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Proposal System "Queen Uruapana" Design adapted to Change Climate, for the Handling of Queen Bee (*Apis mellifera*) in Andahuaylas, Perú

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Abstract

The research proposes the design of a "Queen-Uruapana" system for the management and transfer of the queen bee in different areas of life in the province of Andahuaylas of the Apurímac region - Peru. This system optimizes proper handling and transport of the queen bee to ensure the continuity of the beekeeping population through oviposition. The experiment was aimed at calculating transport mortality and acceptance in the new hive. A sample of 90 fertile queen bees of the Italian breed was taken, distributed in 3 transport models of 30 individuals in each: Benton cages, HDPE plastic cages (High-Density Polyethylene) and the proposed Queen-Uruapana cage system designed in a way horizontal cylindrical 8 cm long, 2 cm in diameter, 10 mm. of the hole for entry and exit of the queen bee with a metal mesh of 0.20 mm. of a hole. The results obtained from transport mortality were: 26.6% Benton cage, with 16.6% HDPE cage and 3.6% in Queen-Uruapana, reducing mortality, the results obtained from acceptance in the new hive were: 12% Benton cage, 3.4% HDPE cage and 96.4% in Queen-Uruapana, increasing recognition in the new colonies.

Keywords: *Queen bee, transport, beekeeping, cage, climate change*

I. INTRODUCTION

Bees have always been considered the most important species on earth, not only for the food of high nutritional quality they produce but for the systemic eco-pollination service they provide us, necessary to ensure food in the world. Nevertheless; In recent years its population has been decimated by many factors, mainly environmental, it has been reported that in last years there was a decline of 37% of the bee population [1] that is why the repopulation of this species in any part of the world is imperative.

The importance of the queen bee is to ensure the continuity of the species because it is the only fertile female within the hive while providing the increase of the beekeeping population generating more excellent pollination of plant species mainly of a food nature [1] [2], which constitutes the base of 75% of the world feeding, the handling of the queen bee is a critical factor in the beekeeping production for these recitals the cages for the transfer is a material of great importance designed with all the necessary characteristics for its excellent handling and must provide greater security in the proper removal, which all obey the same principle to prepare the entrance of the queens as safely as possible, avoiding the crushing or elimination of the new queen.

The purpose of the cage is to leave the queens for a while in indirect contact with the bees until they can be released [2] [3] [4]. Partial contact occurs through the tissue, and thus the queen releases her pheromone into the hive.

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This work begins with the transport of a queen bee to a new apiary for the constitution of the hive, in which some necessary design conditions must be taken into account to guarantee the success of the new population, currently, in the international market there a series of products to transport the queen bee[2] [3]. However, these devices are not built for the various climatic conditions of Peru, because they are imported from countries in other latitudes. In this context, the present research work aims to propose a cage design for the transport of the queen bee in optimal conditions adapted to climate change, which allows it to reproduce and generate an abundant and highly productive hive [3].

The design proposal allows the free transit of the queen bee that prevents the accumulation of wax residues and pathogens [4], the material considered in the new design is aluminum generating advantages compared to other metals, allowing the queen bee release pheromones properly to inhibit oviposition in worker bees and allow their absolute acceptance for their reign.

II. METHOD

2.1. Study area

The study was carried out in the town of Ataccara, which politically belongs to the Huancaray district, Andahuaylas province, Apurimac region, as shown in figure 1. According to the ecological map, it is located in the subtropical Low Montano Subtropical spiny steppe life zone (ee- LMS) (Holdridge, 1967). The area is situated on a mountain slope with altitudes from 2,900 to 3,100 meters above sea level.

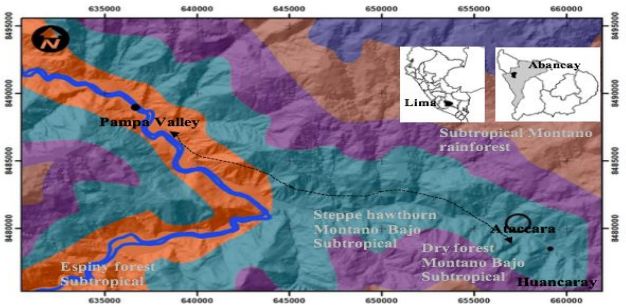

Figure 1.Location map of the study area. The broken lines show the route used to transport the queen bees. The area is in UTM Zone 18. Source: IGN, 2012.

In the year 2019, precipitation of 758.9 mm has been recorded, with November to April being the ones with the highest rainfall, in addition to an average minimum temperature of 7.5 ºC and a maximum of 20.5ºC and average relative humidity of 90.8% as shown in Table 1.

Table 1.Climatic data of the Andahuaylas province

Months	Precipitation (mm)	Temp. max (°C)	Temp. min (°C)	Hum. rel. (%)
Jan	160.7	20.6	9.9	93.2
Feb	156.3	19.9	9.5	95.2
Mar	98.8	20.2	9.2	95.2
Apr	30.8	20.1	7.36	92.5
May	14.6	20.7	5.18	90.3
Jun	0	20.0	4.7	86.0
Jul	14.3	19.5	4.03	89.4
Aug	0	20.5	4.5	84.8
Set	19.5	20.7	7.58	92.2
Oct	52.9	21.5	8.38	87.7
Nov	97	21.4	9.37	90.5
Dec	114	21.3	9.94	92.3

Source: Senamhi, 2020

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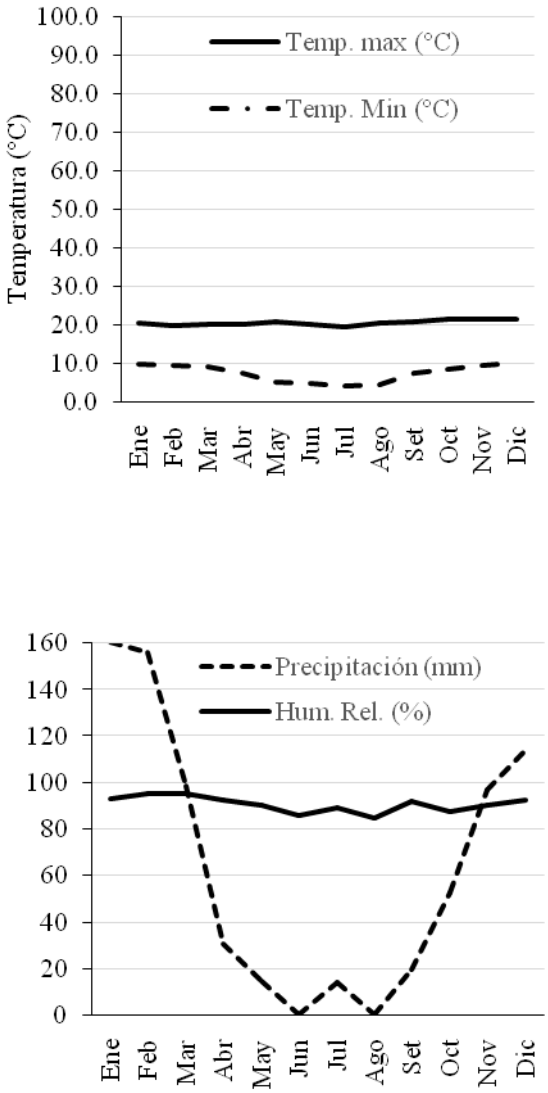

Figure 2.Monthly climatological data of the study area during 2019, considered within the proposal of the Uruapana design

2.2. Queen Uruapana cage design

The design proposal of the Queen Uruapana cage for the transport of queen bees was based on developing a cylindrical model, with a length of 8 cm and a diameter of 1.91 cm. An aluminum-based mesh constitutes the main body of the cylinder. One end has a 10 mm diameter hole that allows the specimen to enter and exit, while the other purpose has a smaller mobile part for the supply of its food.

2.3. Design validation

This procedure was carried out to verify the efficiency of our device concerning others existing in the market. It consisted of transporting queen bees (90) in cages of three different materials: 30 queen wood, 30 queen plastic, and 30 queen metal, as can be seen in Table 2 and Figure 3, respectively[6].

III. RESULTS

Table 2. Validation of the results obtained during the study experimentation

Cage type	Mortality (%)	Queen Bee Survival (%)	Queen Bee Survival (number)
Benton	26.6	73.4	25
HDPE	16.6	83.4	26
Queen Uruapana	6.6	93.4	28

As can be seen in Table 2 and Figure 3, it is possible to compare and determine that the mortality of queen bees is 6.6%, which is lower compared to the other materials.

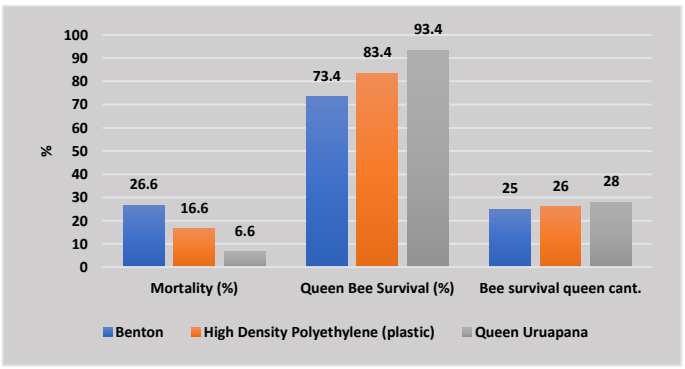

Figure 3.Comparative results of each type of transport cage.

Table3. Validation of the results obtained regarding the amount of surviving queen bees

Cage type	Number of bees	Mortality (%)	Queen Bee Survival (%)	Queen Bee Survival (number)
Benton	25	12	82	22
HDPE	26	3.8	96.2	25
Queen Uruapana	28	0	100	28

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HDPE High-Density Polyethylene cages (plastic)

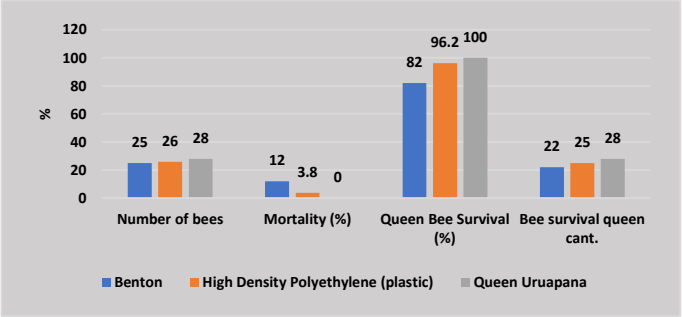

Figure 4.Survival results of queen bees during the experimental stage

As can be seen in Table 3 and Figure 4, it is possible to determine that the life expectancy of queen bees is greater with the proposal of Queen Uruapana.

3.1. Queen cage design

The proposed design of the Queen Uruapana cage is aimed at the adequate transfer for insertion into the new bee hive; the mesh fabric allows the queen to release her pheromones to ensure her acceptance in the new colony [7].

Conditions that a queen bee transport cage Queen Uruapana must have

- Must have adequate space for the protection of the Queen bee
- It should allow observing and filling the candy, food prepared for consumption of Queen bee if necessary.
- The Queen Uruapana cage must have spaces for adequate food that allow the candy to be slowly released to favor the acceptance of the queen bee inside the hive.

Cage Measurements

- The design proposal is spiral, with 8 cm in length and a mesh of 0.2 mm in diameter, at the ends of 2 cm in diameter, and a 10 mm hole that allows the entry and exit of the queen bee.

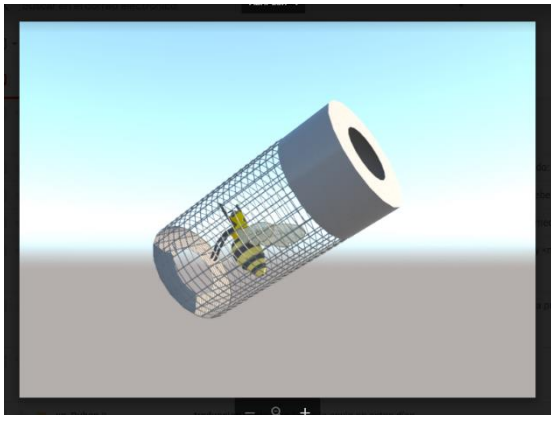

Figure 5. Queen Uruapana front view

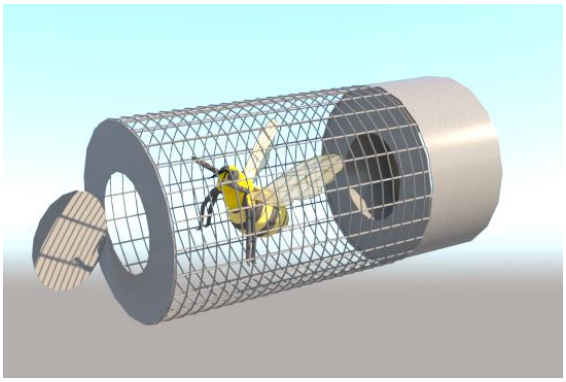

Figure 6.Queen Uruapana horizontal view

3.2 Technical specifications

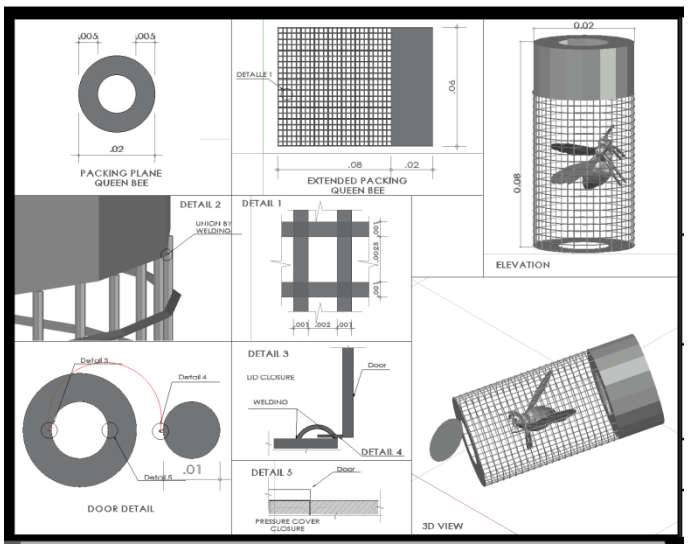

Figure 7.Design drawings

IV. DISCUSSION

The Benton cages are used worldwide for the shipment of queen bees are made of a wooden material of 11 x 3 x 2.5 cm, with three

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compartments; two for the queen and the accompanying bees and a third for the food. It has two ducts that longitudinally across each end of the wood, and the chambers are covered with a metallic or plastic fabric that will facilitate ventilation[8][6]. In the present investigation, the model was not successful due to climatic conditions presented by the place of study; it should be noted that the area of research has approximately 32 microclimates, the effect of which has been evidenced by the highest mortality of queen bees in the present study, which has been helped by the presence of pathogenic microorganisms generated from decomposing biomass.

The cylindrical high-density polyethylene cages proposed for the experimentation of the transport of queen bees, the material under study had less mortality compared to the Benton cage because it presented excellent aeration that allowed the queen to release her pheromones to be accepted in the new hive, however, a weakness of this material was observed due to the constant stalking produced by the bees that tend to spray the plastic generating microplastics that affect the asepsis that the hive should have.

The design proposal of the Queen Uruapana cage in this research is similar to the HDPE cage with the characteristics shown in figures 05, 06, 07 with the current design greater success was achieved in the proper handling of the Queen bees compared to the two transport models, on the other hand, it was observed concerning the asepsis of the material that was also practically successful without risk for the sustainability of the hive [9].

V. CONCLUSION

The Queen Uruapana design allows to minimize the death rate and maximize the acceptance rate of the queen bee in the new hive and can be used in different ecological floors or living areas inside and outside the country.The Queen Uruapana contemplates in its design adaptation to the effects of climate change so that beekeeping is sustainable and allows the continuity of the human species[10].

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