Journal of Experimental Agriculture International

Volume 46, Issue 5, Page 546-555, 2024; Article no.JEAI.114670
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Queen Bee Rearing Trials: Making the Hive to the Production of Queen Cells

Koudegnan Comlan Mawussi [a*], Agouna Abdounazirou [b], Belei Essotolom Gabriel [a], Lamboni Matéyendou [b], Tchabi Atti [b] and Kokou Kouami [a]

[a] Forestry Research Laboratory (LRF); University of Lomé, Togo.
[b] Higher Institute of Agricultural Professions (ISMA); University of Kara, Togo.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2024/v46i52409

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/114670

Original Research Article

Received: 25/01/2024
Accepted: 28/03/2024
Published: 05/04/2024

ABSTRACT

With a view to implementing a method of producing and breeding bees to ensure their increase in hives, replace aging queens and create new colonies in the event of desertion, an experimental study of breeding trials of queens of the bees were conducted in the C2GA beekeeping farm (Gassana Gafolai Cooperative of Affem Boussou) in the prefecture of Tchamba, canton of Affem, located 18 km from the town of Tchamba to the East (in the Central region). Given the time of the research internship which was granted to us for the writing of our dissertation with a view to obtaining the Professional License in Agricultural Sciences, this experience only lasted three (03) months. She particularly took into account the first stages of breeding: from the manufacture of the hive to the production of the queen cells. The last stage, which concerns the production of queens, was not reached due to an unfavorable beekeeping season and lack of time. The experiment was carried out on ten (10) Dadant-type hives subjected to three (03) methodologies and distributed as follows: two (02) hives for the grafting method, three (03) hives for the Alley method and five (05)

**Corresponding author: E-mail: comawuk.77@gmail.com;*

hives for the natural method. The results obtained were more conclusive with the natural method. In fact, only the natural method allowed us to obtain queen cells. This study must be summarized and continued during the different honey flow periods and extended to other farms to better facilitate the choice of the best method of production and breeding of queen bees adapted to Togo.

Keywords: Experimental tests; production; queen cells; breeding; queen bees; Togo.

1. INTRODUCTION

The bee offers us bee products and, through the practice of cross-pollination of plants, ensures significant production gains for several agricultural crops [1]. It contributes more than 80% to agricultural productivity for human and animal food worldwide. Einstein states that: “If the bee disappeared from the surface of the globe, Man would only have four years to live; more pollination, more herbs, more animals, more men…”. It is therefore a question of thinking of “Bee” in the perspectives of research and development and indirectly thinking of “Beekeeper”, at all levels of intervention [2]. Beekeeping is defined as the breeding of bees for the harvest of hive products such as honey, wax, propolis, bee venom and royal jelly. It is an income-generating activity that creates direct (production of beehive products) and indirect (various transformations and marketing of beehive products) jobs.

Today, these bee species are threatened with extinction. The causes of this disappearance are diverse. The misuse of pesticides (insecticides) has negative consequences such as the depopulation of hives s, and consequently, many losses in the production of honey and other hive products. In addition to pesticides, there are other factors such as diseases, parasites and predators, agricultural and beekeeping practices, but also environmental and climate change, and the synergistic effect of pesticides-pathogens [3]. One of the major diseases linked to this disappearance is the effect of hive depopulation syndrome (HDS) which is a parasite of Asian origin developing in hives and thus causing their massive destruction of bees [4]. We also note the loss of queen bees along the way during their nuptial flight or their devouring by predators, including birds, the Asian hornet, etc. The queen is distinguished from other bees by its larger size: 1.8 cm on average once fertilized compared to 1.2 cm for a worker [5]. However, bees play an essential role in the pollination of flowering plants and the balance of ecosystems. This is why they appear in the United Nations Sustainable Development Goals, in particular number 15 in which the life of terrestrial ecosystems is mentioned. Reports from the Food and Agriculture Organization of the United Nations (FAO) have shown that bees play a crucial role in food security, nutrition and biodiversity [6].

In recent years, many beekeepers have reported losses of their bee colonies. The problem then arises of the notorious and continuous desertion of hive colonies. Faced with this shortage of bees, it is important that the beekeeper implements a strategy for the production, replacement and conservation of bees, especially queens, for their rapid renewal in the colonies in the event of loss, aging or death. This will allow the beekeeper to quickly restart his production with young queens and swarms of efficient bees available to continue maintaining a good production yield from his hives. Yves adds by specifying that it is important to breed queens to either replace old queens, or change the queen in the case where the hive is colonized by a certain number of swarms of unknown origins. He adds that you can also breed queens when you want to improve the quality of your “livestock”, or when you have bees that are aggressive or develop fungus. In this case, it is then a matter of making a little selection and progressing [7].

The general objective of this study is to implement a method of producing and breeding bees to increase the bee population, replace old, unproductive queens and create new colonies in the event of desertion. Specifically, it aims to (i) identify suitable material to use and (ii) experiment with a few selected queen production methods.

2. METHODOLOGY

2.1 Internship Website

This research internship on the study of queen rearing methods is carried out on the C2GA beekeeping farm in Affem-Boussou in the prefecture of Tchamba, 18 km from the town of Tchamba in the east of the central region of Togo (Fig. 1). It is a border town with Benin. The main

activity of the locality is agriculture, including beekeeping.

2.2 Materials

To achieve the production and rearing of the queen, a certain number of materials have been identified (Figs. 2, 3, 4, 5, 6, Table 1). It is:

- ✓ **Biological material:** swarms of bees.
- ✓ **Experimental equipment:** hives, cups, curlers, queen cages; the queen excluder; the breeding environment; picking; the frame lifter, the bee brush.
- ✓ **Protective equipment:** boots; the smoker; the combination; the veil hat; gloves. All these materials are necessary for beekeeping but also for queen rearing.

2.3. Methods

2.3.1. Manufacturing of hives

The hives used for the experimental tests during the internship are all Kenyan hives. They are manufactured over a length of 90 cm carrying 25 bars. Manufacturing was simple and easy. The material necessary for the manufacture of each hive consists of: four (04) pieces of boards measuring 90 x 35 cm²; spikes or flat-headed nails; a piece of smooth sheet metal or zinc; 25 wooden sticks or slats. The width of the stick, which must be strictly respected, varies between 32 and 33 mm, both for the hive and the hive. The hive is painted in hardwood 25 mm thick in the forest zone and in formwork wood (white) or in earth in areas with high temperatures or without wood, and finally in cement where there is theft or bush fires. The bars can have a triangular section, a shape which serves as a base, support, start for each spoke to be built by slat. They are placed directly next to each other on the front and rear walls of the hive. In the hive, the rods constitute the first protective barrier of the colony against predators and unfavorable climatic factors. Fig. 7 shows the work required to manufacture the hives. In addition to the manufacture of Kenyan hives, Dadant hives and hives are also manufactured to orphan during breeding (Figs. 7 and 8).

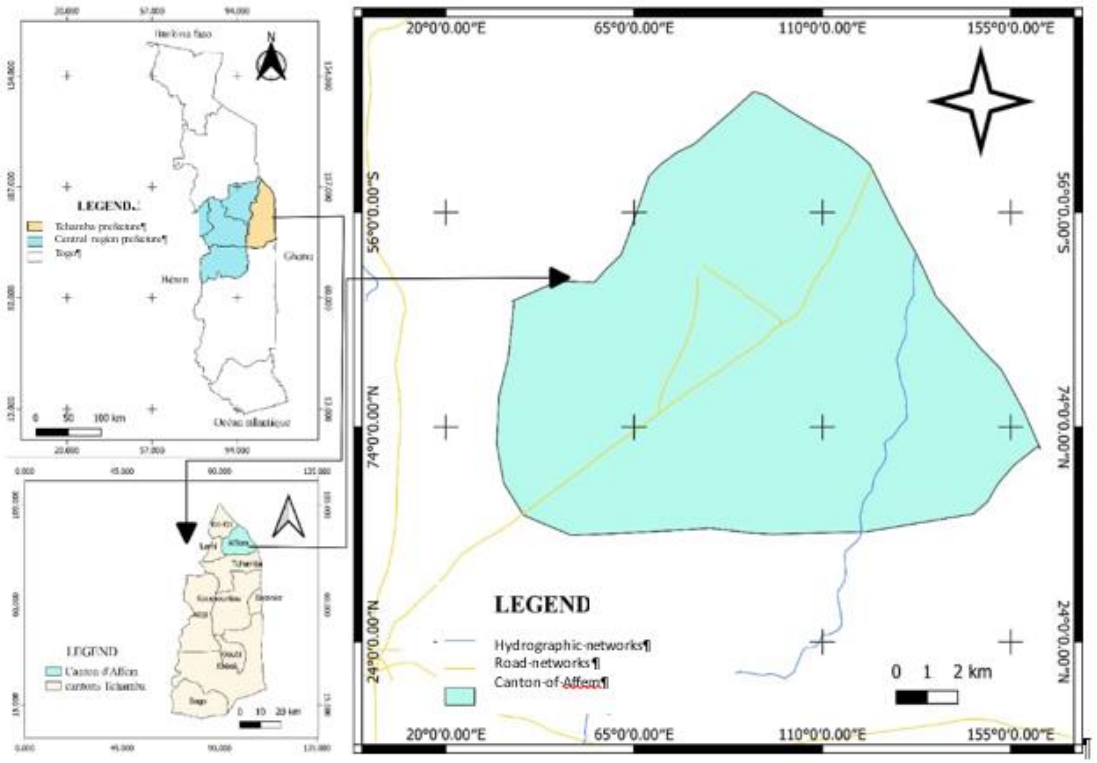

Fig. 1. Map of the internship site (Agouna, 2022)

Fig. 2. Queen rearing kit

Fig. 3. Queen's grid

Fig. 4. Frame lifter

Fig. 5. Bee brush

Fig. 6. Bee smoker
(Source: Photos Agouna, 2022)

Fig. 7. Beekeeping carpentry

Fig. 8. Installing the hive

2.3.2 Installation of hives

The old hives already installed for which there has been no colonization and the hives for which there has been desertion are reinstalled. For good colonization, we sprayed bee charm and syrup into the hives and then placed the hives at height (in the trees).

The highest possible installation has the highest chance of colonization. The installation is always done by placing the hives or hives in the forest (fig. 8).

2.3.3 Checking the health of bees

It is a beekeeping exercise which consists of the beekeeper opening the hive and looking inside the hive. This activity allowed us to monitor the proper functioning of the bees and their health. This is the visit itself. Visiting a colony consists of examining the interior of an inhabited hive, after having opened it, observation gives us additional and more satisfactory information regarding the exact definition of one or more patterns. Out of curiosity, concern, or the desire to do well, it is not advisable to make multiple untimely

inspection visits to apiaries because each hive opening disrupts the colony.

2.3.4 Queen rearing

In the spirit of a comparison for the selection of the most adaptive and the least expensive, the experimental tests of the production of queen bees focused on three different methods.

- **Experience with the Grafting Method (1)**

The grafting method consists of, first, selecting the right colony of bees, and then proceeding to isolate the queen mother of the colony. When this is done, we move on to the familiarization stage which consists of placing the breeding frame prepared with cups within the colony to accustom it and put it in contact for three hours of time. After this contact time, the breeding frame is removed from the hive to allow the eggs to be collected: this is the actual grafting. The collection of newly laid eggs (1 to 3 days) is done using equipment called picking. According to Petit, what is meant by "picking" (from the English verb to pick: to extract) is the transfer of young worker larvae from a hive selected for its qualities (stem hive) into artificial cells called "cupules", to the using a tool called “picking”. We also speak, but incorrectly, of “grafting” [8]. These collected eggs are placed in the cups. The breeding frame is reinserted into the hive. On the 10th day, we move on to the breeding control. During the check, when the cups are capped, protection is carried out using the cup protector. From the 13th or 17th day, a second check is carried out to observe the hatching of the queens.

Table 1. List of equipment and their roles

N°	DESIGNATIONS	ROLES OR USES
1	Populated hive	Subject on which experiment is carried out
2	Bee smoker	Smoker Instrument that keeps the smoke which is used to calm the bees.
3	- Combination - Sailing hats - Gloves - Boots	They allow protection of the body against possible stings from bees during handling.
4	Frame lift	It serves as a lever to lift the frames.
5	Broom or bee brush	It allows you to sweep away bees.
6	Wax oil	It allows you to stick the strip of comb containing the eggs onto a slat.
7	Breeding framework	It serves as a support for the cups containing eggs.
8	Cupule	It serves as egg cells during grafting.
9	Cup holder	It is a support for the cups, it carries the cups.
10	Protects cups or curlers	It allows the queen to hatch and protects the queens so that they do not kill each other after hatching.
11	Picking	Tool for grafting larvae
12	The queen's grid	Serving as a barrier for the queen.
13	The wooden board	Raw material for the manufacture of hives
14	The hammer	Used to nail
15	Peaks	Used to point the hives
16	A sawmill	Wood cutting workshop.
17	The tape measure	Taking the measurement
18	The square	Allows you to have the angle of 90 degrees
19	The planer	Planed the boards
20	Plywood	Raw material
21	Prison	Prevent the entry of rain water
22	The cutter	Used to trim the apiary
23	Wax paper	Ensures bees during colonization
24	Bee syrup	Attracts bees
25	The bee charm	Attracts bees
26	A tricycle motorcycle	Transports equipment to the apiary during installation

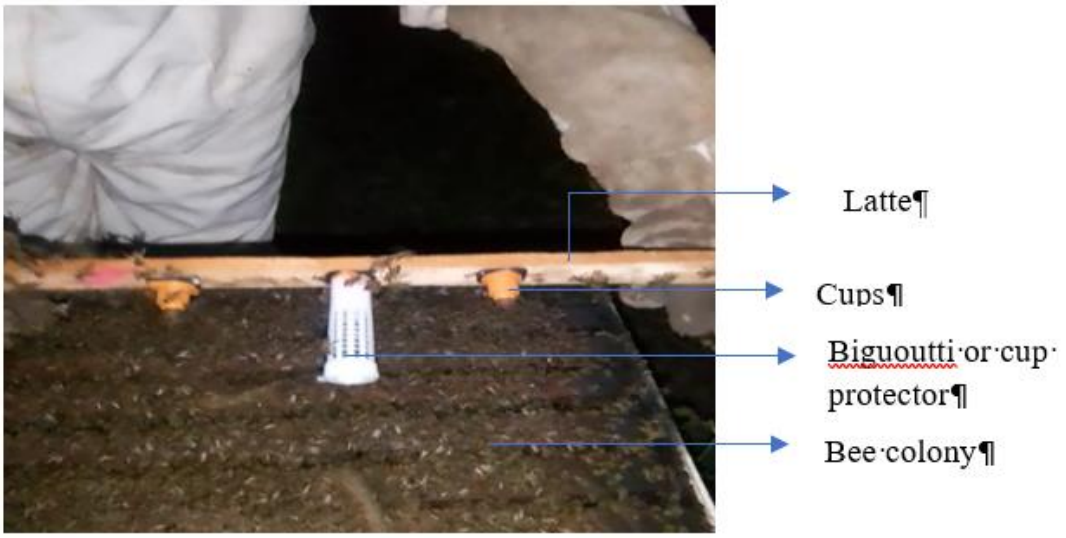

Fig. 9. Protection of queen cells

❖ **Experience with the Alley Method (2)**

After selecting the correct colony, it is orphaned. Then, on a ray frame containing eggs, we proceed to locate the part of the rays having young eggs. A strip is cut out and glued to a slat using the raw wax oil previously heated. This slat on which the cut strip of comb containing eggs is glued is placed back in the populated hive. After the tenth (10th) day, we move on to a first breeding check. Once the queen cells are formed, they are harvested and introduced into the cup protectors (queen cover cage). From the 13th or 17th day, a second check is carried out to observe the hatching of the queens.

❖ **Experience with the Natural Method (3)**

This experiment consists of selecting a hive of good performance which is then ite made an orphan. A check is made on the tenth day after orphaning to observe whether or not queen cells appear. Once the queen cells are formed, they are harvested and introduced into the cup protectors or queen cover cage (Fig. 9). From the 13th or 17th day, a second check is carried out to observe the hatching of the queens.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Manufacturing of hives

Table 3 shows the types of hives manufactured with their number. Out of a total of 950 hives planned, only 776 hives could be manufactured in one (1) month, including 40 Dadants hives, 663 Kenyan hives and 73 Kenyan hives (Table 2).

3.1.2. Installation and Colonization of hives

The results obtained show the total number of hives and hives (Dadants and Kenyans) which are placed for the capture or colonization of bees (Table 3).

Table 2. Statistics of hive types

Types of hives	Hives planned to be made	Hives made during the course	Remaining beehives to be made
Dadants	50	40	10
Kenyan	800	663	137
Kenyan hives	100	73	27
Total	**950**	**776**	**174**

Table 3. Statistics of types of hives and hives installed and colonized

Types Dadants	Hives Dadants	Small Hives Dadants	Kenyan Hives	Small Kenyan Hives	Total
Number reinstalled	40	20	300	75	435
Number recolonized	33	11	197	49	290
Number installed	75	25	250	30	380
Number colonized	47	19	156	14	236

Table 4: Checking the health of bee colonies

Types of hives	Number of hives inspected	Number of hives infected
Dadant	10	2
Kenyan	10	1
Total	**20**	**3**

3.1.3 Checking the health of bees

A total of 20 hives, including 10 Dadants and 10 Kenyans, were inspected during beekeeping visits during the internship period. The results of the inspection reveal that out of all the hives checked, three (03), including two (02) Dadants hives and one (01) Kenyan hive, are infected (Table 4).

3.1.4. Queen Bee Rearing Trials

- **Experiment 1**

The result obtained from the grafting method carried out on two hives (02), at the rate of one hive per test, is not satisfactory, and therefore not conclusive: the success rate is zero percent for all Hives. Note that the cup capping stage was not observed and that the second hive was not orphaned. We just separated the hive body and the hive box using the queen excluder.

- **Experiment 2**

Regarding the second experiment, three (03) tests were carried out. This experiment also did not yield the expected results after three attempts. On the tenth day, the queen cells were not formed.

The two experiments (1 and 2) were discarded because the expected results were not achieved. With the application of these methods used, we noticed for the most part a desertion of bees from the hives (Figs. 10 and 11).

- **Experiment 3**

Unlike the first two experiments, on the tenth day of this one, the formation of queen cells was noted. These queen cells were harvested and introduced into the cup protectors. Five days later, checking the hatching of the queens showed that the queens were not hatching.

Fig. 10. Familiarization of the framework

Fig. 11. Hive deserted by the colony of bees (photo attached)

For this experiment based on the natural method, five (05) tests on five (05) hives were carried out. Unlike other experiments, no orphaning took place here. We just carried out a random division of the hive without looking for the queen and while keeping the frames containing eggs in the

two hives during the separation. Queen cell formation has been observed in sharing hives where there is no queen.

For all five hives where there was formation of queen cells, when they were harvested and placed in the cup protectors for the queen to hatch, there was desertion of all these hives (fig. 13).

3.1.5 Formation of queen cells in Dadants hives

Table 5 presents data on the number of queen cells formed in selected Dadants hives. Queen cells are special structures created by bees to raise new queens and maintain colony stability. The number of queen cells formed was measured in five (05) specific Dadants hives (Table 5).

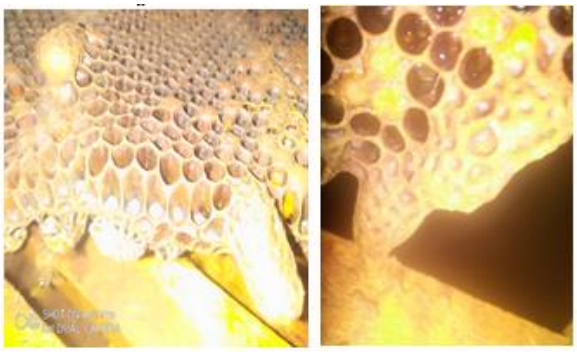

Fig. 12. Queen cells obtained

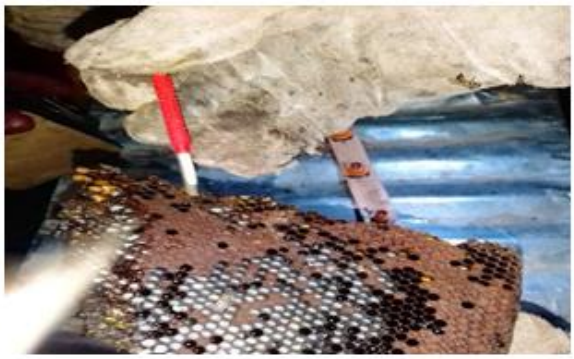

Fig. 13. Transplantation or collection of eggs to put in the cups

3.2 Discussion

3.2.1 Results of hive manufacturing

Out of a total of 950 hives (Dadants and Kenyans combined) planned to be manufactured, only 776 hives were actually manufactured during the course, a negative difference of 174 hives. Likewise for the hives, out of the 100 planned, only 73 were manufactured during the course, with a shortage of 27 hives. These unmanufactured shortages are due to defects constraints linked to time and unavailable resources.

Table 5. Statistics of cells formed per hive

Ruches	Hives Number of cells formed
Hive 1	10
Hive 2	13
Hive 3	18
Hive 4	7
Hive 5	15

3.2.2 Installation and colonization of hives

By analyzing the figs. for the different types of hives and hives recorded in the two cases, we generally notice very significant differences between the numbers. The number of Kenyan hives or hives installed is higher than those of Dadants. This could be explained by a notorious preference of beekeepers to Kenyans rather than Dadants. However, by making a ratio between the total number of hives or hives inhabited (colonized + recolonized) by bees and those installed (installed + reinstalled), we notice a preference of bees for the Dadant type rather than the Kenyan type: for hives (70% versus 64%) and for hives (67% versus 60%). The very relative and diversified reasons for preference would be intrinsic and extrinsic both on the side of the beekeeping stakeholders and on the side of the bee. They could respectively be linked to ease of manufacturing and ease of adaptation.

Comparing the capture rates of bee colonies between hives and hives, we see a slight difference in favor of hives. This difference is believed to be attributed to factors such as hive size and environmental conditions that favor colonization [9].

3.2.3 Checking the health of bee colonies

The study shown in the table aims to examine the number of hives inspected and infected, focusing on two specific hive types, Dadants and Kenyans. This inspection will make it possible to properly monitor the health of the bee colonies in the hives. The results of the inspections reveal that 2 Dadants hives and 1 Kenyan hive are infected. In other words, these colonies are in the

presence of a specific disease that must be diagnosed for their survival. Even if the infection rate remains low (3 infected hives out of 20, or 15%), we note that Dadants hives are more exposed than Kenyan ones (2 Dadants hives against 1 infected Kenyan).

These results highlight the importance of monitoring and controlling the hygienic state of hives, as their infections could have a negative impact on colony health and honey production [10]. Preventative measures and appropriate management strategies are essential to minimize infection risks and maintain bee health.

3.2.4 Queen Bee Rearing Trials

The results of the experiments indicate significant difficulties in breeding queen bees. Success rates have been low to non-existent. This then reveals the presence of technical problems or inadequate conditions for the development of queen cells. The fundamental cause is mainly linked to the inappropriate period of the experiment. Since the experimental tests were not carried out during the peak honey flow period. According to Rhodes and Somerville, factors such as handling, nutrition, temperature or colony genetics can also influence the success of queen rearing [11].

3.2.5 Formation of queen cells in Dadants hives

The results obtained provide an idea of, on the one hand, the method to select, and, on the other hand, the type of hive to choose for such a study of queen cell production. In fact, it is by the natural method that they are formed in Dadant hives. Figs. on the number of queen cells formed show significant variability or differences between the hives studied. These differences could be related to specific environmental conditions, bee population levels, or the particular genetic characteristics of each colony.

Queen cell formation is a crucial process for the survival and reproduction of bee colonies. Queen cells are created when the colony decides to replace or produce new queens. This process can be influenced by various factors, including colony size, food levels and chemical signals.

4. CONCLUSION

In conclusion, the results of queen bee rearing experiments and hive manufacturing observations highlight the need for further analysis and research. Low or no success rates in queen production and rearing indicate technical problems or inadequate conditions for queen cell development. Adjustments in methods and environmental conditions may be necessary to improve results. Furthermore, the discrepancies observed in the manufacturing of hives, particularly for Kenyan hives, require special attention to achieve the planned objectives. An in-depth analysis of the reasons for these deviations and the correct measurements Proper ives are necessary to improve the overall efficiency of the production process.

It should be emphasized that these results obtained for this study only provide instantaneous information on the activity of bee colonies in the hives studied, particularly in those of the Dadant type. Further and more in-depth study would be needed to have more data to determine the behavioral trends and patterns of bee colonies and the actual type of hive and queen production and rearing method suitable for our country.

5. ACKNOWLEDGMENTS

This work remains the result of the involvement of several people. To all these people, we express our gratitude. In particular, our thanks go to:
to the internship supervisor Mr. AMANFO Zoulikifilou, Farmer/Beekeeper by training, for his welcome, his supervision and his various advice throughout the duration of my internship in his beekeeping company “Cooperative Gassana Gafolai d’Affem Boussou”;
The American company Koster Keunen West Africa (KKWA) of Lomé, and particularly to Mr. BEMBAH-BAHISSA Nasser, for their support in breeding equipment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Hutu Ioan. Reproduction technology, breeding and exploitation of bees. In book: Animal production: university course; Edition: First; Chapter: 20. Publisher: USAB, Agroprint, Timisoara. 2020;466. SN - 978-606-785-126-7.

DOI:10.13140/RG.2.2.31553.68960.

2. Balagizi IK, Katwanyi D, Matabaro B. Thinking about bees and beekeeping in South Kivu. Journal of Livestock and Veterinary Medicine of Tropical Countries. 2015;68(1):3-10. Available:https://doi.org/10.19182/remvt.10298 [French]
3. Albouy V, Leconte Y. Our bees in danger [White Paper]. National Research Institute for Agriculture, Food and the Environment (INRAE); 2019. Available:https://www.researchgate.net/publication/335880977 [French]
4. Rabaa A. Mohammed, Mashair A. Sulieman and Elgasim A. Elgasim. Effect of Bee Honey in Safety and Storability of Beef Sausage. Pakistan Journal of Nutrition. 2013; 12(6), 560-566. Available:https://doi.org/10.3923/pjn.2013.560.566
5. Henri Clément. Beekeeping For Dummies. Éditions First. 2014; p. 107. [French]
6. Food and Agriculture Organization of the United Nations (FAO). The State of Food and Agriculture 2020: Overcoming Water Challenges in Agriculture [Report]; 2021. Available:http://www.fao.org/state-of-food-agriculture/en/ [French]
7. Yves LAYEC. Bee Health. published by FNOSAD (National Federation of Departmental Apicultural Health Organizations); 2008; n°224. Page 5.5. Available:https://www.apiservices.biz›documents›articles-fr [French]
8. Daniel PETIT. Principles and methods of breeding Queen bees; 2002. Available:http://daniel.petit.chez-alice.fr/index.htm [French]
9. Kugonza Donald, Kamatara K, Nabakabya D, Kikonyogo S. Effects of hive type and tree shade on colonization rate and pest prevalence of honeybee (Apis Mellifera) colonies in Central Uganda. African Journal of Animal and Biomedical Sciences. 2009;4:87-92.
10. Cédric, L. C. Y. A. Stress in the honey bee (Apis mellifera): analysis of physiological and behavioral modifications; 2017. Available:http://www.theses.fr/.https://www.theses.fr/2017AVIG0687 [French]
11. Rhodes J, Somerville D. Introduction and early performance of queen bees: Some factors affecting success. Publication No. 03/049, Rural Industries Research and Development Corporation, Canberra, Australia; 2003.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/114670