

REPORT OF ACTIVITIES AND DISCUSSIONS RESULTS OF SUBGROUP 3.2.

Honey Bee Management for Pollination Purposes

Coordinators:

01. David De Jong
02. Lionel Segui Gonçalves

Attendants:

03. Farooq Ahmad
04. Kátia Peres Gramacho
05. Ricardo Costa Rodrigues de Camargo
06. Uma Patap
07. Valdemar Belchior Filho

Pollinating agents, especially insects, are clearly essential for agricultural production. Honey bees have become increasingly important, as field sizes have increased and native bees have decreased, due to intensive land use and pesticides. An important advantage of honey bees is that they can be quickly taken to and removed from the fields in large numbers, facilitating the integration of these pollinators into pest management programs. A single truckload can carry 20,000,000 potential pollinators. Honey bees contribute to more than 80% of the agricultural produce pollinated by insects. Unfortunately, Brazil does not have a strong tradition of using bees for pollination, different from the USA, where more than 2,000,000 colonies are rented annually. Beekeeping in Brazil has grown considerably during the last few years, especially due to honey market conditions. Brazil now has about 2,500,000 colonies available for bee products production (honey, wax, propolis, pollen, royal jelly and bee venom) and for pollination purposes. There are beekeepers specialized in pollination, especially for apples, melons and cashews. All of these products are both consumed in country and exported. To obtain export quality fruit, insect pollination is absolutely necessary.

Unfortunately, many of the crops that could benefit from pollination, are either not pollinated at all, or are incidentally and haphazardly pollinated by wild honey bee colonies or by apiaries that happen to be nearby, resulting in production losses due to inefficient pollination. Africanized honey bees are seen much more as honey producers than as pollinators.

For many crops that do not traditionally use honey bees for pollination, such as oranges, peaches, strawberries, sunflowers and forage soybeans, we have data concerning significant increases in fruit and seed production and improved fruit quality with pollination by Africanized honey bees in Brazil (Nogueira-Couto et al. 1998, Couto 2002). Africanized honey bees are very active pollen collectors, making them good pollinators, and they have been found to remain on the target crop longer than do the European honey bees that are traditionally used for pollination in other countries (Basualdo et al. 2000). Africanized bees also are more active on the flowers, fly faster and are quicker to recruit other hive mates, than are European bees, making them more active and efficient pollinators. Africanized bees forage at lower light levels than do European bees, so that they work longer days. They also do not reduce brood production during

winter, so the colonies remain strong, with abundant foragers for pollination activities. It is relatively easy to establish new colonies by collecting swarms with bait hives, and Africanized colonies grow quickly, so that beekeepers can easily produce the large numbers of colonies needed for pollination of crops. There are well-established migratory beekeeping techniques, and truckloads of bees can be quickly and timely moved to flowering crops (De Jong 1996).

QUESTIONS

What are the solutions for the problems of rearing bees in greenhouses?

Africanized honey bees have been used for pollination in greenhouses in Brazil. However many bees are lost from the colonies and it is difficult to maintain the colonies alive under greenhouse conditions. Some researchers and beekeepers have been able to overcome these problems, but the techniques that they use are not published, nor is there an established system that works uniformly under all circumstances. Most attempts to use honey bees in greenhouses are initially unsuccessful, however after numerous trials some researchers have been able to maintain colonies for long periods, efficiently pollinating the crop. In order to make efficient use of this resource, it will be necessary to make controlled studies, and develop standard, practical techniques that should be made widely available to beekeepers and growers.

How to measure the result of using bees in greenhouses?

We can measure the result of using honey bees in greenhouses by examining the crop quantitatively and qualitatively. Normally, this is done by measuring the weight, size and number of fruits, by determining the time till production of the fruits (which may be anticipated by adequate pollination), and by calculating the percentage fruits that are considered of high quality. Another important quantitative aspect is the cost and benefit of the pollination activities. Using honey bees has a cost, and this should be compared with the gain in crop production attained with pollination. Photos of fruit that are produced by plants exposed to bees, versus those that are produced without bees, are often quite useful for illustrating the value of bee pollination. Appearance is important, as the color and shape of the fruit is often affected by pollination. Photos of cross sections of the fruit can show the number and distribution of the seeds, which are clear indicators of pollination efficiency. The fruit quality can also be evaluated by measuring sugar and protein and other substances, and by evaluating organoleptic (taste) factors.

Do we know how to manage Africanized honey bees for pollination?

Yes, we do know for some crops, such as apples and melons, however this is not always done in the most efficient way. Many crops that would clearly benefit from the introduction of bee colonies are not routinely pollinated. Generally speaking, pollination is little valued or understood by farmers, nor are beekeepers aware of the true value of the services that their bees provide. We have data indicating significant increases in fruit, seed and vegetable production due to pollination by Africanized honey bees, however little of this information is

available to the growers. Often objective studies on commercial varieties are lacking. This is true both for field crops and for greenhouse crops. Often, the latter are inviable commercially, unless adequate pollination is provided. Many crops are in fact pollinated incidentally by honey bees from nearby apiaries, or by wild honey bee colonies, however the grower is not aware of the importance of these services. Often he has low production, without realizing that the reason is a lack of pollinators.

What are the main difficulties with managing Africanized bees for pollination?

1. There are no established techniques for using Africanized bees under Brazilian conditions on most crops.
2. Often the hives are not made with standard measures, or with inferior materials, making transport and management difficult.
3. The bees are quite defensive and growers are often reluctant to place them in or near the crops that need pollinating.
4. There is not sufficient care in the transportation of colonies, so that accidents are common and this discourages their use for pollination.
5. Beekeepers are not aware of disease problems, and often incorrectly try to treat their colonies, and some have introduced contaminated bee products and equipment from abroad, threatening beekeeping throughout the country.
6. There is a lack of central laboratories that can provide timely and accurate diagnoses of bee diseases, and also there are no field personnel to advise beekeepers about this kind of problem.
7. Growers are frequently unaware of the importance of bees and pollination, and in fact they often prohibit the introduction of bees into their properties, and they use insecticides indiscriminately and incorrectly without any concern for the effects on the bees and the beekeepers.
8. There is no tradition for making pollination contracts that include a provision for compensation for the beekeeper in the case of losses due to pesticides or the stealing of hives on the grower's property. There should also be a provision about responsibilities in the case of an accident with the bees.

PROBLEMS TO BE OVERCOME

Changes in agriculture have created an increased need for honey bees.

There is pressure to convert natural areas into agricultural land, without concern about maintaining habitat for pollinators. Loss of natural pollinators due to the loss of habitat increases the need for honey bees. More intensive farming and larger fields of crops overcomes the capacity of local native bees to pollinate. We need to develop techniques and policies that will increase the availability of honey bees to satisfy these increasing needs for pollination. Landowners need to be made aware of the value of having bees placed near the crops.

The extension service (agriculture house - casa de agricultura) does not provide appropriate information about pollination. Unfortunately, even in the case of crops for which we have clear evidence that honey bees significantly increase production, growers frequently do not include pollination in their management programs, and often even prohibit the introduction of bee colonies

onto their property, or they may charge the beekeepers, while in other countries the beekeepers are paid for their services. This lack of a tradition to include bees greatly diminishes the potential gain of the growers. We need to have more data and then convince the growers by using demonstration plots.

Bee diseases

Some new diseases from other countries threaten beekeeping, and hence can affect the availability and quality of honey bee colonies for pollination. Unfortunately these incidents of new diseases have not been sufficiently controlled and studied by competent researchers and authorities. Beekeepers are also unaware of the need for good practices that will avoid the introduction of these new diseases. For instance, honey and pollen that has been imported (both legally and informally) is often exposed to the bees. Honey is handled in processing plants, and often some of it is inadequate for human consumption; beekeepers feed such discarded honey to their bees (Message and De Jong 1998). This has resulted in the introduction of American Foulbrood Disease (*Paenibacillus larvae*) spores from imported honey into honey bee colonies. This needs to be more closely investigated, and the beekeepers should be made aware of the danger of such practices (De Jong 1996). A similar problem has occurred with a fungus disease, Chalkbrood, caused by *Ascosphaera apis*, which entered Brazil in imported pollen. The beekeeper normally cleans the pollen pellets and the powdered pollen that is left is fed to the bees. Chalkbrood has now become established in several parts of Brazil as a result of these practices; we need to have more information about the impact of this exotic disease on Africanized honey bees.

There are no central laboratories to identify diseases.

Beekeepers need to have a place to send samples in order to learn what diseases they have, and to determine whether their problems are really caused by parasites or disease organisms. This service exists in all major beekeeping countries, and now should be implemented in Brazil.

Beekeepers do not know diseases

Diseases are normally not a big problem in Brazil, but beekeepers sometimes incorrectly try to treat colonies with antibiotics and acaricides whenever they suspect a disease. Their lack of knowledge and lack of government infrastructure to help them cope with disease problems often makes them take inappropriate actions. Besides the unnecessary costs and damage to the bees due to such home-brew treatments, there is a danger of contaminating the bee products. We need to study the actual disease problems and determine nutritional needs. A lack of information about nutrition, especially protein needs, actually causes many problems that are mistaken for disease. Steps have been taken to more objectively evaluate honey bee diets (Cremonez *et al.* 1998), but these techniques need to be used systematically in order to develop economically viable pollen substitutes.

Problems with quality and standardization of the beekeeping equipment

In some parts of the country non-standard hives are used. Among those who use standard Langstroth equipment, there are often problems with non-standard measurements. Beekeepers are often not aware of the correct standards and they make their hives based on equipment that they have purchased. As the purchased hives are often not exactly built, badly dimensioned hives are perpetuated. New beekeepers have often purchased bad equipment with funds that they have received on credit. These can be badly built hives, with uncured "green" wood, or made with wood that is inappropriate for apiculture. Such hives start to bend and open within a few months. Unfortunately, the funding agencies that set up programs to foment apiculture often provoke these kinds of purchases of substandard materials due to cost-competitive purchasing policies. Later, the beekeepers have a difficult time repaying the cost of the equipment, as it is often discarded within a short time.

The handling and transport of beehives in Brazil is not mechanized

Now all hives and honey supers are transported from trucks to the apiary, and back, by hand. Hives are heavy, especially when they are full of honey. This hand carrying often causes back problems for small-scale beekeepers, which depend on family labor. Beekeepers with larger numbers of colonies must hire help, and this makes their management expensive. A beekeeper in the USA or Canada can handle more than a thousand colonies by himself, or with only a single helper. A similar number of colonies in Brazil would need at least five or six laborers, and the moving process would take much longer than in the other countries. Transporting colonies for pollination requires specialized labor, at specific times. If beekeeping had mechanized alternatives, then this transport would be cheaper and more efficient. However, the fork lifter tractors (bobcats) currently used in other countries are too expensive for Brazilian conditions. It would be more cost efficient to pursue intermediate, less costly, alternatives for mechanization. We need to identify appropriate techniques for hive lifting and transportation, and test and adapt them to local conditions.

Problems with a deterioration of natural areas

The lack of natural areas means that bees have no wild flowers for supporting and maintaining colony growth. This often means that the colonies are weak or can even die and therefore are not available for pollination services. In various parts of the country there is so little natural forage that beekeeping is uneconomical, especially in regions where there is intensive agriculture and therefore with a great need for bees for pollination. We need to find ways to incentivate the maintenance of natural areas on farms (possibly through tax incentives) and to have states and municipalities plant trees that provide forage (nectar and pollen) for pollinators.

There is lack of natural forage for the bees

The lack of natural forage during various times of the year can be partially overcome by artificial feeding of sugar and protein diets. However sugar is often too expensive, so it would be useful to have a means to provide sugar or sugar

syrups at a low price for the beekeepers to properly prepare their colonies for pollination. The most important nutritional problem is a lack of appropriate protein when pollen from flowers is not available. At the moment no adequate artificial diet is available. Such diets need to be developed and tested. A relatively simple laboratory technique developed in Brazil is available for the initial screening of food by-products that could be used as protein sources for bees. Large scale testing should be done, with field testing and demonstration of the most promising alternatives (Cremonese et al. 1998).

There are misconceptions about how bees could impact on crops.

In some crops, such as oranges, there are misconceptions about danger of bees transmitting plant diseases. Generally, decisions are made without any real evidence of such a problem.

There are often problems with beekeepers getting permission to place bees on farmland - due to fear of the bees interfering with cultural practices, while growers are unaware of the value of pollination.

We need to have case studies about how bees interact with crops and to have documented information that will help growers and beekeepers understand the real effects of bees on crops. Some of this information is available from other countries, and can be used and appropriately communicated. However local experimental work should also be done to test the impact of bees under local conditions.

There are problems with transporting bee colonies

Beekeepers are not aware of their responsibilities and correct procedures when they have an accident during transportation of hives from one region to another. They are often unaware of the best ways to transport bees, and therefore accidents are more common than they should be. They often lose bees that escape from the hives, and many colonies die due to overheating. The local authorities are often unaware of the importance of the need for timely movement of colonies, and may interfere with transport.

There is no sanitary control of the movement of colonies.

Though Chalkbrood, a fungus disease, has recently been diagnosed in Brazil, and American Foulbrood is suspected, there is no sanitary control of the movement of colonies. Consequently these new bee diseases could be spread to new regions, causing damage to apiculture, which could affect the availability of bees for pollination. It is recommended that there be intensive studies of these new diseases, to determine their occurrence and their impact on the colonies. Government agencies should be prepared to diagnose diseases in the laboratory and to train bee colony inspectors who can make field diagnoses and develop and implement appropriate control policies.

Beekeepers have problems with hives being stolen

Apiaries often have to be placed in remote places where the colonies are easily stolen, due to inappropriate management and fear of the bees. The

government and the police normally gives little support to the colony owners, and often take no action, even when there is proof that colonies or colony products have been stolen. Policies should be developed to provide legal and police support to reduce this colony thievery problem. Case studies need to be made to find ways to maintain apiaries in ways that there is less impact on farm workers and animals, so that apiaries can be kept in more protected areas. Insuring colonies against robbery is also nearly impossible, making financial security for the beekeeper nearly impossible.

Problems with pesticides

Presently many honey bee colonies are killed by pesticides. Beekeepers avoid crops where insecticides are used - this reduces honey production and agricultural production. Crops such as cotton would be more productive if the bees could pollinate them. Native bees and wild honey bee colonies are killed by excessive and inappropriate use of pesticides, making it necessary to bring in commercial honey bee colonies for pollination purposes. Labeling of these pesticides should include information about toxicity to bees.

Case studies to assess main pesticide problems that affect bees.

Develop a manual about the use, value and care of honey bees. Take advantage of case studies about improvement of production and quality of farm products to educate farmers about how to best incorporate pollination into their management practices. The impact of the most commonly used pesticides on flowering crops should be investigated.

Farmers and policy makers are often unaware of the need for pollination.

Growers often unaware of need for pollinators and of pollinizer varieties. International pollination techniques need to be adapted to local conditions. The agricultural policies normally ignore the need for pollinators. EMBRAPA, SEBRAE and other appropriate institutions, such as universities, should develop projects to test the value of pollination on crops and varieties. They should also develop crop management schemes that minimize the impact the effect of insecticides on honey bees. This information should then be made available to the farmers. There should be demonstration fields and courses to make the farmers aware of how much they can gain by including pollination in their management scheme.

We need clear recommendations about number and size of colonies needed, and how to place them. Agricultural extension does not currently train farmers about ways to manage their crops for maximum pollination. They need to develop courses and educational material. They should develop case studies in cooperation with local growers (on-farm experiments).

Consumers are not aware of how to select good quality (well pollinated) fruits and vegetables.

Demonstration materials should be developed to help the consumer recognize and choose good quality products. Fruits and vegetables, such as melons, watermelons, apples and cucumbers, often have fewer than normal seeds, which results in inferior products with a bad taste. Such an awareness and educational programs will create a more sophisticated consumer and will incentivate growers to use bees to produce high quality fruit.

Rearing and management of Africanized honey bees in greenhouses

Current problems:

- Lack of knowledge of the minimum requirements necessary to use Africanized bees in greenhouses (size of the colony, best time to introduce the bees to the crop, culture specifics and management techniques).
- Misconceptions about Africanized bees as effective pollinators.
- Aggressiveness of the bees;
- Lack of technical and practical experience.

Proposals:

- Make producers aware of the usefulness of honey bees for pollinating in green houses;
- Inform public and private agencies involved in rural extension, technical assistance and promotion.
- Encourage research institutions to make studies on this subject, through specific guidelines and financing.
- Develop informative material, as a tool to encourage increased use of honey bees in greenhouses, informing about successful experiences in Brazil and from other parts of the world, and by examining economic criteria.
- Develop incentives for using honey bees as pollinators in greenhouses and reducing the use of pesticides (tax deductions, low interest loans, etc.).
- Publicity campaigns informing about the better quality of well-pollinated fruits and vegetables, uncontaminated by pesticides.
- Encourage and make available techniques for producing food in greenhouses.
- Capacitate technicians involved in extension and who assist farmers so that they can help them use honey bees as pollinators in green houses.

State of the art of the use of Africanized honey bees for pollination.

Currently, honey bee colonies are rented for pollinating apples, melons, cashews and some vegetable crops in Brazil. There are efficient techniques for transporting the bees, but data on other cultures are lacking. Isolated experiments have demonstrated the value of bees for many crops in Brazil, but these have not influenced the growers, and more objective and thorough experiments are needed, preferably with demonstration plots to show the value of pollination to the farmers.

Rental prices for bee colonies

Beekeepers and growers are generally unaware of how much they can or should charge for their services. There is little tradition for this activity, and beekeepers often have a difficult time to determine their real costs and the

monetary benefits for the farmers. This requires economic studies, which should then be made available to both parties.

Case studies to determine need for pollination of major crops

Use of Africanized bees for pollination

Recommendations for case studies

Cotton

o Mid Eastern states: high tech production in

o NE: MA, CE, PA, PE, AL, BA

Problems:

- Incorrect use of pesticides
- Lack of knowledge about natural pollinators.
- Though this plant produces abundant nectar, the intensive use of insecticides results in extremely reduced pollinator populations in and around the fields.
- We have some data that cotton is benefitted by honey bee pollination
- We need to determine the real effect of honey bees on cotton yield and quality, and determine the integrated pest management techniques that will permit co-existence of the bees with the crop. Economic studies should be made to determine the costs and benefits of including honey bees in cotton production.

Melons

o Principal producers: CE, RN

o Export product

o Initiated and expanded continuously during the last 6 years, always with honey bee pollination.

Problems:

- Incomplete information about the benefits of using pollination to improve the quality and the quantity of the fruits produced
- Fear of the strong defensive behavior of the Africanized bees
- Productivity can be increased more than 40% with adequate pollination, however the responsibilities of the farmer and the beekeeper are often not well defined

We need to have good data on the real economic advantages of using honey bees for melon pollination, and how to maximise this contribution, taking into account the negative effects of cultural practices on the honey bee colonies. We also need to determine the most efficient means to improve pollination efficiency.

Citrus

Export crop (juice concentrate).

Problems:

- Intensive use of insecticides

- Spraying during flowering
- The increased quality and quantity of fruits that come with pollination is generally unknown.
- The growers unjustly fear that the bees will spread diseases.
- Fear of the strong defensive behavior of the bees - the farmers may reject having them near their orchards

We need good data on the benefits of pollination for fruit production and quality in all the various varieties of oranges. We need to demonstrate these benefits to the farmers and work with them to reduce the impact of pesticides used in the groves on the bees.

Coffee

o One of the principal Brazilian export products

Problems:

Lack of financial incentive for beekeepers to introduce their colonies into the coffee fields

- Flowering is very fast, less than a week.
- Flowering occurs at a time when the bees are in orange orchards
- Coffee honey is not highly valued
- Use of pesticides

Though we have some good data on the value of honey bees for improving coffee production, we need more thorough testing in modern cultivars and fields to determine the best recommendations for pollination. As beekeepers would not normally take their hives to coffee plantations, economic studies should be made to determine adequate pollination fees, taking into consideration the benefits for the growers.

LIST OF RECOMMENDATIONS

1. Recommend that a document be developed about the state of art of the use of Africanized honey bees for pollination.
2. Recommend to prepare and distribute a manual on standard methodologies for rearing Africanized bees for pollination purposes.
3. Recommend to develop a central library with all the available Brazilian literature on pollination, including theses and congress proceedings, and that this be made available via internet. This has been initiated at the University of São Paulo campus in Ribeirão Preto, SP, but it needs to be improved and made more widely available. There is a book with a collection of 300 thesis abstracts (in Portuguese and English) and a list of over 2000 publications on bees made in Brazil until 1992 (Soares & De Jong 1992). This material has been updated periodically and is kept in a database, which is available to some researchers. We need to create a means to archive and digitalize all of these articles and theses, so that this information will be more widely available, and will not be lost.

4. Recommend to initiate a scientific journal on pollinator biology in Brazil. Brazil has many bee researchers, however much of the information is not readily available. A scientific journal will help remedy this problem and will help direct students and professors to study pollination problems. This journal could be produced online at relatively low cost, and could help consolidate bee research in Brazil.
5. Develop a manual on research techniques for pollinator studies, especially to determine the value of pollinators for crop production.

PROBLEMS

- Beekeepers generally are not concerned about determining the pollinating efficiency of their colonies, but are only trying to produce the largest possible amount of honey.
- Beekeepers do not know how to stimulate the bees to collect pollen, which increase pollination efficiency, instead of nectar.
- Beekeepers do not know how to direct bees to a crop that needs pollination.
- Beekeepers distribute their beehives in a manner that is convenient for management, without concern or knowledge about the most efficient arrangement to facilitate pollination
- Beekeepers manage their bees only for honey production because the farmers normally do not pay for pollination services
- We do not know the support capacity of agricultural areas for honey bee colonies:
- How many honey bee colonies can be placed in a specific area?

Rational Program of Pollination

Actions Why?

1. Determine how well crops are pollinated currently and investigate the production potential if there is full, adequate pollination. Some crops are already well pollinated, and additional pollinators do not increase production. In other crops and regions, there are so few natural pollinators that supplemental pollination can make the difference between uneconomical production and profit
2. Estimate economic viability of pollination program - The producer need to have an idea about whether it will be economically viable to use pollination for his crop, considering the costs involved with personnel, transport, and renting bee colonies, compared to the increases in production.
3. Identification of the requirements of the crop and determination of the pollination needs - Each vegetal species has its own specific pollination needs and appropriate pollination techniques are needed to fullfil these needs.

4. Determine the pollination strategy that should be used. There is a need to determine the number of colonies per hectare, the arrangement and temporal placement of the colonies and integration with other cultural practices.
5. Design and install apiaries and infrastructure necessary for pollination. Determine the number of apiaries and colonies that will be needed at appropriate times to give support to the pollination activities.
6. Training of personnel responsible for maintaining the colonies in conditions adequate for pollination. Preparing colonies for pollination requires specific management so that they will be at an adequate stage of development and with sufficiently large populations to adequately pollinate the crop.
7. Training of personnel to collect pollination data in the field or hire such help. The results of pollination should be constantly monitored.

RECOMMENDATIONS

What are the conservation measures necessary to keep a stable population of Africanized bees in the cropping areas?

- Incentives, such as tax exemptions for beekeepers and for growers for pollination of crops in Brazil;
- PDF-B should make a policy of recognizing the need for Africanized bees for pollination.
- Conduct case studies to show the importance of wild pollinators in respective habitats
- Stop indiscriminate logging and commercial felling of trees by enacting laws
- Promote and encourage re-conversion of a certain percentage of intensively cultivated areas to provide rescue space for the multiplication of wild honey bee colonies by providing incentives (tax exemptions, subsidies etc.)
- Train farmers in making judicious and safe use of carefully selected, less toxic, pesticides in safer formulations
- Promote IPM (Integrate Pest Management).
- Provide nesting strips/spaces in the vicinity of the cultivated areas and encourage multiplication and growth of native plants that can provide food for wild bees
- Encourage agro-biodiversity by planting some areas with native plants

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