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Study of factors limiting the development of beekeeping in the conservation of natural resources

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Abstract

Introduction: The development of beekeeping depends on many factors. This study is conducted in the rural communes of Marosakoa and Andranofasika, around the protected area of Ankarafantsika. It is one of the rural communes with a beekeeping vocation and honey producers in the Boeny Region, even if it is dominated by traditional beekeeping.

Objectives: The overall objective is to describe and analyze the constraints of beekeeping in the conservation of natural resources.

Methods: Survey with direct interview by questionnaires formulated at the level of 54 beekeepers using traditional hives and modern hives equipped by the PAGE / GIZ program, documentation and follow-up at the level of apiaries for 6 months in the rural municipalities of Marosakoa and Andranofasika, around the protected area of Ankarafantsika were carried out to determine the constraints of beekeeping. The data collected was processed and analyzed with XLSTAT software.

Results: Environmental, economic and social constraints, desertion and varroa mites were observed in apiaries and hampered beekeeping production. The use of APIGENER product can contribute to the fight against the Varroa destructor parasite in bee colonies to the development of the beekeeping sector.

Conclusion: All these constraints reduce the quantity of beekeeping production and the prices of honey and wax. They have impacts on the conservation of natural resources.

Keywords: Beekeeping; Ankarafantsika; Constraints; Development; Natural resources

1. Introduction

Human societies have always known about honey and other products that come from bees [24]. Bees contribute to the livelihoods of people in almost every country in the world. Bees are divided into two main categories: social species on the one hand and solitary species on the other. Social bees live in groups within colonies; the best known is the honey bee Apis mellifera also called honey bee [15]. In Madagascar, the bee Apis mellifera unicolor is endemic and well adapted

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there. She is described as very active and gentle [6]. Most melliferous plants are pollinated by bees. The pollination service they provide is a common good between beekeepers, farmers and society as a whole [7].

In a beekeeping activity, several constraints are noted, particularly at the level of production where the dominance of traditional beekeeping which limits yields and allows only one harvest per year. More generally, beekeepers who practice the activity in a traditional way do not master all the beekeeping techniques that improve the productivity of their operation. Beekeepers all over the world face increasing constraints and the major challenge for beekeepers in developing countries is how to solve the obstacles with scarce resources. These barriers can be grouped into the following categories: biological, technical, environmental, commercial and institutional [4].

The general objective of the study is to identify the factors influencing the development of the beekeeping sector in the conservation of natural resources. Among the different beekeeping areas of Madagascar, our study is limited around the protected area of Ankarafantsika in the rural communes Marosakoa and Andranofasika of the Boeny Region where beekeeping has been a source of income for farmers for a long time. It has been exercised and transmitted from generation to generation.

2. Material and methods

Beekeeping can be practiced wherever bees can forage. But to be able to practice it, beekeeping equipment plays an important role in a beekeeping operation.

2.1. Study site

The study was conducted around the protected area of Ankarafantsika. It is 150 km south east of Mahajanga and 450 km from Antananarivo. It constitutes a vast territory covering an area of 130,026 Ha and is crossed over 17 km by the national road N°4. It is part of the administrative district of Mahajanga, Boeny Region, between the District of Marovoay and Ambato-Boeny. It is bounded to the east by the Mahajamba River and to the west by the Betsiboka River and located at 16°20' South latitude and 46°92' East longitude. The study site is located in the rural commune of Marosakoa in the District of Marovoay and the rural commune of Andranofasika in the District of Ambato Boeni, rural communes of intervention of the Environmental Management Support Program (PAGE / GIZ of the German Cooperation) around the protected area of Ankarafantsika. PAGE/GIZ is committed to a process of promoting honey from the Boeny Region, through the promotion of a profitable value chain for all the actors concerned. The aim is to improve the income of communities living in and around protected areas, so that they are more involved in the protection of the natural and forest resources of their surroundings. This area was chosen because it all has beekeeping potential.

2.2. Biological material

Biological material is made up of bees and the plants they visit. The success of the beekeeping activity is achieved by a better knowledge of the bees and the honey plants of the environment of the apiaries. The bees in the study area are social bees that live in groups within colonies. It is characterized by a uniform dark color and has little hairiness all over the body. It is the race Apis mellifera unicolor, endemic bee of Madagascar. A colony is made up of a queen, workers and drones. Melliferous plants are made up of forest plants, fruit trees, cultivated plants and herbaceous plants.

2.3. Survey sheet

The survey sheet makes it possible to collect information from experienced and novice beekeepers in the rural communes of Marosakoa and Andranofasika and to analyze it within the framework of a statistical study with the parameters. It makes it possible to identify the beekeeper with their activities and the various constraints encountered by beekeepers. In the survey sheet, the survey questionnaires consist of a set of specific questions, which are formulated in advance and posed directly to the beekeepers.

2.4. Methods

The methods define the stages of data acquisition, the steps to follow and formulate the processes to achieve the results. We carried out documentary research with the library of the University of Mahajanga and the library of the University of Antananarivo and with officials in the rural communes Marosakoa and Andranofasika around the protected area of Ankarafantsika. To achieve our objectives, we conducted surveys with 54 experienced beekeepers. The main methods that we have applied in the field are surveys with direct interviews by questionnaires formulated at the level of beekeepers. The choice of beekeepers surveyed was made according to their beekeeping techniques, their experience in the field of beekeeping and their ability to answer the questions asked and to provide relevant information on the problems encountered for the development of beekeeping. The hive inspection makes it possible to identify the bee in

the study area and to verify the beekeeping techniques of the beekeepers. Tests using APIGENER products have been carried out to determine the existence of varroa mites.

2.5. Data processing and analysis

The data has been processed and analyzed to provide a synthetic and complete overview of our entire study. It is at this stage that we used the statistical methods with the XLSTAT software.

3. Results

3.1. Prioritization of beekeeping constraint factors

The hierarchical analysis of the factors makes it possible to prioritize the constraining factors of beekeeping around the protected area of Ankarafantsika. The analysis showed four main constraining factors influencing the development of beekeeping (Figure 1).

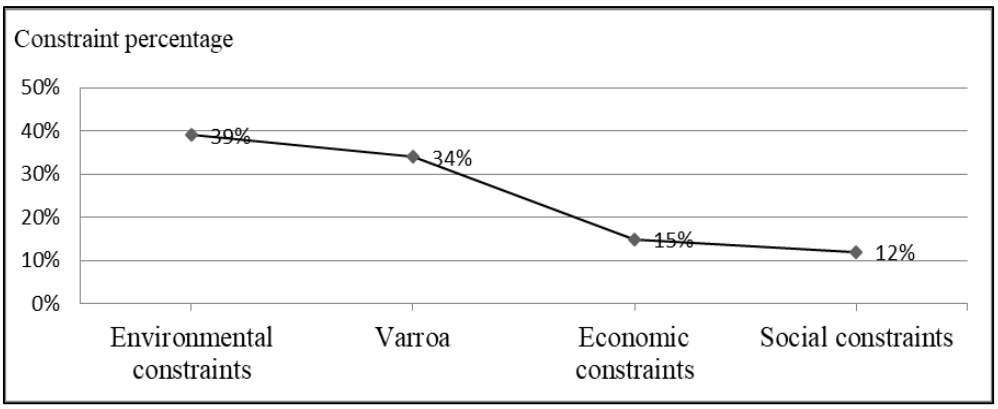

Figure 1 Prioritization of beekeeping constraints

The environmental stress factor has more influence on the development of beekeeping (39%) than the other three types of stress factors. The stress factor related to varroa mites comes in second place (34%). The factor of economic constraints and the factor of social constraints respectively occupy 15% and 12%.

3.2. Pearson correlation

Variables. The Pearson correlation matrix makes it possible to measure the intensity of the link between environmental constraints, economic constraints, social constraints and varroa (Table 1).

Table 1 Pearson correlation matrix

Variables	Environmental constraints	Economic constraints	Social constraints	Varroa
Environmental constraints	1	-0.527	-0.682	-0.097
Economic constraints	-0.527	1	0.453	-0.682
Social constraints	-0.682	0.453	1	-0.387
Varroa	-0.097	-0.682	-0.387	1

Values in bold are different from 0 at significance level alpha=0.05

The correlation coefficients vary between -1 and 1. A positive value indicates a positive correlation. A negative value reflects a negative correlation. A value close to zero reflects the absence of a linear correlation. The variables economic constraints and social constraints are characterized by a positive and weak correlation. The environmental constraints and economic constraints variables, the environmental constraints and social constraints variables, the economic constraints and varroa variables, the social constraints and varroa variables are weakly correlated in the negative direction. On the other hand, the variables environmental constraints and varroa mites are not correlated.

The Pearson correlation circle shows the correlation of variables on the F1 x F2 system of axes. The correlation of each point on an axis expresses the quality of representation of the point on the axis. It takes values between 0 and 1. If the value is close to 0, the point is not correlated and if the value is close to 1, the point is well represented on the axis (Figure 2).

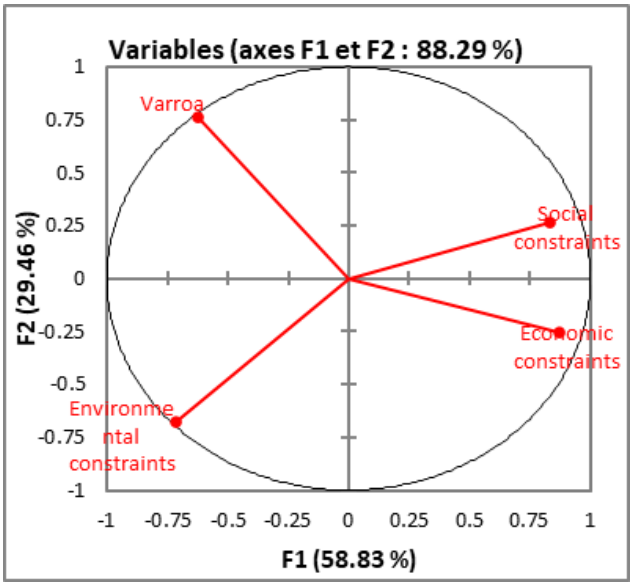

Figure 2 Relationship between constrained variables in beekeeping

The social constraint variable and the economic constraint variable are positively correlated to the F1 axis, while the environmental constraint variable and varroa are negatively correlated to the F1 axis. Regarding the F2 axis, the varroa variable is positively correlated and the environmental constraint variable is negatively correlated.

3.3. Environmental constraints

The production of honey, its quality, and the good health of the bees depend on the quality of the environment where the apiaries are located. The fewer the environmental constraints, the more honey production there will be.

3.3.1 Toxicological exposure

The use of chemicals on agriculture causes harmful effects on beekeeping. Therefore, the colonies gradually decrease until they disappear. Apiaries that have been located within a radius of less than 3 km from a crop field containing chemicals are considered to be exposed to toxicological risks (Figure 3).

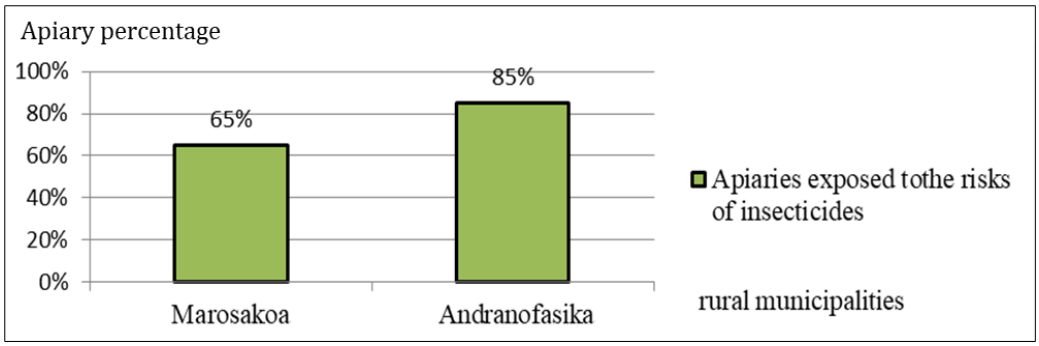

Figure 3 Exposure of apiaries to the risks of chemical products

In the Marosakoa and Andranofasika rural municipalities, 65% and 85% of apiaries are respectively exposed to the risks of chemical products.

The trade names of the insecticides used in the crops by the farmers surrounding the apiaries are categorized into five products: AKITO, BASUDINE 10 G, DECIS 50 EC, KARATE 5 EC and K-OTHRINE PP2 **(Figure 4).**

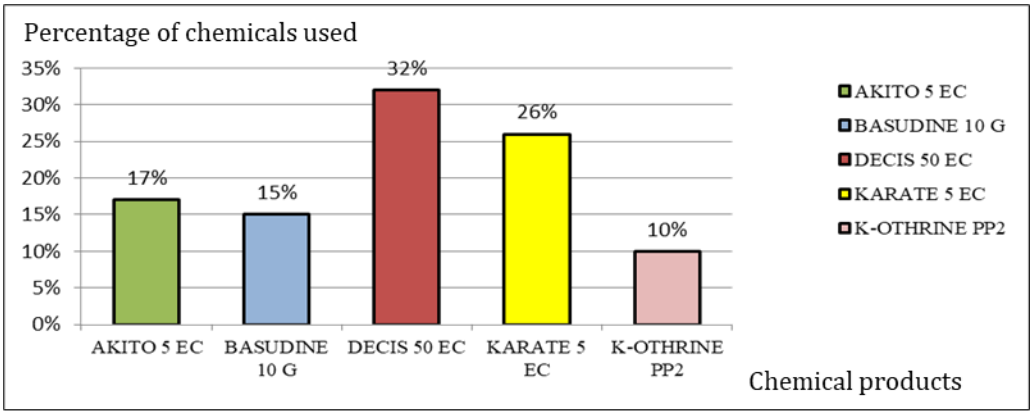

Figure 4 Chemicals used

In the rural municipalities of Marosakoa and Andranofasika, the DECIS 50 EC chemical product is the chemical product most used by farmers on their crops. It represents 32% of the chemicals used. The chemicals KARATE 5 EC, AKITO 5 EC, BASUDINE 10 G, and K-OTHRINE PP2 represent respectively 26%, 17%, 15% and 10% of the chemicals used by farmers to control insect pests and diseases for their cultures.

Chemicals have characteristic properties. The labeling provides information to the user: hazards and risks associated with the product and precautions for use (Table 2).

Table 2 Properties of chemicals

Trade name	Dosage	Culture	Pest scientific name
Akito 5 EC	0.25 l / Ha	Rice	- *Helicoverpa armigera ;* - *Cosmophila sp.*
Basudine 10 G	15 Kg / Ha	Corn (Soil)	- *Agrotis sp.*
Decis 50 EC	0.25 l / Ha	Fruit trees	- *Helicoverpa armigera ;* - *Earias sp.*
Karaté 5 EC	0.4 Kg / Ha	Cabbage	- *Plutella sp.*
K-othrine PP2	500 G / T	Legumes	- *Sitophilus sp.* - *Zabrotès sp.* - *Araecerus sp.*

3.3.2 Forest degradation

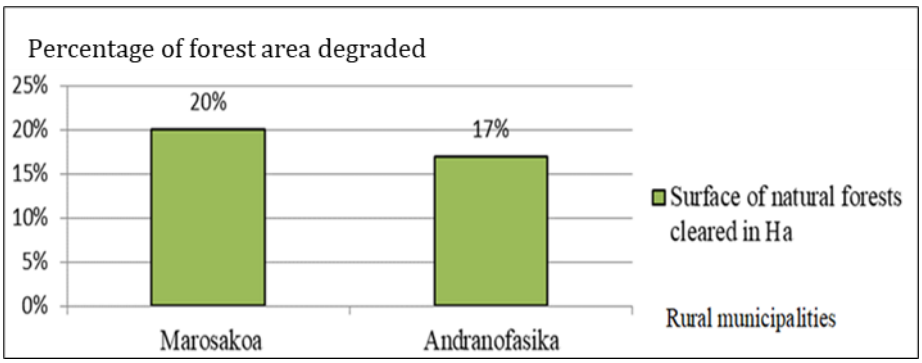

Figure 5 Rate of degradation of natural forests from 2009 to 2019

The forest degradation has high consequences on the beekeeping activity causing a decrease of the melliferous resources. The main reasons for deforestation in the rural Communes of Marosakoa and Andranofasika remain the lack

of awareness of the population on the importance of the forest in the cycle of life in general and water in particular. This favors the clearing of land for slash-and-burn cultivation and the illicit exploitation of the forest. For 10 years, the area of degraded forest has not stopped increasing (Figure 5).

The area of natural forests cleared between 2009 and 2019 in the rural commune of Marosakoa reaches 20% of the total area of natural forests. And for the rural Commune Andranofasika, the area of cleared natural forests is 17% of the total coverage of natural forests. This rate of degradation is alarming.

3.3.3 Climate change

The impacts of climate change observed by the beekeepers in the rural Communes Marosakoa and Andranofasika are categorized in eight levels of perception (Figure 6).

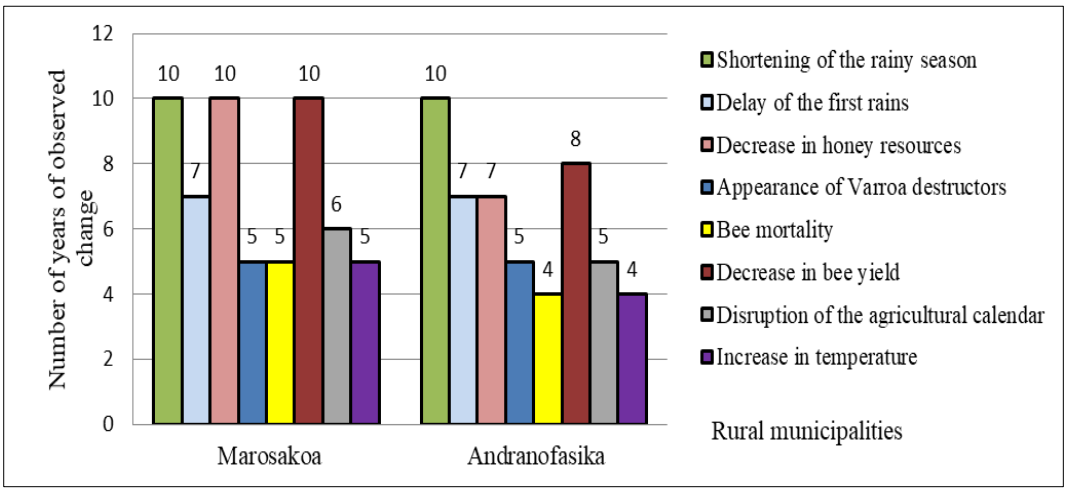

Figure 6 Beekeepers' perception and dating of climate change

The global changes felt by beekeepers for the last 1 to 10 years are reflected in the general shortening of the rainy season (2 to 3 months instead of 3 to 4 months), the delay of the first rains, the decrease of melliferous resources, the appearance of *Varroas destructors*, the mortality of bees, the decrease of beekeeping production (The production of honey per harvest and per modern hive went down from 15 Kg in 2012 to 10 Kg in 2022), the disruption of the agricultural calendar, and the increase of the temperature.

3.4. Economic and social constraints

The constraints of an economic and social nature are not to be neglected. The improvement of the beekeeping practice depends on it as well as the improvement of marketing.

3.4.1 Beekeeping practices

The production of honey is assured by the workers and comes from the nectar or honeydew having undergone an important drying and a transformation of the contained sugars. The quantities of honey produced by a traditional hive and a modern hive in the rural municipalities Marosakoa and Andranofasika are very varied, and depend on the importance and the diversity of the melliferous plants, the seasons of production and the conduct of the beekeeping. The type of hive and the harvest period influence honey production (Figure 7).

In very good conditions, the quantity of honey obtained in a modern hive varies from 10 kg to 15 kg per harvest (7.1 liters to 10.7 liters), that is to say 20 kg to 40 kg (14.2 liters to 28.5 liters) of honey per hive and per year for 2 or 3 annual harvests. For a traditional hive, there is only one harvest per year with a yield of 2 kg to 5 kg of honey per hive, that is to say 1.4 liter to 3.5 liters. The Boeny Region produces up to 25 tons of honey per year of which 4 tons for the rural commune Marosakoa and 4 tons for the rural commune Andranofasika.

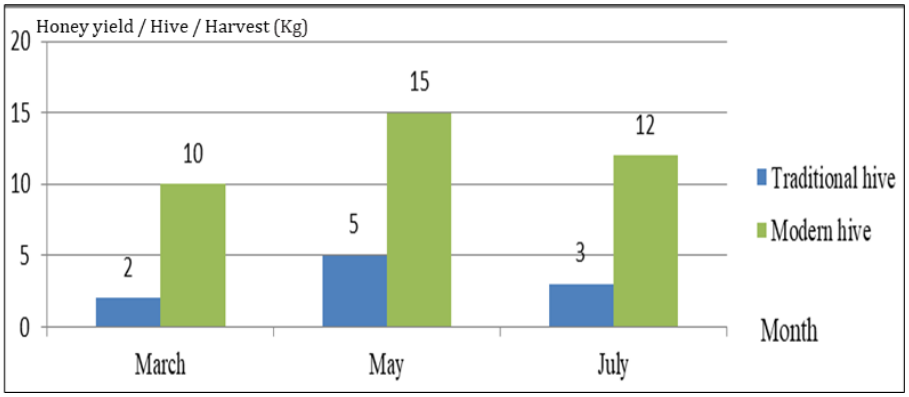

Figure 7 Average honey yield

3.4.2 Rural insecurity

The insecurity in rural areas in the rural municipalities of Marosakoa and Andranofasika favors the recrudescence of the theft of modern hives installed far from the houses (Figure 8).

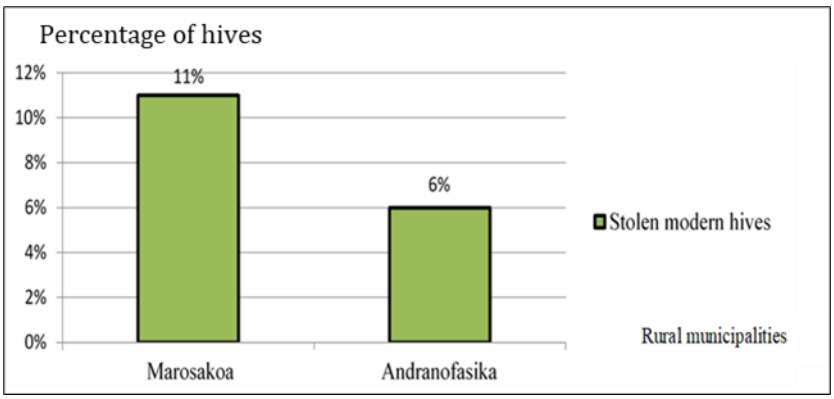

Figure 8 Stolen of modern hives

The 11% of modern hives in the rural commune of Marosakoa and the 6% of modern hives in the rural commune of Andranofasika have been stolen. The insecurity in the countryside, with the frequent theft of modern hives, does not contribute to encourage investments either. This phenomenon makes beekeepers more reluctant to acquire modern hives. Thefts can be directed at the whole hive. These acts discourage beekeepers.

3.4.3 Commercialization

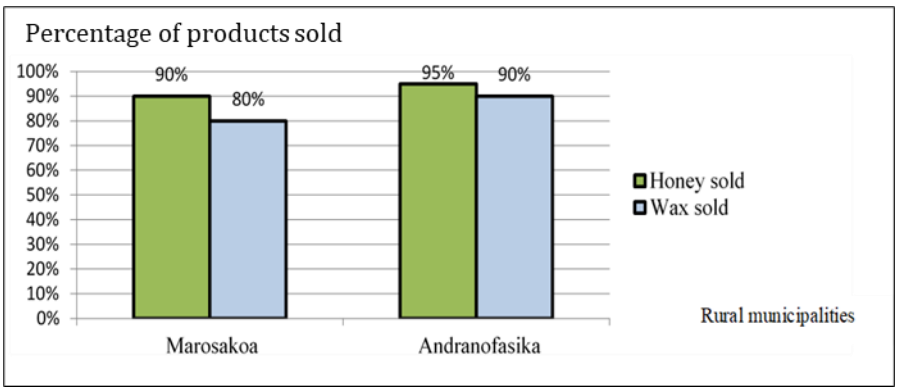

Figure 9 Quantities of honey and wax sold

In the rural Communes of Marosakoa and Andranofasika, honey and wax are brought to the markets of the villages, the District of Marovoay and the District of Mahajanga I by the producers to be sold either directly to the consumers or to

collectors (intermediaries or final). The marketing of honey and wax is poorly organized. Collectors set their prices for their own profit. The majority of the honey and wax produced is destined for sale (Figure 9).

In the rural commune of Morafeno, 90% of the honey produced and 80% of the wax produced is intended for sale. The rates of honey and wax sold in the rural commune of Tsiamalao reach respectively 95% and 98% of the products of the hive harvested.

Price variations

On the local market, the prices of honey and wax vary according to the season, the type of honey and the place of purchase (Table 3).

Table 3 Price changes for honey and wax

Products	**Unit**	**Marosakoa**		**Andranofasika**	
		Minimum in Ariary	**Maximum in Ariary**	**Minimum in Ariary**	**Maximum in Ariary**
Honey	Liter	18 000	22 000	19 000	22 000
Wax	50 grams	4 000	6 000	4 500	6 000

In the rural Commune Marosakoa, the price of the liter of honey varies from 18 000 Ariary to 22 000 Ariary and the piece of wax of 50 grams varies from 4 000 Ariary to 6 000 Ariary. For the rural Commune Andranofasika, the price of the liter of honey varies from 19 000 Ariary to 22 000 Ariary and the piece of wax of 50 grams varies from 4 500 Ariary to 6 000 Ariary.

3.5. Varroa destructors

Varroasis is a disease caused by an ectoparasite " varroa destructor ". It is a very contagious disease, affecting adult and larval bees, with serious consequences on the life of the colony. The bees have become weakened and have abandoned the hives.

At seven randomly selected infested hives in the study area, the tests gave an infestation rate of 15% for each infested hive. This rate is higher than the infestation threshold of 5%. The results of varroa testing with APIGENER, while randomly taking four hives in the rural commune of Marosakoa and four hives in the rural commune of Andranofasika show that the number of infested hives is high (Table 4).

Table 4 Diagnosis of varroa mites in modern hives

Rural municipalities	**Number of hives tested**	**Number of infested hives**	**Rate of infested hives**
Marosakoa	4	3	75 %
Andranofasika	4	4	100%
TOTAL	8	7	87.5%

In the rural municipalities Marosakoa and Andranofasika, the rates of hives infested by varroa reach 75% and 100% respectively. This means that the average rate of hives infested by varroa mites is very high because this rate reaches 87.5% for both municipalities.

3.5.1 Variation in the number of fallen varroa

Three hives from different apiaries in the rural commune of Marosakoa and four hives from different apiaries in the rural commune of Andranofasika were tested using APIGENER products to confirm the existence of varroa mites. The evolution of the number of varroa mites falling on the boards of the hives per week is identified (Figure 10).

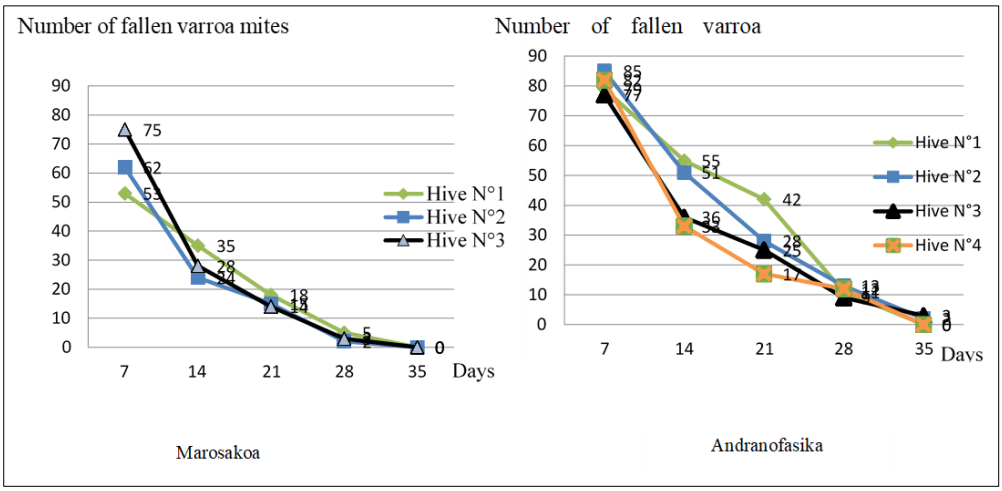

Figure 10 Evolution of the number of varroa mites fallen per week in the municipalities of Marosakoa and Andranofasika

During the first week, the number of varroa mites in the three infested hives of the Marosakoa Rural Commune varied between 50 and 80. In the second and third week, the number of varroa mites counted in each hive per week decreased to very few, with a number less than 14. From the fourth week, the number of fallen varroa mites counted is low, less than 5. This number is zero in the fifth week. In the Commune rurale Andranofasika, the number of fallen varroa mites in the four hives during the first week varied between 70 and 90. During the second and third week, the number of varroa mites dropped per week decreased between 10 and 60. From the fourth week on, the number of fallen varroa mites was reduced and became zero in the fifth week.

3.5.2 Effect of varroa on honey and wax production

The presence of varroa mites decreased the quantities of honey and wax produced by the bees (Figure 11).

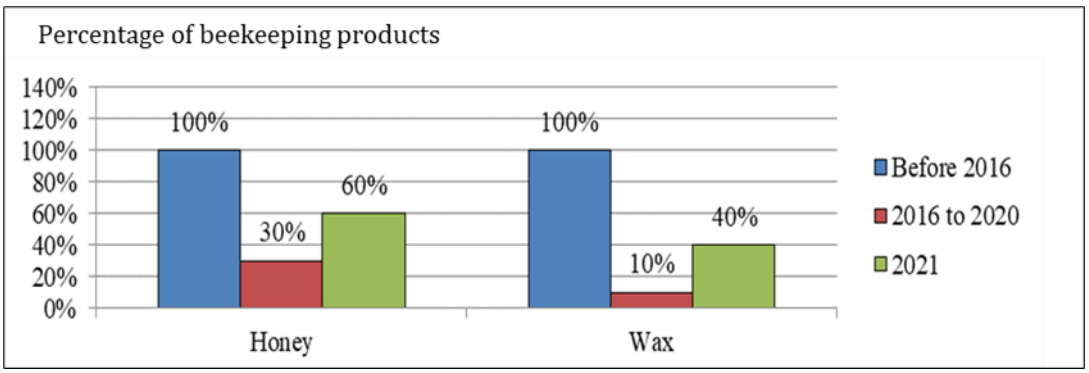

Figure 11 Variation of honey and wax production by period

All honey and wax productions decreased during the first 5 years of the varroa infestation. Honey and wax production decreased by 70-90% respectively. From the end of the year 2021, honey and wax productions started to increase again.

4. Discussion

The main constraints of beekeepers in the rural communes of Marosakoa and Andranofasika are socio-economic, technical and pathological. These results are similar to those reported by Tchoumboué [32] in the highlands of West Cameroon who indicated that the constraints of beekeeping are the enemies of the bee, the need for technical supervision, and the lack of financial resources, theft and the absence of a market.

Environmental constraints, such as toxicology, deforestation and climate change, affect bees in the rural communes of Marosakoa and Andranofasika in the Boeny Region. Chemicals (insecticides, fungicides, herbicides) used today in excessive quantities for cultivation and often combined pollute the nectar, poisoning the "forager" bees and then the

other bees in the hive. Deforestation deprives bees of a major food source. These results are consistent with the work of Naquet [24], who indicated that environmental factors, chemical and biological pathogens, and climate change can affect bee and colony health.

Rural insecurity hinders economic activities in the rural communes of Marosakoa and Andranofasika. Some beehives are destroyed for the theft of honey. This result is in line with the work of Josée [17] who stated that the current level of rural insecurity in Madagascar has reached a high level that the rural population no longer feels safe even in their own homes. The multiplication of daily acts of violence such as armed attacks, robberies and rapes testify to this situation.

The major problems faced by beekeepers in the rural communes of Marosakoa and Andranofasika until a few years ago were varroa mites. They caused the desertion and progressive mortality of the bee colony. In the seven hives infested with varroa mites in different apiaries in the study area, the bee colonies became weakened and abandoned the hives. Crop production and honey and wax production decreased. These results are consistent with the work of Pierre [26] who found that varroa mites contribute to a weakened bee colony. Foragers that are much weakened cannot return to the hive, they die in the wild, or are found wandering in the grass near the hive (2 or 3 meters from the hive). They are consistent with the research of Razafindrazaka [27] who found that varroa mites of bees exist in Madagascar and can affect the balance of the hive resulting in a substantial reduction in the yield of apiaries and crops.

5. Conclusion

Well before putting an end to the present work, it seems appropriate to us to make a briefing of the objectives. This last one consists in studying then in understanding the various constraints of the apiculture in the conservation of the natural resources. Beekeeping in the study area faces numerous problems such as deforestation, toxicological constraints with respect to the protection of honey plants against pests by means of chemical products, climate change, the practice of traditional beekeeping techniques, the absence of a structured market and the presence of varroa destructors. Conscious of the impact of the presence of these problems, the beekeepers in the rural Communes Marosakoa and Andranofasika must take precautions and adequate measures for the development of the beekeeping sector.

The trials of treatments against varroasis by the product APIGENER are effective. The results obtained demonstrate the relevance of this product. It is very important to be concerned about the modalities of granting the Marketing Authorization of APIGENER product for the treatment of varroasis disease. A strategy for the supply of this product must be discussed between the beekeepers' associations and the BIOZEN Company to facilitate the acquisition of treatments by the beekeepers from the organizational, financial and operational point of view.

In the current context of the fight against poverty and the conservation of natural resources, beekeeping deserves to be promoted as a convincing economic alternative for beekeepers in rural areas. The presence of farmers' organizations allows beekeepers to have access to support organizations by developing exchanges and partnerships between actors in the international market system. A coherent strategy will have to insist on the identification of strategic and adaptive research needs and programs, the provision of technological assistance to producers in terms of input supply and product marketing, and the permanent training and retraining of technical personnel involved at all levels of small-scale beekeeping.

To develop beekeeping in the rural Communes Marosakoa and Andranofasika around the protected area of Ankarafantsika, an in-depth beekeeping behavioral study according to the temporal variations with the parameters of the climate changes remains to be determined. In the field of adaptation strategies against global environmental changes, the promotion of solar energy in rural areas will be able to reduce the rates of deforestation and increase the melliferous resources necessary for beekeeping. Further investigation of the local population is needed to assess their potential level of support for the proposed technology to increase awareness and promote the use of renewable energy and energy efficienc.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors hereby declare no conflict of interest on this research.

References

[1] Agropolis I., 2015. Climate change: impacts and adaptations, 88 p.

[2] André, 2016. Getting started in beekeeping, 31 p.

[3] Andriambolatiana S., 2013. Climate change: Policy and perspectives in Madagascar, 30 p.

[4] Bradbear, 2010. The role of bees in rural development, 238 p.

[5] CREAM, 2013. Monograph Boeny Region, 158 p.

[6] Douhet, 1962. Beekeeping in Madagascar in its tropical context, its possibilities. Beekeeping Division, Madagascar, 94 p.

[7] François G., 2012. Sustainable beekeeping development plan, 31 pp.

[8] IEGC, 2007. Climate Change, Synthesis Report, 103 p.

[9] GIEC, 2014. Climate Change, Synthesis Report, 180 p.

[10] Gilles A., 2010. The biology of the bee, 26 p.

[11] Gilles A., 2010. The individuals of the colony, 13 p.

[12] Gustave B., 2015. Assessment of the impact of environmental threats and stressors on bees, 20 p.

[13] Harison et al, 2016. National biodiversity strategy and action plans, 214 p.

[14] Helene D., 2011. Farmers' perceptions and adaptation strategies in the face of climate change in Madagascar, 108 p.

[15] Jean M, 2007. The beekeeping guide, France, 249 p.

[16] Jean T., 1996. Impact of pesticides on bees and other pollinators, 10 p.

[17] Josée et al, 2001. Diagnosis of urban insecurity and prevention strategy in Antananarivo, 96 p.

[18] Josephe D., 2012. Characterization of climate change adaptation strategies in peasant agriculture, 50 p.

[19] Karine L. and Rakotovelo, 2004. Study of the beekeeping sector for export development. Synthesis and recommendations, 38 p.

[20] Karlo B., 2016. Varroasis and its agent, 21 p.

[21] Madagascar National Parks, 2008. Development and Management Plan of the Ankarafantsika, 95 p.

[22] Nathalie P., 2010. The decline of bee populations in Quebec: Probable causes, impact and recommendations, 66 p.

[23] Nicola B., 2010. The role of bees in rural development, 248 p.

[24] Naquet, 2011. Diseases of the farmed honey bee, 10 p.

[25] Patrick C., 2011. The apiary step by step, France, 34 p.

[26] Pierre G., 2011. Application of a control strategy against the varroa destructor parasite in honey bee colonies in Quebec, 219p.

[27] Razafindrazaka A., 2010. Potentialities and constraints of the beekeeping sector in the district of Manakara, Vatovavy Fitovinany Region, 107 p.

[28] Ricodeau M., 2008. Treatments of varroasis, 12 p.

[29] Romalahy et al, 2020. Global Results of the General Census of Population and Housing of Madagascar, 192 p.

[30] Shneider E., 2007. Synthesis of the Honey Sector, Analanjirofo Region, 20 p.

[31] Sophie D., 2012. Beekeeping, a vector activity for sustainable rural development, 66 p.

[32] Tchoumboué et al, 2001. Socio-economic and technical characteristics of beekeeping in the western highlands of Cameroon, 146 p.

[33] Tsiory M., 2013. Pollen analyses of honeys from Madagascar and two Mascarene islands, 102 p.

[34] Vestalys, 2008. Analysis of the beekeeping sector in the Analamanga and Haute Matsiatra regions, 43 p