REGIONAL TRAINING OF TRAINERS ON BEE-KEEPING TECHNOLOGY, HONEY PRODUCTION AND POST HARVEST HANDLING OF BEEHIVE PRODUCTS: DAR ES SALAAM FROM 10TH-12TH AUGUST, 2015

TRAINING MANUAL FOR POLLINATION SERVICES

EAST AFRICAN REGION

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Pollination

Module 1: Introduction to Pollination

1.1 Introduction

Pollination is the process by which pollen is transferred from anther (male part) to the stigma (female part) of the plant, thereby enabling fertilization and reproduction. It is unique to the angiosperms, the flower-bearing plants. In spite of a common perception that pollen grains are gametes, like the sperm cells of animals; pollination is an event in the alternation of generations. Each pollen grain is a male haploid gametophyte, adapted to being transported to the female gametophyte, where it can effect fertilization by producing the male gametes, in the process of double fertilization

1.2 Learning Objectives

General Objective: To impact knowledge of pollination services to ensure the sustainability of crop production

- By the end of the session, participants will be able to;
    i. Define pollination.
    ii. Understand the importance and use of pollination services to yield crop production.
    iii. Identify and list down bee forage plants in their areas.
    iv. Explain possible dangers to bees arising from spraying crops with pesticides.

Target Participants: Beekeepers associations, extension service providers, and organizations/Institutions

Suggested Number of Participants: A maximum of 40 persons

Duration: 2 hours

Materials: Flipchart and masking tape, marker pens, notebooks and pens, worker bee, flowers, pictures and hand outs.

1.3 Learning Methods and Steps

These are the steps used in the learning process.

Methods: The learning methods included the following;

i. Lectures – Power point presentation.
ii. Brainstorming.
iii. Group discussions
iv. Activity- develop a flowering calendar
v. Field visit.

Steps: This was the steps that were used in the learning activities;

Step 1: Write the title "Pollination" on the flip chart and introduce it by defining it and let the participant contribute on what they know about pollination (ref. Introduction of this training manual)

Step 2: Engage the participants to brainstorm on the importance of pollination.

Step 3: Allocate the participants in 2- 4 groups and assign them the following tasks

Groups: The learning groups

Group 1: Identify and list bee forage plants in your areas.

Group 2: Explain the dangers of agricultural pesticide use on bees (ref. to Pesticide section).

Step 4: In plenary, participants present findings, the trainer clarifies and summarizes the outputs.

Step 5: Output from the field visits

The Use of Pollination Services to Yield Crops production

Module 2: The Value of Bees for Crop Pollination Services

Pollination is a vital step in the reproduction of flowering plants and is necessary for all seed and fruit production. Over 75% of all the crops in Sub Saharan Africa benefit from insect pollination. Other agents of pollination are wind, animals, birds, water, man and reptiles. Insects including bees forage plants for food, and they visit many flowers a day in searchof pollen and nectar. Many flowering plants depend upon these insects for the pollen transfer (pollination) as they forage.

Adequate insect pollination improves the quality of the crop; uneven, misshaped and small fruits are often indication that pollination has been insufficient. Among the insects, bees are considered the most efficient pollinators because they have hairy bodies which easily pick up pollen grains as they move about in flowers. During a single day one bee may visit several hundred flowers. Furthermore, bees are consistent foragers and tend to work one kind of flower at a time.

Scout bees will locate the best flowers and then encourage their hive mates to use the same source. Pollen from the anthers is trapped in hairs covering the bee and carried to the stigma of the same plant or another from the same species. This is the first step towards fertilization and the production of seeds and fruits. Bees, therefore, play a vital role in food production and overall agricultural productivity, as pollinators. So beekeeping provides pollination services.

Conserving forest biodiversity is therefore important for beekeepers. Forest trees native to Africa that are important for bees include among others; *Acacia specie; Coffea species; Combretum species; Diospyrus species; Dombeya species; Julbernardia globiflora; Pentaclethra macrophylla; Vernonia amygdlina*; *Calliandra callothyrsus; Eucalyptus sp and Musa sp.*

Insect pollination and pollinator protection are not included in most of the training books for agronomists, extension officers and farmers. Many farmers all over the world do not recognize the need for bee pollination and consequently many bees are killed by careless use of pesticides. Even many beekeepers and honey hunters do not know about pollination and cannot inform the farmers about the need for protection of bees. It is estimated that about one third of all plants or plant products eaten by humans are directly or indirectly dependent on bee pollination. More than half of the world's diet of fat and oil comes from oilseeds such as cotton, rape, sunflower, coconut, groundnut and oil palm.

Even though some of these have special pollinators belonging to other types of insects, these plants all depend on, or benefit from bee pollination to some extent. In addition, many food crops and forage for cattle are grown from seeds of insect-pollinated plants. The great value of bees as pollinators has been known for many years, but unfortunately, this knowledge is not widely appreciated and understood. Some types of crops have flowers that may only be pollinated during a short period. If such a crop is not pollinated during that time, the flowers will fall and no seeds or fruit will develop.

2 .2 Pollination in Banana tree

There have to be sufficient numbers of bees in the pollinated crop. This is especially important in crops where the single flower may only be pollinated in a restricted time or in crops where the nectar production, or bee visits only take place during days where the temperature is at a certain level. In such a crop, the pollination in some years has to take place within three or four days. This can be the case in growing white clover seed. The flowers only produce some special smelling products attracting the bees to the flowers when the ground temperature is above 15 ^{0}C. When the temperature is lower, only a few bees are interested in visiting the clover flowers. It means that the whole pollination work in some years has to be done in a very few days, where thousands of worker bees are needed to do the job. If the farmer does not provide fields with honeybees or other bees for pollination, the whole harvest can fail. A honeybee can therefore visit 18-20 flowers in one minute.

Example, In South Africa the pollination of F1 onion hybrid seed production is entirely dependent on high insect pollinator activity to ensure cross pollination, seed set and profitable seed yields. They know this will give a far better chance for a good harvest. Some farmers believe that the beekeeper will get a big honey harvest when moving bees to fields for pollination, and therefore they do not want to pay for the work. The beekeepers often lose many bees when moving hives for pollination purposes, and they often do not get a worthwhile honey harvest from pollination work. It is therefore necessary for beekeepers to be paid for the service. It is recommended that there should be at least four combs with unsealed brood, to ensure that bees have to collect a lot of pollen for feeding the brood. It is sometimes found that the farmer or owner of a plantation wants the beekeeper to pay to place the beekeepers' hives in the farm. If neither beekeepers nor farmers are aware of the pollination value of the bees, this situation will never change. The farmer receives a smaller harvest and the beekeeper does not gain access to a good site for the bees.

The pollinatory value of bees, even in the same crop, can vary from one place to another. This is because there are many variables: the temperature, the water table, the other pollinator insects in the environment, and other available forge for bees, etc. The best arrangement can be a

permanent apiary inside a fenced area of a plantation, to ensure adequate pollination. It can be an agreement between the farmer and the beekeeper, so that the farmer provides the beekeeper with a protected site, and the beekeeper provides the farmer with permanent pollination. The space needed for ten hives would only need to be between 10 and 60 m2, and this can be any scrap of otherwise unusable land. A good place for an apiary is where there is forage for the bees outside the blooming of the crop: if this is the case, the bee colonies will be strong for the crop pollination period.

2.2.1 Significance of Bee Pollination

2.2.1.1 Bee pollination gives better quality and quantity of harvest

Bee pollination not only results in a higher number of fruits or seeds, it may also give a better quality of produce, and the efficient pollination of flowers may also serve to protect the crops against pests. The better weight due to sufficient pollination arises from the development of all seeds in a fruit. An apple, for example, will only develop all the seeds inside if it has been pollinated by several bees and fully fertilized. It is possible for an apple flower to develop about ten seeds. If all the seeds do not develop, the fruit itself does not develop where the seeds are not developing. This results in poorly shaped apple of low weight.

The bee pollination in Sunflower creates a higher content of oil in the seed. Sufficient bees will also take care that all the plants in the field are pollinated in the same period, so the seeds ripen at the same time. This allows harvest of a uniform crop. A sufficient number of bees for pollination can also protect the crop against serious pest attacks. A single sunflower is waiting for pollination and fertilization before it closes and falls off. If bee pollination is needed, yet there are not enough bees present, pollination can take many days. In that time the flower is attacked by different pests eating the pollen, sucking the sap, laying eggs in the flower, or spoiling it in other ways. If there are sufficient bees in the field, the flowers will only have to be open for a short time, and the different pests will not have so much time for their destruction. In that way, adequate numbers of bees ensure rapid and efficient pollination and protect crops against pests.

2.2.1.2 Where to Place Hives for Pollination

It is important that colonies of honeybees can be moved quickly to a crop that is ready for pollination. It is not possible to have readily available, high populations of transportable colonies of other pollinating insects, except the small bumblebee colonies used in greenhouse pollination. If honeybees are placed in a crop for pollination, they will be working in the field, even in relatively bad weather, because of the short flying distance. The hives of honeybees have to be moved at night-time or at least when all the bees have returned from foraging. The hive entrance must be closed, and some ventilation provided with a net screen at the top or bottom. When the hive is transported, the bees inside start moving around and produce much heat. If they are

moved in the tropics in day-time, they must be kept cool with wet sacks placed over the hives. They always have to be moved with soft and slow movements.

It is also recommended to feed the bees with water. If a hive with bees is not handled carefully, or it is too hot during the transport, the temperature inside can become so high that the combs start melting and the whole colony can collapse. The melted wax mixed with honey is extremely attractive for stingless bees, other honeybees and ants and they will start robbing the melted colony as soon as the entrance is opened. The result can be the death or absconding of a good honeybee colony.

2.3 Bee Hives located near the Sunflower farm in Dodoma

When moving bees some forager bees are always lost. Maybe they do not orientate when they fly out in the morning in the new place. If a hive is only moved a few meters the forager bees will return to the place where the hive entrance used to be. When they do not find their hive there any more, they try to enter into other colonies, with the risk of being killed. Therefore colonies should never be moved a distance of less than two kilometers. It is better to have greater

distances and longer moving times: then the bees will be more aware that something has happened, and they will orientate when the hive is opened in the new place. If it is necessary to move a colony a shorter distance, it should only be moved one metre a day. The beekeeper can guide the bees to special crops for pollination. By feeding the colony inside the hive with sugar syrup mixed with flowers from the crop. To a certain degree, this will make the bees search for that scent and find the crop concerned. The feeding has to take place inside the hive to prevent fighting between bees from different colonies.

It is important not to spill any sugar water on the ground because it will attract ants to the area.
It is important to place colonies for pollination inside or as near as possible to the crop requiring pollination. If there is another crop also attracting the bees, the hives must be placed so that they have to cross the field the farmer wants pollinated, before they can reach the other attracting crop. If possible, the hives should be spread out within the crop. If we consider that maximum harvest of seeds or fruits require maximum pollination, it is clear that there is a potential lack of bee colonies in many areas of the world. This lack is much bigger than the number of existing bee colonies, and even if all hives were easy to transport and could be placed in the b fields for the most effective use, still there would be a lack of many millions of bee colonies.

2.4 Why Honeybees often are the Most Important Crop Pollinators

The effectiveness of honeybees is due to their great number, their social life and their ability to pollinate a broad variety of different flowers. A colony can consist of 20-80 000 bees, and they will normally be visiting flowers over a distance of two kilometres when they are collecting pollen and nectar. If nothing is to find in the neighbourhood, they can fly even seven kilometers. A normal *Apis mellifera* honeybee colony will make up to four million flights a year, where about 100 flowers are visited in each flight. The honeybee's pollination effectiveness also arises from the special constancy to flowers of one species. Scout bees communicate to other bees in the colony which species to visit, and even give small tastes of nectar and scent from that flower.

When the pollen loads of honeybees are investigated, pollen mixed from different species of flowers will only be found in three percent of loads. The rest will be with pollen from just one species. This clearly indicates the flower faithfulness of honeybees.

2.4.1 Beehives in crop farms

Honeybees do not waste their time visiting flowers not yet ready for pollination. Some flowers can only be pollinated during a certain time of the day; they guide the bees to come at that time by restricting their nectar production to that time. Individual bees learn when the different flowers produce most nectar and apparently 'remember' it from day to day. As mentioned before, a worker bee remembers "opening hours" for 7-10 different types of flowers.

2.4.2 Flowers which are not ready for pollination

It is estimated that 75 percent of all wild blooming plants depend upon insect pollination, and most of the flowers are pollinated by honeybees a. All the crops, fruit trees and wild flowers blooming before midsummer are dependent from visits of bees to be able to develop their seeds, berries and fruits. The economic value of bee pollination in nature and the great ecological

importance of that cannot be counted, but for sure, it must be much greater than the economic value of crop pollination.

2.5 How to See If a Crop Is Adequately Pollinated

It is difficult to give exact numbers for how many colonies a particular crop requires for the best pollination, but at the time of harvest, it can be judged if there have been sufficient bees, and that experience must be used for the next season. At harvest time, a well-pollinated crop has:

i. Well-shaped fruits.

ii. Well-filled seed pods

iii. A uniform seed set

iv. Tight clusters of fruits or seeds.

2.5.1 A well pollinated crop – Dodoma Tanzania

From research and experience, it is possible to recommend a certain number of bee colonies per hectare when growing a crop, but many other factors can influence if it is right. It should be known how many wild colonies or apiaries there are nearby and if there are other fields in the neighborhood with attractive crops competing for the bees. This estimate is partly a matter of experience. It is possible to measure the need for bees directly in some crops.

In cotton, for example, at the flowering time there should be one honeybee to every ten open cotton flowers to provide adequate pollination. Every time it is possible to count ten flowers when walking in the field, there should be at least one honeybee observed among them. If it is possible to count 20 flowers before one bee is seen, the number of hives for pollination should be doubled. It is recommended to use between five and 12 colonies of bees for pollination of one hectare with cotton. The case with cotton also illustrates a great problem. Cotton needs many bees for pollination, yet at the same time, cotton is one of tropical crops on which most pesticide is used. Cooperation between farmer and beekeeper is essential if both are to benefit from each other.

Table 1: Examples of cultivated plants that need honeybee pollination

Crop	**Bee colonies* to 1 ha**
Seed	8 colonies
Apple	4
Apricot	2
Asparagus seed	4
Avocado	5
Bean (Lima)	3
Blackberry	7
Blueberry	8
Cabbage	5
Brassica (canola, oilseed rape)	5
Carrot seed	8
Clover seed (White)	4
Citrus	2
Cotton	8
Cucumber	7
Mango	15
Sunflower	2
Peach and nectarine	2
Onion seeds	17
Watermelon	5
Strawberry	8
Pumpkin	4

The use of pesticides

3.1 Pesticides

Bees are living hazardous lives, as farmers all over the world use more synthetic pesticides. Environmental pollution by pesticides continues as an increasing problem, especially in the tropics and subtropics. It arises from the development of large-scale cultivation of single crops or monocultures. The increased use of exotic cultivars of crops is often accompanied by increased use of pesticides. When these plants are growing under new environmental conditions they are often attacked by pests to which they are not adapted, and that problem is often approached by using more pesticides. When bees are in agricultural areas, they often collect their nectar and pollen from cultivated plants from fields with oil seeds, orchards or vegetable gardens. Farmers are treating these same areas with pesticides and herbicides.

Most of these chemicals are poisonous for bees and some are extremely dangerous both for bees and for people. If they are spread even in very small amounts over a blooming field, they can result in serious destruction of many bee colonies. Some types of pesticides only show their negative effects after a long time or with great doses, but synthetic pesticides can never be used without any risk. Even if they do not kill the bees, they can disturb the normal function of the colony, for example by causing bees to lose their ability to orientate correctly, or to communicate. We often find heavy use of pesticides in small vegetable gardens, producing food for the family and the local market. The use of pesticides should be banned in these places, because it poisons people eating the sprayed products, and because the local drinking water and other food were contaminated.

Herbicides (used against fungus and weeds) are often thought to be of no danger for bees, but that is not true. If the bees have no fresh water close to the hive or nest, they will collect dew in the morning on the leaves of grasses or other crops, independent of any flowers around. If such a crop has been sprayed, the bees can be poisoned as they are collecting their water. To prevent this from happening the beekeeper should always provide the apiary with fresh water. It can be given in a tin can with sticks or grass inside where the bees can sit and drink without drowning. If monkeys are a problem because they want the water, the tin can should be secured to a tree or

pole and covered with a metal net. The water source must never become dry, as then the bees will immediately start looking for water in another place.

Ensuring an apiary always has water has other good functions. The bees do not need to use so much energy for fetching water and can make more honey instead, and if they always have water nearby, they do not disturb people at the wells, who may step on the bees with bare feet. If bees are killed by a farmer using pesticides illegally, the farmer must pay compensation to the beekeeper. If the beekeeper has not supplied the apiary with water, it can be a problem to receive the compensation. In one case a farmer who killed many bees by spraying carelessly, had to pay compensation to several beekeepers, but also to the neighbouring seed growers because their harvests were diminished due to the lack of bees in the area.

Many pesticides forbidden in the industrialized countries are dumped in developing countries: i.e. companies selling their stocks of pesticides to developing countries after the product has been forbidden in Europe or in North America. An estimated one third of all pesticides used in the developing countries do not fulfil international standards for security. FAO has declared that this is a serious danger for the health of people and the environment. Instead of paying for safe destruction of the pesticides these companies can receive support for exporting them. Even when selling the products at a very low price this is better business for the company than safe storing or destruction. Some of these products have a bad quality and contain chemicals leading to fatal accidents if not used very carefully. A great problem in developing countries is bad labeling of products. Often the farmer receives a pesticide in old bottles or plastic bags without any hazard warning sign. There are also cases where pesticides containing DDT have been sold as a harmless natural product. When pesticides are delivered in second hand food containers like cola bottles or sugar bags, this results in people accidentally drinking or eating the poison. Often pesticide containers are subsequently used for rainwater containers, and people are poisoned in that way.

Some pesticide producers are more interested in selling their products, than in giving information concerning the dangers of using them. In developing countries, it is often easy to get hold of cheap pesticides, but often impossible to get sufficient protective equipment for use of the person spraying. Some tropical honey hunters have the idea that insecticides made for killing flies and

mosquitoes can be used in honey hunting. Instead of using fire and burning the bees, they now use the spray. The honey gets a nice smell of perfume and does not smell from smoke, and they do not know that people eating this honey can be very ill and even die.

The poisoned honey is sold in second hand bottles in Bees and their role in forest livelihoods the market and the costumers cannot see if the honey is from a beekeeper or a honey hunter. It should be the responsibility of the producer to take care that the product is used in a way as safe as possible for the farmer. Many farmers in the developing countries cannot read a label, but it is possible by using drawings to inform about their use and danger. There are groups of tropical farmers acting against the import of dangerous and (in industrialized countries) forbidden pesticides, but the lobby of the producers has until now succeeded in preventing such a ban.

3.2 How to Protect Your Bees against Pesticides

The beekeeper can help reduce bee poisoning in different ways:

i. Bees can be kept at a distance safe from areas where pesticides are being applied. This must be at least seven kilometres to be quite sure. In that case, the farmer gets no pollination from the bees. The beekeeper and farmer can co-operate. If the beekeepers learn about different pesticides and their use, they can discuss with farmers, warn them against the most dangerous pesticides and develop beneficial agreements concerning pollination services and the prudent use of pesticides. It will often be an advance if the beekeepers have an organization, which can help in negotiating with farmers or authorities.

ii. Bees can be moved away before the spraying takes place, and be kept away as long as the poison is still active in the flowers. If pesticides are used on flowering plants, near the hives, and it is too difficult to move the hives away, the bees can be confined inside the hives. That can be done by closing the entrance with a net and cover Bees and their role in forest livelihoods the hive by large burlap sacks. In hot areas or hot days, it is necessary to put water on the sacks to cool the bees. The bees should also be provided with water inside the hive, so that they are able to cool the brood.

iii. It may be necessary to apply water to the sackings every one to three hours to keep the colony sufficiently cool during the day in the tropics. If the hives are placed in shade, and the sacking is kept wet, the bees can be covered for up to two days in the tropics. Overheating of a colony of bees may lead to rapid death, as described in connecting with movement of bees. Larger colonies are more sensitive to overheating than small, and it is important that there is plenty of space and good ventilation in the hive.

iv. If the bees are near a water pipe, it can be possible to keep them inside the hive by constantly sprinkling them. Make an agreement with the farmer, so that he or she does not spray in lowering crops or at least that does not spray in daytime when the bees are working in the field. The spraying should only take place during late evening or night. Tell the farmer, that there are some repellent insecticides with a smell that makes bees abandon the flower instantly.

3.3 Alternatives to Pesticides

In discussions with farmers, it can be useful to know that there are alternatives to pesticides – at least in small-scale farming. When using pesticides, a detailed knowledge of the life cycle of the pest is necessary. A pesticide used at the wrong time, in the wrong place and in a wrong manner, can be more harmful than not using it. Wrong use of an insecticide can kill the pest for a while, but it also kills many enemies of the pest. After some time, the pest population will recover, but then there will only be a few natural predators left to eat the pest, because they normally do not recover as fast as the pest. Now the pest population can grow even larger. Then even more insecticides are needed and after some time it often happens that the pest develops resistance to the chemicals, and new, stronger and more expensive pesticides must be bought. It can continue in this way until so much poison has been used, that the environment is spoiled or the farmer ruined. That is what happened in Central America in the cotton growing areas, where the crop had to be sprayed 44 times during the growth.

The cotton growing had to stop, and the areas was used for cattle, but the environment was so polluted that the export of the cattle meat to the United States was stopped. If pesticides have to be used, it must be done in combination with other ways of fighting pests. Often the local farmers have traditional knowledge of how to live with or fight pests, and many of these methods seem to work. In reality, most pesticides used in the tropics are for export crops, and in that way some of the poison returns to the industrialized countries, where they were produced. There are many ways of controlling crop pests without using imported pesticides. Local conditions are of importance but some few activities useful in gardening and small-scale farming can be mentioned here.

i. Make sure that the cultivated plants are properly nourished. Too much or too little fertilizer, water or sun can cause aphid attack.

ii. Plants can be grown as mixed crops, so that the pest or disease cannot spread so easily as in a mono-crop, e.g. maize intercropped with cassava reduces the spread of cassava bacteria wilt.

iii. Planting with the right density can prevent some pests. For example, groundnut should be sown close to prevent aphid attack to the lower part of the plants.

iv. All infested fruits or tubers have to be removed from the field, so that pests from them cannot develop a new generation.

v. Do not let leaves or fruits touch the ground.

vi. Prevent flow, splash or runoff of water from infected plants to healthy ones.

vii. Rotate the cultivation of different plants. Crop rotation is very unfavorable to nematodes.

viii. Always use healthy seeds, plants or potatoes when starting a new plant generation.

3.4 Other Alternatives to Pesticides

i. If possible use resistant plant varieties, e.g. some of the old types of millet in West Africa are better protected against birds and beetles because of their sticky hair. Bees and their role in forest livelihoods.

ii. Self-made natural products can be used to fight pests without them developing a resistance, e.g. fine ashes to prevent leaf chewing insects. The juice of tobacco stems is poisonous to aphids; vegetable oil or fatty soaps mixed with water combats aphids; earth mixed with salt prevents termites to spoil poles (for a time).

iii. Do proper weeding and destruction of infested plants. If possible, use the weeds in compost making, so that the high temperature will destroy germs of diseases and pests eggs before the material is returned to the fields.

iv. Try to organize fields in an environment providing a habitat for a great variety of the farmer's natural allies, such as insect eating birds, spiders, wasps, etc. When clearing new land some areas of trees and bushes should be left between fields.

v. Make some biological control. This means to import or cultivate the natural enemies of a pest. It could be parasitic wasps, or by using harmless bacteria which only attack worms and do not poison other creatures.

4.1 Cooperation between Farmers and Beekeepers

Knowledge of bee pollination can be so small that farmers try to get rid of the useful bees by using smoke among their orange trees and coffee bushes. They wrongly think the bees are spoiling the flowers, while they actually helping the farmer. To help farmers obtain better harvests and to protect the beekeepers' bees, it is necessary to have much more information about the need for bees for pollination of special crops. If the beekeeper is informed, he or she must inform the farmers so that they also take care when using pesticides. If farmers and beekeepers cooperate, it is possible to a certain degree to protect the bees against the chemicals.

4.2 Main Types of Pesticides

Pesticides kill by direct contact, stomach poisoning or fumigation. There are eight main types of pesticides. The most dangerous pesticides for bees are among the insecticides, but some of the other pesticides harm them too. Most insecticides are dangerous for people as well as bees.

Table 2: Main types of pesticides

S/N	Type of Pestcide	Kill
1	Rodenticides	Rats and mice
2	Fungicides	Fungi
3	Miticides/acaricides	Mites
4	Herbicides	Plants
5	Insecticides	Insects
6	Chlorinated hydrocarbons (organochlorines)	
7	Organophosphates (organophosphorus)	
8	Pyrethroides	
9	Nematicides	Nematodes
10	Molluscicides	slugs, snails
11	Bactericides	

Conclusion

Farmers around the world can no longer depend on the free services that pollinators provide without taking their needs for survival into consideration. By implementing a few simple practices these vital organisms can be protected and conserved. Many of the methods and techniques mentioned in this manual are not only beneficial to pollinators but also to the agricultural system as a whole. The health and needs of pollinators are vital for the future of sustainable agriculture, as is improved soil fertility, food security and productivity which are by-products of these methods. Educating all stakeholders in the agricultural field about the importance of pollinators will be of great benefit to all and will ensure a more productive and secure future.