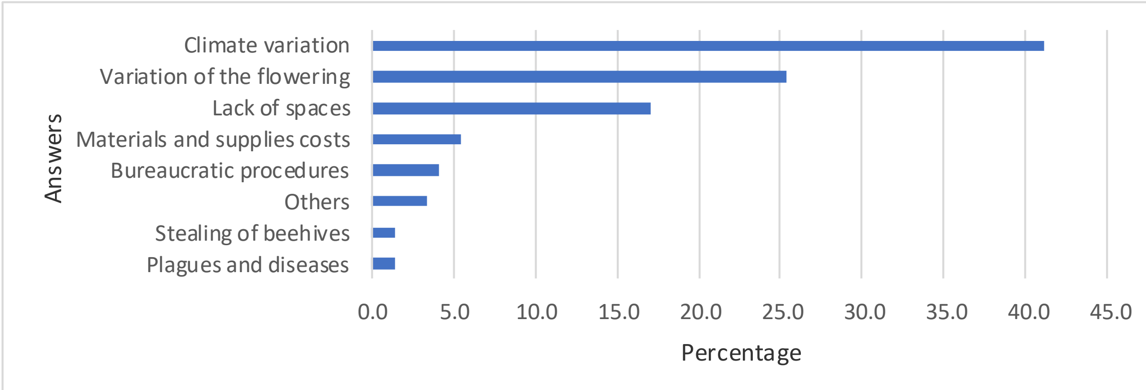


Results

Beekeepers' perception of climate change

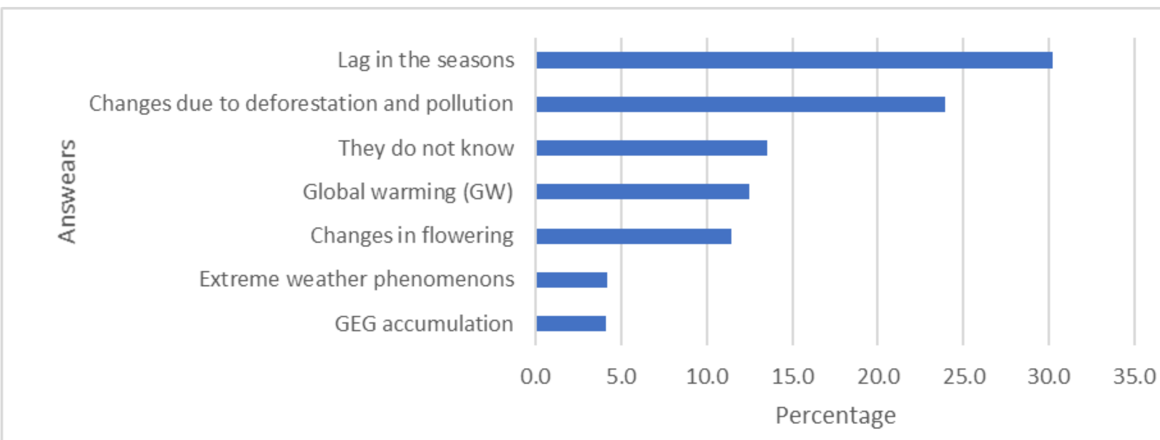
In order to determine whether climate change was a problem and how important it might be in relation to other situations, the first question was: What do you think is the main problem that beekeeping faces today? 66.4 % of the answers were "climate variation", followed by "the variation in the flowering seasons". The next most frequent answer was the lack of space or the increase in the number of apiaries per area (17.1 %) (Figure 2).

Figure 2: Perception of the main problem for beekeeping in the central region



In question number two, what do you understand by climate change? 30.2 % answered that it is "a problem of seasonality"; another 24 % defined it as "changes in natural cycles due to deforestation"; 13.5 % answered "I don't know", and 12.5 % mentioned "global warming" (GW) (Figure 3).

Figure 3: Beekeepers' perception of the concept of climate change

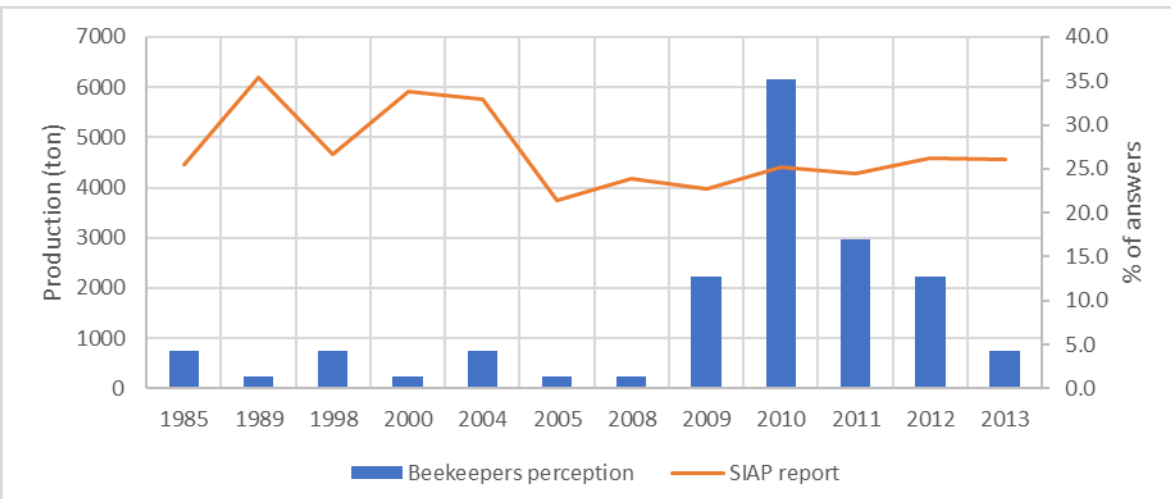


When asked through which media they had learned about climate change, most beekeepers answered, through the television (39 %) as the most important information medium, followed by the newspapers (20 %).

The next question was: Do you remember any extreme weather events that have affected beekeeping? 70 % answered "Yes". Of those 58 % mentioned as the main event "the shortage of blooms", because of a climatic event that beekeepers called "an unexpected frost", in two different areas; one was the area of the high plains (51 %) corresponding to the state of Veracruz, and the other, the area of the high plains corresponding to the state of Puebla (59 %).

Given that the producers of the region had an average experience of 20 yr in the activity[8], they were asked: "Do you remember a particular year in which the production of honey has been low or bad?" 35.2 % of the beekeepers perceived 2010 to have been such a year, due to the presence of a hurricane. Although when reviewing the state's production volume records, 2005 was found to be the year with the lowest production[17], while only 1.4 % of beekeepers remembered that year as, "a bad year in bee production" (Figure 4). In 2010, Mexico was hit by hurricane Karl, which affected this beekeeping region through the loss of beehives[22], and thereby the relationship between the meteorological phenomenon and honey production was confirmed, although this does not coincide with the official records of production in that year[17]. Nevertheless, for beekeepers, the economic impact marked that year as a bad year for production.

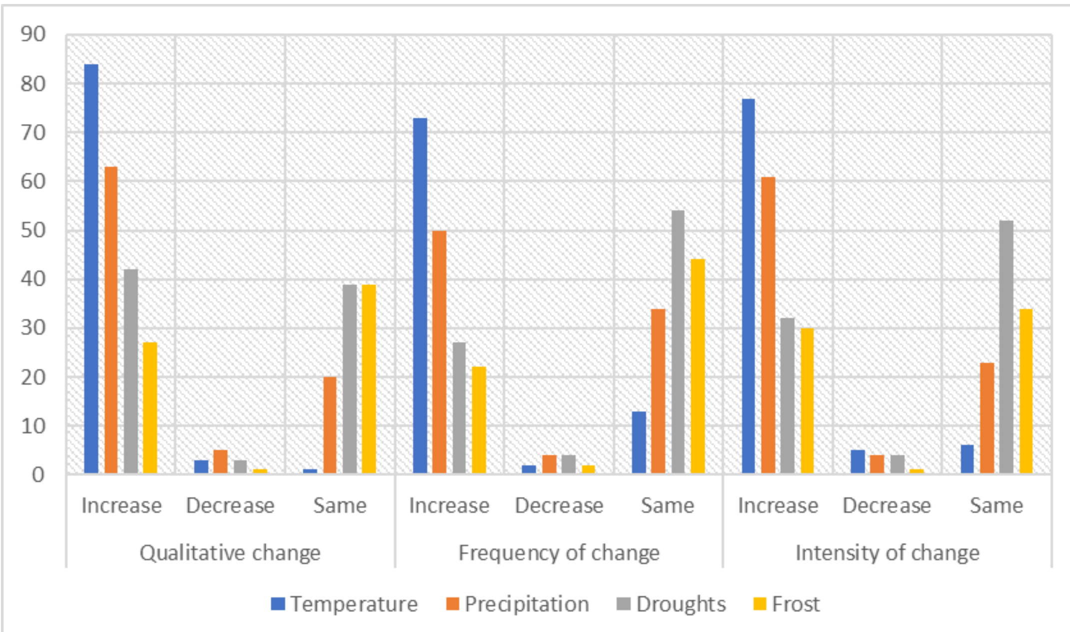
Figure 4: Perception of the years with presence of extreme weather events that damaged beekeeping in the central region, *versus* the total production reported in the state



Based on the perception of the climatic conditions in the last two decades, 97.7 % of the beekeepers perceive that the climate in the region has changed. Hence, the following question: How have the climatic factors temperature, rainfall, drought, and frost changed in the last twelve years? In order to answer this question, three categories of change were established: a) qualitative: whether the beekeeper perceived an increase, decrease or constancy in the climatic factors; b) frequency: whether an increase, decrease or constancy in the pattern of the event was perceived; and, finally, c) intensity: whether the events had decreased or increased the force of impact.

Reportedly, 95.5 % of the producers perceived a qualitative increase in temperature; 71.6 %, in precipitation, and 47.7 %, in drought, but no change in frost. Regarding changes in frequency, 83 % of the individuals perceived an increase in temperature; 56.8 %, in precipitation, and 30.7 %, in droughts, while no changes were perceived in frosts. In terms of intensity, 87.5 % of the individuals perceived that changes in temperature are more severe; 69.3 %, that precipitation is more intense, while 59.1 % perceived that drought conditions remain the same, and 38.6%, that frosts have remained constant (Figure 5).

Figure 5: Changes in four climatic factors involved in the beekeeping activity.



In regard to question eight — “In the last years have you noticed changes in the beekeeping interest blooms?—, 100 % perceived changes in the blooming and changes that affected the volumes of honey production. Based on this fact, they were asked if they knew of any adaptation measures in beekeeping to reduce the impact of climate change, and which ones they knew of. 71.6 % were aware of certain adaptation strategies: reforestation with melliferous species (35 %), artificial feeding (32 %), queen replacement (11.1 %), better apiary management (11.1 %), and transhumance (10 %).

Beekeepers' attitude to climate change

Table 1 shows the frequency of response in the nine statements, where the activity of "Reforesting" stands out, with 92 % of the interviewees having said to "SA" with the "Replacement of certified queens", while fifty-one percent "SA", although the lack of productive viability of the acquired biological material, the costs, and the lack of trust in the distributors have a negative influence on this activity. For example, in the state of Yucatan, queen breeders cover less than 1% of the demand. The remaining percentage is covered (when extremely necessary) with queen bees from different states that may be carriers of diseases or genotypes that will not prove highly productive in the region[23].

Table 1: Percentage of responses in attitude variables

Variable	Attitude				
	1	2	3	4	5
Reforesting				8.0	92.0
Replacement wih own queens	1.1	2.3		23.9	72.7
Replacement with certified queens	1.1	3.4	4.5	39.8	51.1
Changes in management tasks	8.0	10.2	8.0	23.9	50.0
Technical assistance		1.1		17.0	79.5
Adoption of GBP			1.1	26.1	72.7
More working hours			1.1	19.3	79.5
Bloom logs	1.1	2.3	3.4	17.0	76.1
Driving and work logs			4.5	15.9	79.5

The statement "Changes in apiary management" had a cumulative percentage of 50% in "SA" and while the other half showed a "IN" (neutral) or negative attitude. Despite the fact that 72.7 % said they were willing to adopt the provisions of the Good Beekeeping Practices "GBP". In the case of beekeepers, the "adoption" of such practices is perceived merely as a requirement to access support programs and not as a method to produce honey under technical recommendations, which should help beekeepers to carry out management records for the planning of the next cycle, similarly to the actions carried out by beekeepers in other countries such as Nigeria[4].

Two attitudinal questions including perception and behavior were established. The first is: “Are you willing to implement any of the above strategies that you are not currently carrying out within your beekeeping activities, and what activity would that be?” The most frequent response was "reforestation", with 59 %, followed by a percentage of the population that answered "none" (29 %); others answered, "artificial feeding" (7 %) and "change management" (3 %), and only 1 % mentioned "receiving technical assistance or training".

The last question in the section was: “What actions do you think federal and state institutions should be taking to help beekeepers adapt to climate change?” 46.6 % said that "economic resources should be allocated directly" to them, allowing them to decide on how to spend these; 13.6 % stated that "melliferous species reforestation programs should be implemented", and 10.2 % said that institutions should "facilitate and speed up beekeeping procedures" for transhumant beekeepers. The remaining percentage considered actions such as: "prohibition of pesticides" (7.9 %), "conservation of natural areas" (7.9 %), "beekeeping training" (5.7 %), "supervision of apiaries" (3.4 %), "dissemination of the importance of pollinators" (2.3 %) and "promote national consumption of honey" (2.2 %).

Behavior of beekeepers in the face of climate change

In this section, the question was asked: “Have you implemented any strategies to adapt to current climate conditions and maintain production?” 80.7% said that at least some of the strategies have been implemented as an adaptation measure. However, the remaining 20.3% carry out some of these activities, but do not identify them as adaptation strategies. For example, artificial feeding (42.3 %), reforestation of melliferous species (26.8 %), replacement of queens (12.7 %), management changes in the apiary (9.9 %), transhumance (7.0 %), and genetic improvement (1.4 %).

To conclude the section, was asked: “What is the main limitation or obstacle for not carrying out any of the previous strategies?” Only 89.7 % answered: 56.9 % said "lack of economic capital"; 15.4 %, "indifference"; 5.0 %, "lack of own physical spaces" (for reforestation); 7.6 %, "lack of support from the government"; 5.0 %, "lack of time", and 2.5 %, "institutional bureaucracy" in procedures for the mobility of beehives.

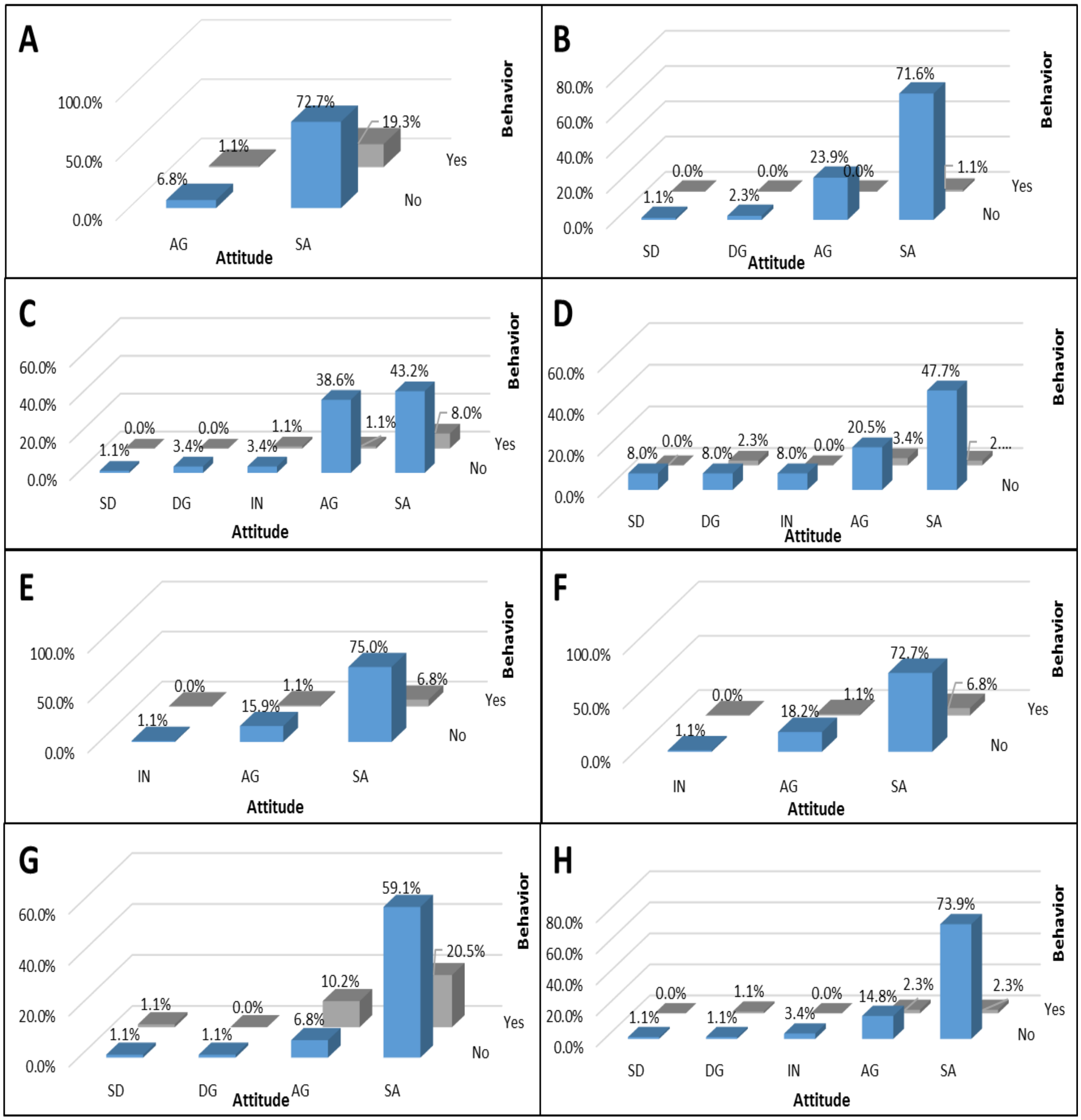
Cognitive dissonance in the face of climate change

Beekeepers were observed to perceive climate change as a problem for their activity, through a system of ideas associated with beekeeping, i.e., a lag or change in the seasons (rain, dry and frost) and in blooming within an annual cycle.

This shows that the perception is built based on the effects that occur in beekeeping and ignores the origins and causes of the phenomenon at the global level. Therefore, the attitude and behavior regarding implementing adaptation strategies will depend on the perception of the negative impacts of the phenomenon on beekeeping, as shown by the decision matrix in Figure 1, and are as follows:

Reforesting. - It exhibited negative dissonance, since 72.73 % of the beekeepers expressed that they "SA" to carry out this practice. They regard the reforestation of melliferous species as relevant; however, only 19.33 % perform this action (Figure 6A); the dissonant beekeepers justify themselves by reinforcing the idea that they lack spaces of their own to implement it.

Figure 6: Cognitive dissonance in beekeepers regarding attitude and behavior in adaptation strategies



A) Reforestation, B) Replacement with own queen broods, C) Replacement with certified queen broods, D) Management, E) Good production and manufacturing practices, F) Increased number of visits to the apiary, G) Technical assistance for artificial feeding, H) Registration of blooms for transhumance.

Strongly Agree (SA), Agree (AG), Neutral (IN), Disagree (DG), Strongly Disagree (SD)

Queen replacement. – It exhibited a negative dissonance, 71.59 % of the beekeepers “totally agree", and 23.86 % disagree, but only 1.14 % carry out this practice. However, in this same strategy, negative consonant beekeepers were observed, 2.27 % of whom claimed to “disagree", and 1.14 %, to “totally disagree” (Figure 6B). As for replacement with their own queens, this activity exhibited a similar state of dissonance between the "disagree" (43.18 %) and “agree” (7.95 %) attitude versus behavior, since only 9.09 % carry out this action, while 4.55 % maintained the negative consonant status (Figure 6C).

Management activities. – Here, most of the beekeepers who “totally disagreed" (47.73 %), "agreed" (20.45 %), and were "neutral" (7.95 %) were in a negative dissonant state, and only 5.68 % had made any changes in the management of their apiaries. A lower percentage were negative consonant in the "disagree" (7.95 %) and "totally disagree" attitudes (7.95 %) (Figure 6D).

GBPs. - There was a negative dissonance between the percentage of beekeepers who said that they “totally agree" (75 %), "agree" (15.91 %) and are "neutral" (1.14 %), *versus* 7.96 % who said they had taken action to implement GBPs (Figure 6E).

Artificial feeding and technical assistance - Artificial feeding of bees as an element linked to technical training was contrasted with the willingness of beekeepers to attend training courses, so that the negative cognitive dissonant state occurred in 65.91 % of beekeepers who "agree" and "totally agree" versus behavior, as only 30.68 % said that they were carrying out this practice, while negative consonance occurred in 2.28 % of the beekeepers (Figure 6G).

Bloom log, work log, and transhumance - Although transhumance is the main type of beekeeping practiced, it is not conceived as an adaptation strategy *per se*; however, when contrasting this activity with the willingness to keep bloom logs, 92.05 % of the beekeepers were observed to be willing to make such records and identify the need and importance of it, but only 4.55 % do so (Figure 6H), displaying negative dissonance between these two ideas.

Table 2 shows that most beekeepers are in a state of negative cognitive dissonance, which, according to the CDT, is a common cognitive status, as few things are clear enough to allow opinions and behaviors to be anything other than a mixture of contradictions[12].

Table 2: Cognitive status between attitude and behavior of adaptation strategies in beekeeping

Strategy	Dissonant (+)	Consonant (-)	Consonant (+)	Dissonant (-)	Total (%)
Reforesting	1.1	6.8	19.3	72.8	100
Replacement with own queens	0	3.3	1.1	95.6	100
Replacement with certified queens	0	4.5	10.3	85.2	100
Changes in management tasks	2.3	16	5.7	76.0	100
Technical assistance	1	2.2	30.8	66.0	100
Adoption of GBPs	0	1.1	8.0	90.9	100
More working days	0	0	7.9	92.1	100
Bloom log	1.1	2.2	4.6	92.1	100

Discussion

The analysis of the beekeepers' cognitive system on climate change according Festinger's CDT showed that most beekeepers have a negative cognitive dissonance. Beekeepers perceive the effects of climate change on beekeeping; however, they do not have a precise definition of the concept and causes of this phenomenon —a fact that evidences information gaps, as well as erratic ideas[24].

This confusion of the concept is attributed to the information received from the media[25]. For example, the scientific community talks about climate change, the news of global warming and the emission of greenhouse gases (GHG) by oil industry. This produces a heterogeneous idea in the public, while the correct subjective assessment of the phenomenon by the population should motivate changes in behavior under personal responsibility. Given which, understanding the human influence on climate change is a prerequisite for accepting the need to carry out adaptation and mitigation actions[26,27].

In this research, the perception of climate change in beekeeping was motivated by the productive needs of beekeepers and the negative impacts generated in beekeeping(6,28) — similarly to beekeepers and honey hunters in Africa, who perceive the negative effects of climate change, through the increase or decrease in temperature and rainfall patterns, depending on the season and the type of beekeeping they carry out(29), as well as to maize producers in the northern United States, who recognize that some form of climate change exists, but minimize the participation of human activities in it(15).

When contrasting attitude and behavior, the majority exhibited a state of negative dissonance despite the positive disposition of the beekeepers (IL: 4.7). The simultaneous incompatibility between these two cognitions generated arguments aimed at reducing the dissonant state(13). People do not incorporate the effects or the origins of climate change(12), and they consciously delegate the responsibility and solution to other citizens or groups, including authorities, specialists or government institutions(30).

The above shows that climate change is perceived and recognized in a certain way(26), but only when the problem has an economic impact is it common sense to incorporate it into the system of cognitions as a priority(25).

Therefore, the presence of dissonance is generated when the beekeepers are not capable of carrying out the actions that they say they would be willing to perform in order to maintain their livelihood, relativizing the problem as a way of reducing the stress generated by the incongruence in the cognitive system(13). This may cause potential negative effects on beekeeping, such as low profitability, poverty, and abandonment of the activity(7), since the beekeepers assume that "nothing can be done against the climate".

Therefore, it is necessary to integrate a training program aimed at informing and explaining the nature of climate change and its impacts; to situate the beekeepers within this context, where they can adopt elements that may allow them a clear perception that will promote a positive attitude and motivate their actions. In this sense, it is necessary to design not only formal training programs but also informative and dissemination programs that may reach the population through mass media.

Conclusions and implications

The study shows that beekeepers perceive the phenomenon of climate change as the main problem for their activity but do not relate the causes and effects of the phenomenon to other aspects of their daily life. Despite having a positive attitude towards adaptation strategies, they generally fail to implement them. Thus, the cognitive dissonance present between attitude and behavior is reduced through rational arguments that allow them to justify the incongruence between what they want to do and what they do. Finally, it is recommended to include the needs and belief systems of the beekeepers that can influence the adoption of adaptation strategies. This requires involving other social, economic, and technological variables that may influence the present state of cognitive dissonance.

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