ADVANCED BEEKEEPING MANUAL
ETHIOPIAN BEEKEEPERS ASSOCIATION

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Participants in the preparation of the Manual:
1. Ato Ayalew Kasaye
2. Nuru Adgaba (PhD)
3. Ato Gezahegne Tadesse
4. Amsalu Bezabeh (PhD)
5. Ato Kibebe Wakjera
6. Ato Wondyirad Abreham
7. Ato Teklay Gebreamlak
8. Ato Gebreigziabeher Hagos
9. Workenesh Abebe
10. Girma Demeke
11. Zenabu Kebede
12. Tensaie Negusie
13. Tesfamariam Assefa
14. Dr. Belay Gebremichael (facilitator, LCB)
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1. Introduction

Ethiopia is the leading honey and beeswax producing country in Africa. There are several factors for Ethiopia to be famous in apicultural recourses. This is mainly due to its flora highly supporting foraging bees, the presence of large quantity of honeybee population, and ample fresh water, a suitable weather and geographical features, the presence of large number of native farmers and others engaged in the development and management of apiculture for many centuries.

The agro-ecological features of the country have also contributed to the growth and propagation of large population of various plant species to exist. This in turn creates favorable living conditions for all living things including honeybees. The presence of such invaluable plant species existing at different geographical locations has helped the bees to utilize the raw materials nectars and pollen grains. These opportunities support the living situation of bees to rear and multiply to greater extent. To this end in Ethiopia there are over 10 million bee colonies which are fairly distributed throughout the country.

Out of these bee colonies about seven million are placed in local hives, while about 500 thousand bee colonies are estimated to live in transitional and frame hives. The remaining 2.5 million bee colonies are wild bees living everywhere in the country, such as under branches of trees, in craves of rocks, cliffs, and in earth holes.

Honeybees produce many valuable products. But the Ethiopian beekeepers and the people in the country at large believe that honey and beeswax are the only produce obtained from beekeeping. They still believe that these two products are the end results of bee culture. Above all agricultural products, Ethiopia was first recognized by its bee wax export item. Large amount of
honey and beeswax is obtained from traditional hives. The recent production and introduction of transitional and frame hives have largely contributed to enhance the production of honey and beeswax. The annual production of honey and beeswax is estimated to be 43 thousand tons and about 3200 tons respectively.

Traditional bee culture is one of the ancient agricultural practices of the beekeepers of the country. Ancient people had developed the types of traditional hives from locally available materials. They hang their hives in tree branches in order to trap wild swarming colonies during the reproduction seasons (usually from September to the end of November). During the honey flow seasons, the traditional beekeepers remove the combs out of hives without making sure that the honey is ripe or whether the comb is with brood or honey. Due to proper managerial difficulties, the honey harvested is of inferior quality. The harvest can not also exceed five kilo grams of honey per hive in a year. In comparison from transitional hive at present about 15 kg of crude honey can be harvested where as 25 kg of pure honey can be collected from each frame hive per year. Despite this improvement Ethiopian honey production is relatively low compared with other countries. The major factors accountable to the low productivity rate could be lack of skilled man power, and technical support as well as technicians who could provide guidance and supervision according to bee culture working calendar.

Realizing the general problems the country is facing the government has taken important initiatives; coordinating regional states, associations and investors to smoothly implement the envisaged apicultural development programmes so that rapid development progress could be maintained and there by the benefits from the sub-sector be maximized as planned. It is almost a decade since such progressive operation plans are under way.
At present, those involved in apicultural development and in the transformation and promotion of bee products include farmers, individuals and investors who are working as part-time business while others as full time actors in beekeeping. Now a days, the number of honey processors and exporters is increasing in leaps and bounds. They started their business as collectors and processors of crude honey for domestic and international markets. Besides the efforts done by the framers, processors by themselves are directly and indirectly involved in the production and promotion of honey and other bee products. In order to boost the production of quality honey and beeswax at ground level, two activity plans were developed. The first activity plan is training of out grower farmers who would produce more products and become good suppliers of the produce to processors based on bilateral agreements. The other activity plan is the direct involvement of processors in the development of production of honey and other bee products.

Basic in-service training on different but on most valuable components of bee culture which would empower, trainees to scale up quality production is intensively offered. The role of both governmental and non governmental organizations in rendering training services to rural communities is of paramount importance.

The Ethiopian Beekeepers Association (EBA) is one of the leading institutions that have been actively working in transferring knowledge to upgrading skill promoting production and in conducting research pertinent in solving rural beekeeping problems and in preparation of teaching manuals and distribution to all engaged in the development of the sub-sector. EBA has prepared standard manuals in different languages of the country to be distributed to all stakeholders.
2. What is Beekeeping?
Honeybees have the capacity to live together harmoniously in a nest, foraging nectar and pollen grains from flowering plants to satisfy the food needs of the colony members in the nest. Honey bees are the most useful and friendly insects to all living things on earth. Such insects that live and work together for their nest activities in an area selected are called social insects. In order to get the necessary benefit from these social insects humans have been exerting their utmost efforts to tame them. In due course bee keepers have tried to make nesting hives from locally available materials and hang in a tree branches so that wild bees can get in. Then, they take them to home yard in order to harvest and collect the possible bee products. This practice has a long time history in Ethiopia.

The method of trapping a colony of bees and then taking them to home yard, allowing them to rear and multiply, prepare honey and beeswax is known as bee keeping.

Before the commencement of beekeeping, when the idea of keeping bees was not known honey hunters used to travel searching for wild honey from the areas where bees were residing such as in the craves of rock, in the old open logs, and underground holes. In some parts of the West, south-west, and in the North-west zones of Ethiopia honey hunting during the peak seasons is a typical exercise up until now. This activity of collecting honey from the wild honey bees is called honey hunting.

3. Why Beekeeping?
Unlike developing countries, in the most developed nations, the primary objective of keeping honeybees is for the pollination of various plants. The secondary use of keeping bees is simply for the production of bees products
namely honey and beeswax. In Ethiopia and other developing countries, the basic purpose of beekeeping is to produce honey and beeswax to get better income and to assure food security.

Beekeeping in Ethiopia is one of the agricultural activities practiced side by side with many other farming practices. Nevertheless, the main objective of beekeeping of our country is to produce honey and beeswax for use. Home consumption takes the lion’s share from the collected honey and beeswax while the rest of the produce is used for sale. The income generated from honey bees produce has greatly contributed to reduce poverty and achieve food security. Honey has great value as dietary components, for medicinal purposes, and income generation. At present, beekeeping activity is becoming very important in poor crop growing areas, in areas where the land has been heavily eroded. The result obtained so far from beekeeping in such places of the country is encouraging. In addition to this beekeeping is so important in natural resources conservation in areas where necessary protection was not practiced. Bees forage on flowering plants and at the sometime transfer pollen grains from one plant to other plants of the same species. This phenomenon even in the resource poor areas has helped to increase production and productivity.

Realizing the use of bees in the pollination of plants and yield increase, many investors, cooperatives and individuals are showing interests of keeping bees near and around farm gates. Nowadays, the farming communities in rural areas must also practice keeping more bee colonies in order to obtain more advantages for pollination of crop plants.

Some of the most important advantages of beekeeping are the following:

1. Beekeeping development requires little initial capital.
2. Beekeeping development activities can be done in harmony with other agricultural activities and do not require a day to day follow up.

3. If bees get ample forgeable flowering plants from the area they reside, the owner does not need to supply them with other fodder like other livestock species. Bees can utilize some leftover stuff not used by humans and animals.

4. Beekeeping can be done as part-time and full time business

5. Beekeeping can be practiced by all members of the society namely, male and female, young and aged and handicaps.

6. Crafts men producing beekeeping tools and equipment can be benefited from the sale of these items.

7. Beekeeping can also benefit peoples like Tej makers, candle producers, beeswax collectors and packers, exporters of honey and beeswax, etc. and avails employment opportunity for many people in general and for the youth in particular.

8. As stated earlier beekeeping can be started with limited capital and can be extended with the increases of resources.

9. Landless individuals or groups, and organized youth can utilize enclosure areas for beekeeping provided they work in line with the safety rules designed to safe guard the environment.

10. Beekeeping can be done in rural areas, in towns and cities.

11. Beekeeping as an income generating scheme can be practiced on small plots of land not used or not to be used for other activities.
Such activity can also be exercised in residential areas of many people.

12. Beekeeping can widely be used in areas not suitable for crop growing and forage development.

13. Bee’s products in most instances are non-perishable. Major bee products like honey and beeswax can be stored for several years maintaining their properties of standard quality.

4. **Who Can Do Beekeeping?**
Honeybees always defend their nest from various enemies and prey. They protect their products in the hive like honey and brood, from being taken, eaten and damaged. One of the major defense mechanism of bees against their enemy is stinging. Man is one of the enemies of bees. When humans approach bee colonies for their own purposes, the bees defend their hive to a greater extent. So the person receiving bee venom could be poisoned. Those persons or beekeepers allergic to bee venom should do their beekeeping activity very carefully. But the irritation one feels does not hurt the one working in bee colony operation as far as the necessary protective cloth and proper working tools are used. Bee keeping is a profitable agricultural activity that can be done by all interested individuals.

5. **Beekeeping Development in Ethiopia**
Ethiopia is the leading country in Africa in its potential of honey and beeswax production. The natural resources it has include: varieties of honeybee floral, high numbers of bee population, water bodies carrying fresh highland and lowland waters, and many other collective natural resources like the soil,
rainfall and weather conditions that made the country the home of many land race produces besides the honeybees products.

Due to these favorable conditions, the country is expected to be the leading producer of honey. Annual honey and beeswax production is estimated at 500,000 tones and 50,000 tones respectively. However, the current production record of honey and beeswax indicates to be 43 thousand and three thousand tons respectively. The majority of these bee products for the last century have been coming from traditional beekeeping practices while very little from other types. Nevertheless, due to the support rendered from governmental offices and NGOs, the expansion of the development programme and the use of other hive types made by farmers and many craftsmen and the coming of investors, to the scene have immensely contributed to the development of bee products.

Despite its natural potential and availability of forgeable resources, the country has not reached to the level of producing large amount of honey and beeswax. On top of this, the quality standard of the produce has been far below the expected level.

There are many drawbacks that can be accounted for the low level of production in the beekeeping sector. These are namely:

1. As stated above, beekeeping in Ethiopia is mostly done by unskilled farmers that use traditional hives. Lack of skilled personnel that assist and support the operation of beekeeping, development agents and practical staff.
2. Lack of well organized and planned extension services in the country. Even the service reached areas were not treated as they should deserve. Hence, the rapid change in product promotion did not attain the expected level.

3. To exploit the natural resources properly and maximize honey and beeswax production, there were/are no proper tools and equipment to be delivered to the rural farmers. Those farmers or individuals who can to a certain extent afford to buy working tools were/are not able to get the types of working tools as needed. For many beekeepers, the tools and equipment imported and even those produced in the country are very expensive and this in turn has exerted negative impact to the production of better quantity and quality products.

4. Problems of beekeepers were not solved by research findings. Those limited research results which in some cases are valuable in solving and bettering the expected production merits did not even reach to the farmers.

5. Some of the bee colonies are less potential in production

6. Deforestation which is a global problem has a negative impact on the depletion of honey plants. Hence, the honeybees are suffering to a great extent. Deforestation, drought, population explosion unwise use of pesticides have immensely contributed to the decline of bee population and its products.

7. Lack of credit facilities to farmers to buy working tools and equipment on credit basis.
8. Lack of marketing knowledge has hampered the supply of honey and beeswax for domestic and international markets by big investors coming to the business. Beekeeping as stated earlier has been mostly done by farmers and mini capital holders that can not properly exploit the available potential of the country.

The Federal Democratic Republic of Ethiopia has taken wonderful initiatives during the last years in upgrading the quantity and quality of bee products promotion through introduction and distribution of frame hives technology to be used widely in the country. The policy has supported poor farmers to acquaint, produce and use transitional bee hives made from locally available materials. This technology of propagation and distribution of transitional hives is well supported by government offices all over the country. Using this technology is expected to have boosted production although much work has not been done. In order to facilitate the use and wide array of operation of the technology, honeybee development packages were formulated and distributed to offices of various regions. Moreover, a new proclamation on apiculture resources development and protection that solely supports the transformation and promotion of bee keeping in the country was also decreed.

6. Apiculture Resources Development and Protection Proclamation

The major objective of this proclamation is to boost honey, bees wax and bring about and other products and improve in the living standard of the rural community. The Ethiopian government has proclaimed the apicultural resources development and protection policy with the following aims and objectives:
1. To determine the honeybee races or sub-species, population potential, distribution and to pay necessary protection.

2. Pay all necessary efforts to upgrade or increase products, production and productivity, so that rural farmers in general would be benefited from the intervention.

3. Maintaining products quality and proper handling of honeys and beeswax before and after harvest and transport the raw materials to processors.

4. Establishment of honey and beeswax markets whereby quality standard produce can be exported.

5. The policy would encourage job opportunity.

Above all the policy would support and encourage:

- Determination of honeybee races, population size and distribution
- Selection of productive positional races, rear, multiply and enhance largely use
- Collection of bee products from forest areas, agricultural activity areas, from craves and the like without disturbing the ecology and other resources
- Determination of honey plants, population size and distribution, and propagation of the potential plants
- To raise the awareness of people not to important used beekeeping tools and equipment and bee colonies from abroad.
- Use of pesticides without the consultation of concerned experts or offices is also prohibited. Hence, the policy supports the development of friendly environment in the country.

7. Apiculture Resources Development and Protection Proclamation

This proclamation has the following objectives.
1. Ensures production, productivity and production of quality bee products that solely support the well-being of the poor, poverty reduction and the maintaining of all factors enabling end results possible.

2. Protection of all resources including honeybees and bee floral species for better and wider uses.

3. Empowers and encourage those involved in beekeeping development programmes and creating possible means to others to be engaged in the business.

4. It encourages part-time and commercial beekeepers to actively participate in the activity so as to accelerate the development venture.

The proclamation has several articles that have given more emphasis on development, resources protection, handling proper working tools and equipment, information exchange, development inspection, penalty and null and void Laws.
8. Honeybee Species, Sub-species and Their distribution in Ethiopia
   a. Honeybee Species

There are over 20 thousand bee species in different parts of the world. The honeybees are one of the species that have the ability to exist in different agro-ecological zones. The original honeybees were found in Asia, Europe and Africa. As a result of human migration these honeybees have now migrated to the new world of Americans, Australia and Newzeland. Hence, it is possible to find honeybees in all corners of the world except the polar zones.

So far there are about seven identified species of honeybees in the world. Nevertheless there could be more unidentified species of honey bees. The honeybee species found in Ethiopia is called Apis mellifera. The original places for this species were Africa and Europe, but now it is well bred, multiplied and distributed to the whole world and there is no place on our planet where Apis mellifera is not found. It quickly adapts to varying weather conditions, soil, foraging plants and to the changing environmental conditions. Hence, it is favored by most people of the world. It is obviously true that the impact of different geographical features change the color of honeybee’s productivity, production potential, character, and behavior, resistance to climate stress, diseases and on various unforeseen incidences. So Apis mellifera has all the important characteristics preferred by humans.

In Africa, several sub-species of bees are found in different geographical locations. Investigation of the sub-species in Africa was started by pioneer researchers in 1804 then in 1822 1836, 1906, 1924, 1961, 1974/75, and 1990 and in 2000/G.C/. In Ethiopia, the existence of five sub-species namely Apis mellifera scutellata, Apis mellifera monticoloa, Apis mellifera jementica, Apis mellifera woyi Gambela, and Apis mellifera bandasi are
verified. These species are fairly distributed in different locations of the country (Fig 1).

Apis mellifera monticola is found in the highland areas of the country while Apis mellifera jemenetica resides in the eastern escarpment zones of Ethiopia. On the other hand Apis mellifera bandasi and Apis mellifera woyi are found in the central zones and Gambela national state respectively.

b. Members of Honeybee colonies

The honeybees as the social insects live harmoniously together in a hive. The group members are one queen bee, several thousands of worker bees and several hundreds of drone bees. This clearly indicates that the types of bees in a hive have a very good cooperation to perform nest activities for the well being of the coming off springs.
1. The queen Bee

There is only one queen is one beehive (Fig 2). In rare cases one may see two queen bees in one bee colony during the reproductive swarming period.

![Queen bee](image)

Fig 2: Queen bee

Queen bee is developed from fertilized egg. The larvae continuously fed on royal jelly (bee milk). The larva developed in a different queen cell is large in size and quickly completes its metamorphosis cycle and is hatched on the 16th day as adult queen bee. The queen bee is larger than worker bees. It has an extended abdomen, good looking color, short wings and long legs.

2. Worker Bees

They are female bees (Fig 3) developed from fertilized eggs. During the larval stage and while completing their metamorphosis cycle, they are fed
with less nutritious food type, grow slowly, and are hatched after 21 days. Their body size is short with slightly extended wings.

The number of worker bees in a hive increases during the favorable seasons and decreases during unfavorable time of the year. There is no accurate way of knowing the increase and decrease of the number of worker bees at various periods. However beekeepers in other countries can estimate the occupancy rate of frames, whereas this practice has not yet been used in our country.

3. Drone Bees

They are male bees (Fig 4) living in a hive with female bees. Drone bees are larger in abdominal area than the other two types of bees. Due to lack of complete genetic constitution of the parents, the drones have haploid number of chromosomes. Hence, it is developed as parthenogenesis insect. The drone is born without the combination or fertilization of eggs. It has a complete metamorphosis cycle and is hatched after 24 days. The drone lacks the complete apparatus setup in its body this induced it to work limited nest activities in the hive. The drone has big circular eyes and very large
wings. Like the number of worker bees the number of drone bees, would increase and decrease depending on the availability of fodder resources. During the dearth period, it could be possible to see no drone bees in the hive.

9. Anatomy of Honeybees
The body of the honey bee is divided into three parts: the head, thorax and abdomen (Fig 5). With the exception of the abdomen, the other two parts of the body, (the extended and attached body parts) are seen clearly:

9.1 The head
On the head of all types of honeybees the visible parts seen are:

1. The eyes. Bees have five eyes namely three simple (ocelia), and two compound eyes. Visible colors to bees are ultra-violet, blue, green, yellow and orange. Nevertheless, red and black objects are not properly determined by bees.
II. **Proboscis**

Two separate organs mainly labium and maxilla when temporarily joined together form one setup of organ, called the proboscis. These two separate organs are folded back of the head when bees are not sacking liquid food. While the bees are flying the probocis is not visible. The length of the probocis is an important variable in characterization of bee races. Drone has short probocis and is incapable of collecting food even from the comb cells. The other female bee (the queen bee) has long properly functional proboscis.

III. **Antennae**

Honeybees contain a pair of antennae. An antenna is an important organ in the life of bees. Their antennae have 11 to 12 segments with infolded sensitive hairs that detect any vibrations and scents. If the antennae of bees are removed, they are no better than dead bees. With this organ the bees determine food types and its location change of weather, vibration as a result of knocking, direction towards events discovered. An antenna also serves the bees as a radar and navigation tool.

IV. **Mandibles**

The mandibles are very hard, tough organs of bees. With it they, tear hard food, chew and masticate fodder and wax, bit others and construct comb cells. Scrap off propolis from plants before transporting with hind legs, make holes with it and allow trapped queen to escape.
Thorax

Thorax of bees is the centre of locomotion. Thorax is the hardest part of bee’s body, and the queen bee is safe if handled on the thorax. The body of bees is segmented, each segment accomplishes different tasks. The thorax of bees has four segments namely prothorax, mesothorax, metathorax and propodeum. The major breathing hole is located in prothorax and propodeum.

The extruded appendages found on thorax are wings and legs of bees. To undertake this function the legs and wings are attached and visibly seen. Bees have two pairs of wings and three pairs of legs. The front wings are larger than the hind wings. While flying each pair of wings would be hooked together by humuli and unhooked when they land. Besides helping the bees to fly, wings help the bees to ventilate the hive when it is cold and hot. In addition, during the ventilation processes the moisture content of the honey can be reduced before the honey is ripe.

The legs help the bees to walk, transport food, cluster, clean, construct comb cells, load and unload things in and outside the hive, and sense the surface contacted. Pollen loads are transported by hind legs while the spines of the middle legs help the bees to unload pollen loads. The notches of front legs do the cleaning and feeling of the roughness and smoothness of the hive walls and others. Worker bees like smooth surface. They opt to start doing business quickly when the frames and the surfaces of the box are smooth.

The leg of a bee has six segments namely coxa, trochanter, femur, tibia, tarsus and claws. All parts have different functions. Pollen basket or carbicula of bees is located on tibia of the hind legs. Only worker bees have this collection basket.
9.3 Abdomen of bees

Abdomen is another major part of the body of bees. It is large and has several segments where many of them are visible while three segments are constricted during the larval development and yet not visible. All the systems of alimentary canal, respiration, reproduction, nervous system, endocrine system, and the circulatory system are located inside the abdomen. Other important organs like spematheca (sperm sac), stinging apparatus and genital organ of male bee are found in the abdomen. Drone bee has no stinging apparatus like female bee types.

The stinging apparatus of the queen bee is smooth, slightly curved and permanent while the stinging apparatus of the worker bee fig 6 is barbed type and used for one time function. The gland attached to the stinger that produces alkaline venom, becomes very active after the stinger of the worker bee is detached from the abdomen and stick to victimized persons or animals. To reduce the amount of poison getting into the body of the victim it is good to pull out the lancet quickly. On the ventral side of the worker bees there are eight wax glands that enable to secret liquid wax. Nurse bees have developed wax glands than the old field bees.

Fig 6: Stinger of a worker bee
9.4 Honeybee Reproductive System
The existing queen bee in the hive lays two types of eggs. One is a fertilized egg that has genes produced from both parents while, the second type is infertile egg which has no combination of male parent gene. In the process of completing the metamorphosis cycle four stages are involved; the egg, larva, pupa and finally the adult bee. The queen bee after being an adult stays in a hive for five days or so and then matures to accept drones for mating outside the hive in the air. Prior to her nuptial flight, she produces attractant pheromone and all male bees receiving the scent would make search for her in the air. The mating opportunity and her needs to have more drone bees mating depend on the availability of potential food stored and amicable weather conditions. Research results indicate that within two or three days virgin queen bee could make mating with several drones even up to twenty. After mating is completed within three days the queen bee stays in the hive and start laying eggs. This is the normal and usual reproductive phenomenon. Sperm cells ejaculated by drone bees are stored in the spermatheca (Fig 7) of the mated queen bee. These cells are adequate for the rest of her lifetime.

![Fig 7: Spermatheca of queen bee](image-url)
During the metamorphosis cycle and development processes as the eggs are laid and deposited in comb cells, they would stay as eggs for three consecutive days but with some changes in positions. On the fourth day they will be changed into larvae. That is the first day of larval development. From this time on wards the larvae start eating food. For the first two to three days feeding of royal jelly for all larval types in the comb is a must. Fortunately, however, the larva destined to become a queen bee would be provided royal jelly without interruption. Other wise the worker bees will dismantle the former comb cell and construct new queen cell cup while the selected queen’s larva is still in the former cell cup.

Larval feeding for worker and drone bees would be disrupted and change of food type for continuous feeding, with less nutritious food instead of royal jelly.

The lesson learnt here is that worker bees in the hive can convert fertilized eggs to queen bees as long as fresh larva is present in comb cells.

10. Activities of honeybee colonies

10.1 Duties of Queen Bee
The queen plays a pivotal role in maintaining peaceful conditions in the hive. To be seen by worker bees in the hive, she moves around and makes contact with several of them. Pheromone or what is called queen substance production by the queen bee is for her own great advantage. She produces and smear it on her abdomen. Bees in the hive would come and remove it from her abdomen, chew and transfer it to others to chew again and this chewing would continue for the whole day (Fig 8). Some would come, contact the queen and remove the substance chew it and pass it over to others. This is a good signal to indicate the presences of the queen bee in
the hive. The task of the queen bee is producing the substance while the task of worker bees is also to remove and chew the substance. The pheromone or the queen substance has another negative effect on the reproductive performance of worker bees. The reproductive function of the worker bees that chewed the substance will be retarded. Hence, they have no feeling of mating with drones or they do not try to create other queens in the hive.

According to normal distribution curve, the optimum reproductive performance of the queen bee in most places of the world is when she is two years old. Then after, there would be a decline rate of egg production until four years of age. During the decline rate of production of eggs and pheromone, the worker bees would take an option of creating other queen bees in the hive even at her presence. The major duty of the queen bee is to lay two types of eggs through out its use as long as there is no scarcity of food.

Fig 8: Worker bees attending queen bee
10.2 Activities of Worker Bees
Worker bees after emerging from capped comb cells, undertake two major types of activities namely;
- In-hive activities and
- Field activities

Very young worker bees after emerging from comb cells would stay in the hive for nearly three weeks doing several and tedious tasks. After three weeks of age, young bees will mature to become field workers. They bring various types of food to their hives and store in comb cells. Field work done by bees is a very difficult task that in most cases reduces the life span of bees untimely.

V. In-hive activities of young worker bees

1. Sanitation

The worker bees have genetic potential that enables them to control the cleaning of nest, and comb cells in the hive. Bees are very neat and such hygienic behavior can help them to control any foreign materials and their own waste. If big alien creature like for example, a reptile or rat dies inside their hive and they are unable to remove it, then they plaster and bury the object with propolis and wax. Healthy bees also remove sick, weak and dead bees and dead larvae from the hive immediately.
2. Construction of comb cells

Worker bees construct three types of comb cells. Their engineering ability is beyond the reach of humans. A cell has hexagonal dimension to be used for larval development, storage of food types like honey, pollen, royal jelly and water. Hexagonal cell combs are of two types, small and large. The small combs are used for worker’s larval development (Fig 9) while the larger ones (Fig 10) are to be used for drone larval development. Both the comb cells of worker bees and drones are constructed in horizontal position. The queen cell cup is irregular and amorphous looking and the head end is in down wad position (Fig 11).

![Worker bee cell](Fig 9)

![Drone cell](Fig 10)

![Queen cell](Fig 11)
3. Royal jelly (bee milk) production

Both mandibular and hypopharyngeal glands are responsible for the production of royal jelly, (the milky white substance) that best suits the feeding of the queen’s larva. Young nurse bees are the major actress in the production, preparation and feeding of larval brood.

4. Feeding larvae and queen bee

The most tedious task of worker bees is feeding the larvae. They deposit food for the growing larvae. Attendant bees provide food every now and then until the larvae grow and develop to pupal stage. They also provide pure honey and royal jelly to the adult queen bee.

5. Capping comb cells

a. Comb cells are capped when the larval development reaches to pupal stage.

b. Ripened honey is also capped to maintain the maturity shelf life for the period needed.

Young bees take the responsibility of doing this task. While capping, fresh beeswax young bees seal every cell cup properly. For example if 5000 cells per comb are with larval brood or ripe honey and if there are ten combs to be sealed or capped it is the responsibility of the young bees to undertake this task.

6. Defending nest

In structurally organized living things, to maintain ones well being is a natural phenomenon. The bees are well organized in groups to work
attack and defend their nest. They defend their nest from any intruder or robber bees coming from elsewhere to attack and rob the resources one colony has. Drifting bees many times get in into different colonies that are why one can see several worker bees patrolling near hive entrance as a defending mechanism.

7. Hive Thermoregulation

Bees do a wonderful task in the hive. When the hive temperature is above the normal scale, the bees perform all the ventilation activities to reduce the rising temperature. When the temperature in the hive is high they bring in too much water and spray it on combs to regulate the heat. In a similar manner, if the hive temperature is below the required level, the bees try to bring fresh and warm air in, to normally the temperature. They also huddle together or form cluster in the hive to maintain brood temperature to normal.

8. Honey Moisture Reduction

When field bees come with load of nectar from foraging areas, and deposit the nectar in comb cells the water content of the nectar is high (up to 60%). While transporting this invaluable natural food, the nectar is stored in the honey stomach or crop then several enzymes would be mixed. These enzymes would help in the breaking down processes of starch or cellulose to simple sugars. The bees while trying to reduce the water content of nectar to 15 to 20%, the enzymes would also accelerate the ripening of the honey at the same time reaching to 65 to 70% carbohydrate.
9. **Mouth to Mouth Food Exchange**

Field bees collect nectar, pollen, propolis and water from the field and transfer it to nurse bees. The nurse bees that reside inside the hive organize and properly store the incoming food types accordingly. The nurse bees are well organized to perform the inside hive activities and are well aware where to place the different food types coming in. The field bees instead of going to deposit the food carried from outside, prefer to transfer it to nurse bees mouth to mouth.

10. **Worker bees jointly work in smoothing hive walls, seal cracks using propolis, fix frame ends on hive grooves using mixed propolis, and strengthen the inside frames or combs built in local hive not easily removed or moved when touched using again bee glue mixed with wax.**

11. **Removal of Adult Drones and larvae from the Hive**

Drone bees are in capable of performing any task inside or out side the hive. When the nectar or honey deposited layer in the cells decreases the drones cannot collect their food. When drones starve and become weak, the worker bees either kill them or chase them out of the hive. They do similar things by removing unnecessary larvae from the hive.

**Activities of Worker Bees Outside the Hive (Field activities)**

Field bees do many things outside the hive. But their major task is to gather nectar and pollen grains from flowering plants and carry it to the hive every day starting at dawn some times and up to late afternoon. While foraging for food, bees have a language to communicate with the bees that have not seen the food discovered. When one bee coming from outside the hive
performs a sort of dance, the others would watch at the bees and receive the message. The two types of dance are called: the circle dance and tail wagging dance. Both dance types indicate the availability of food and the location of the resource discovered.

**Circle dance**

Generally the circle dance is an indication of the presence of food source within an area not more than 100 meter away from the hive (Fig 12). Disclosing direction of the food source to attendant bees is not necessary, because the aroma and the scent of the food would be absorbed when coming in to contact with the dancer. They immediately fly to the food source without even waiting for guiding bees.

![Fig 12: Circle dance](image)

**Tail wagging dance**

Tail wagging dance is performed when the location of the food source discovered is beyond 100 meter from the hive (Fig 13). Hence those attending the dancer bees would learn the direction of the
food source carefully. At this time the attendant bees would prefer to travel with dancing bees to minimize cost of utilizing reserve food from the hive.

Field Bees have the following activities:

a. Collect nectar and fruit juice from outside and transport it to their hives from flowering plants.

b. Collection of Pollen Grains

Honeybees search for food. Pollen grain is one of the food types used to feed the larvae and young bees in the hive. Pollen grains from the plants are removed by the hairs of hind legs of worker bees and pressed to form a sort of ball shaped of pollen pelt. The worker bees collect the pollen basket or carbicula, transport it to their hive and unload it in the comb cells properly. If one or several bees come in contact with eucalyptus tree, all the bees contacted would search for a similar plant while performing the collection activity throughout the day.
c. Collecting water.

Colony of bees need water to drink and use it for other purposes in the hive. Some of the field bees would collect water and store it in the hive.

d. Collection of Propolis

Propolis is a resin of plants and yet collected by bees for several purposes in the hive. They scrap or remove the resin from the plant by their mandible and pack it on the basket of their hind legs and transport it to the hive.

Worker bees residing in a hive have much work to be done every day during the working hours. Work load of worker bees is higher during the breeding season and at honey flow months. The impacts of fatigue and heavy duties will obviously reduce the life span of worker bees to only 4 to 6 weeks.

10.3 Duties of Drone Bees

Drones would mate with virgin queens outside the hive. Other than this invaluable task the drones have nothing to do in the hive. Drone bees after mating with the queen bee die soon due to the constriction and the irreversibility of the abdominal part. As long as stored food is available in the hive, drone bees can stay up to 6 months or so.

11. Types of Beekeeping in Ethiopia

There are three types of beekeeping development practices in the country. These types of beekeeping are: Traditional beekeeping, Transitional and Frame hive beekeeping.
Traditional Beekeeping

Beekeeping activity in the country for many centuries is done using local hives made from locally available materials. The shapes of the hives are mostly of cylindrical. The tools to undertake the activities are also made up of local materials not conducive to operate hives for hours. The skill and practical knowledge is also backward. And hence, the bee keeping activity in Ethiopia is categorized as traditional.

Every since the start of bee keeping practice in the country several kinds of local hives have been used in different regions and zones. The types of traditional hives, their shapes and working materials vary from place to place. Traditional hives can be made from bamboo, mud pots, logs, barks of trees, and from climbers (Fig 14). Using such types of hives has merits and demerits.

Merits of Using Traditional Hives and Beekeeping:

- They require low cost of production and minimal skill while making.
- Traditional beekeeping does not need much time and attention,
- They need simple mechanisms while harvesting honey and beeswax,
- There is a possibility of using such hives to trap swarming colony, and
- Using traditional hive to swarm trapping is easier than other hives.
- Unlike frame hives, traditional beekeeping does not require modern tools and equipment to undertake the necessary operation.
Demerits of traditional hives and Beekeeping

- They are unfavorable to undertake proper inspection,
- Quality and good honey cannot be harvested
- It is not possible to determine whether the honey is ripe or not
- It is difficult to harvest larval combs.

Hence, there is a possibility of removing the brood which is more difficult to replace it to its position in the hive.

- The removal of brood combs affects the living condition of the bee colony. Hence, the number of the bee colony will decrease and this in turn affects the annual production of honey.
- In discriminate removal of combs during the harvest time and then crushing of all honey produce together affects the quality standard of honey in the country.

Fig 14: Samples of traditional hives
The average annual production of crude honey per traditional bee hive in the country might not exceed six kilogram's. This situation of production rate could be improved if the traditional beekeeping is conducted in areas where there are trained farmers that can render proper services, pay good attention to bee management practices and place bee colonies to areas of forgeable potentials. The availability of the above conducive factors would help to boost the annual per hive production of honey and bees wax up to 15 to 35 kg and 1.5 to 3.5 kg respectively.

12. Improvement of Traditional Bee hive Construction
Improving the construction materials and the model of a hive would obviously increase production of bee products in general.

Tips how to Construct Improved Traditional Beehive

- Cylindrical hive dimension should be 1.2 meters in length and 30 to 40 cm in diameter
- Both ends of the hive should be open but with proper lid cover for each side.
- Construction of bee shade is essential for protection of the colonies from adverse conditions that affect brood development and nest activities.

13. Transitional Hive Beekeeping
Transitional beehive is an intermediate hive. It is slightly better than the traditional hive by shape and internal mode of operation. The transitional hive has 27 to 30 top bars to be placed on top edge of the hive. It is easy to
operate, inspect and harvest honey by removing the entire honey comb from the bars. The comb once removed cannot be replaced again like frame combs.

The Ethiopian transitional hive is exactly the prototype of Kenyan top bar hive except for the change made in the construction materials. The Kenyan top bar hive is trapezoidal in shape (Fig 15). The top edge of the narrow side of the trapizoidal shape is wider than the lower edge of the rectangular edges being smaller. The Tanzanian top bar hive, has rectangular shape (Fig 16) These beehives are in use mainly in East Africa.

![Fig 15: Kenya Top Bar Hive](image1.png) ![Fig 16: Tanzania Top Bar Hive](image2.png)

Transitional hive was first introduced to Ethiopia in 1965 and then distributed to bee keepers as extension package in 1985. Transitional hive has merits and demerits.

**Merits of Transitional Bee Hive**

- Any farmer with short training can construct them with locally available materials
- Local carpenters can also easily construct them from any timber
- It can be produced with low cost
• Transitional hive is operable, simple to inspect and seasonal hive management practices can be done accordingly without endangering the bees in the hive.

• At harvest time it allows to investigate if the honey is ripe or not by picking up the bars and placing it back before any decision is made.

• It’s simplicity and appropriateness helps to harvest pure honey without removing brood combs.

• The mere advantage of the transitional hive is the high yield of honey 15 to 20 kg per hive per annum and beeswax production of 1.5 to 3 kg per hive per year.

• It is also possible to have more bee products by using of transitional hives.

**Demerits of Transitional Bee Hives**

• Removed combs would be used for only one time and not replaceable.

• The combs built on the top bars of the transitional hives are sometimes too heavy and need proper care while picking them up so that they should not break, during inspection.

• The modified transitional hive produced in Ethiopia is called “Ethio-Reberab.” The production cost is simple and easy to construct with simple training.
Construction of Ethio-ribrab hive from non timber and locally available materials

Hives made from timber become relatively, expensive and are un affordable for many of ordinary farmers in the country. Despite the fact that efforts have been made for many years to adapt timber made box (Frame) and top bar, these products have not reached the majority of bee keepers in the country. Considering these scenarios transitional hive made from non timber and locally available materials was developed and tested at research and farmers’ levels and found to be suitable to socio-economic conditions of many beekeepers in the country. The hive can be produced from different materials that can be found in different agro-ecological areas of the country and also elsewhere in the world.

The general shape and dimension of the hive are more or less similar to the Kenyan top bar hive. However, so many amendments and modifications were made to overcome some of the limitations of Kenya top bar hive and also to make the hive more suitable to local conditions.

To construct the hive; all dimensions are given on Fig.17. Since the dimensions of the materials can vary, there is need to consider and maintain the inner side measurements.

Construction of the frames of Ethio-ribrab hive wall

For the construction of this hive first prepare well matured, dry and straight eucalyptus and any other straight sticks. Prepare four straight sticks with one meter length and four straight sticks with 30 cm length both with more or less four to five cm diameter thick for the construction of hive body wall frames; Then construct the frame of one side wall by fixing the two one meter long sticks with two 30 cm long sticks in rectangular shape (Fig.18). This has to
fixed using four reinforcing sticks between the two corner sticks in their respective positions as indicated in Figure 18. When fixing the reinforcement sticks all should be 1 cm away from the inner side, which is to avoid bulging of the hive wall from the inner side particularly during smearing. Similarly construct the other side wall in the same manner.

Fig 18: Dimension of Ethio-Ribrab hive
Once the two long sides are prepared; it can be connected with four sticks two with 40 cm length from the top side and the other two with 22 cm long from bottom to form the short sides. These four sticks should be five to six cm thick in diameter. During connection two options can be used. The first one is cutting the sticks exactly according to the same lengths given above and fixing them between the two sides. The second option is to cut all the sticks adding five cm from both ends that mean instead of 40 cm cutting at 50 cm and instead of 22 cm cutting at 32 cm so that extra five cm will be at end of every stick. During fixing these extra five cm from each stick will be partially removed by splitting. It would be good to remove the two third of the thickness of the extra five cm and leaving one third of the thickness. These partially removed extra parts will help to fix the two sides from the outside maintaining the same internal dimension 40 cm from the top and 22 cm from the bottom (see figure 19). This way of fixing help to maintain the straight angle of the hive and also avoid splitting of the sticks during nailing and the fixing will be also more firm. Once the two short sides are fixed; at the center of each side one stick should be fixed. While fixing be careful in that all the three vertical sticks are aligned straightly. Finally fix straight the bottom of the hive using four reinforcement sticks.
Making of the hive wall

The walls will be made with very thin split of bamboo (Arundria) or shembeko sticks or climbers. First construct the small side wall from bottom to top then the longer sides (Fig 20). The splits should be uniformly thin and straight. Between the splits there should not be much space more than one cm and should not be very close each other to avoid unnecessary mud during smearing.
Fig 20: Constructing hive wall starting from the small side and then the longer sides

Fig 21: Grooves on the two longer sides

Once the construction of the wall is finished two grooves should be made from the two longer sides exactly at the center of the wall. The grooves can be made by fixing two sticks in parallel way. The grooves should be one cm wide and one cm depth (Fig 21). The importance of the groove is to insert partition board when the colony becomes weak and also to insert queen excluder to separate the honey chamber from brood chamber. Both the partition board and the queen excluder should be prepared by measuring the space before transferring of the colony. Be very sure both can easily and perfectly fit to the groove (Fig 22). The queen excluder can also be used to
confine the queen during colony splitting for queen multiplication purpose (Fig 22).

Fig 22: Partition board and queen excluder

**Plastering of the hive**

After finishing of the construction of the hive it should be plastered with well fermented and soft mud. The mud should be prepared at least for one week before plastering. During plastering care should be taken not to use unnecessarily too much mud that makes the hive very heavy. Moreover, during plastering all the inner side walls should be made uniform and smooth using piece of wood deepening with water. When the first plastered mud become well dry and crack it should be plastered again using smooth mud or using animal dung mixed with wood ash (Fig 21).

**Hive cover making**

To make the hive cover considers the dimension of the finished hive; because the size of the cover may vary slightly depending on the thickness of the materials used. Measure the dimension of the finished hive by adding two cm extra space from all sides of the hive which is very important to easily open and close the cover. However, generally one can take standard
measurements that are 110 cm long stick for the length and 60 cm long for the width (Fig 23) on how to fix the cover. Then after, reinforcement sticks should be fixed after every 15 cm parallel to the corner (60 cm long) sticks. To avoid the influence of the external weather the inner part of the hive cover should be prepared with insulating materials like splits of bamboo, shembeko and thin eucalyptus sticks (Fig. 23).

![Hive cover](image)

**Fig 23: Hive cover**

**Preparation of top bars**

In the construction of Ethio-ribrab hive; the very important part of the hive that requires great care is preparing and maintaining the correct dimensions of the top bars (Fig 24). Top bars are very important because it affects the nature of comb construction. If the top bars are not straight and not with the required thickness, bees will construct irregular combs. This attaches one top bar with another which makes the hive operation more difficult. If it is not possible to prepare or if suitable materials are not available, it is better not to use such hive.
Fig 24: Dimension of a top bar (cm)

Fig 25: Top bars (a, b and c)
For top bar preparation one has to select physically matured materials; the materials should be straight and dry. The diameter or the width of top bars must be between 3.5cm - 4.0 cm. Top bars below or above this dimension should never be used. For top bars two types of shapes can be used, flat and round types. The length of the top bars in average should be 48 cm. Each top bar should be longer than the width of the hive by at least one cm from both sides which is important to pick and handle the top bars during hive inspection and honey harvesting.

Round top bar preparation

Round top bars can be prepared from eucalyptus sticks, shembeko, shimel and from any round and straight sticks. For round top bars half of the thickness (about five cm length from both ends) should be removed (Fig 25 a & c) to make the top bars to properly lay on the edge of the hive.

Preparation of flat top bars

Mostly flat top bars are prepared from bamboo splits. As has been used for round top bars, the bamboo tree selected for top bars should be mature, straight and dry. If possible the inter node distances should not be less than 48 cm length (Fig:25 b). Bamboos have good quality as they split easily and straight using hand tools like knife.

Important remark

Unlike machine made top bars or frames (in box hive) there is no mechanism to guide bees to construct straight combs on each bar without attaching one to another. So in this hive great care should be taken to properly fix combs that are removed from traditional hives during colony transferring. The combs should be with brood, pollen, honey and /or nectar.
The combs should be cut in the shape of the hive and should not reach the side and the bottom of it. A minimum of three combs is necessary to fix. Combs that are fixed are not only useful to guide bees to construct straight combs, but are also important to attract the transferred bees to establish and adapt in the new hive. After a week, the transferred colony should be inspected and any irregular comb being constructed by the bees should be removed and/or corrected.

14. Frame hive Beekeeping

This model is the third type of beekeeping practice in the country. Since the invention of modern frame hives in 1845 many countries have modified and/or developed their own types of frame hives best practiced by native beekeepers. From the world famous frame hives, Langstroth and Dadant from USA, and Zander from Europe are widely used among beekeepers of the world (Fig 26). These important frame hives were introduced to Ethiopia in the late 1950. The Holeta Bee Research Centre during the former periods has contributed in training and distribution of the technology to the rural community. However ever since 1978 the role of the Ministry of agriculture in this regard is of paramount importance.

Frame hive according the Ethiopian context, comprises of base box and two supers of equal sizes. In each box there are ten frames. Hence, a set of one hive would have 30 frames.
A unique advantage of frame hive beekeeping is the use and reuse of the combs without breaking or damaging it. This phenomenon would help for the quick use of the comb by foraging bees. Moreover, honey produced from frame hives can be extracted using honey extractor without damaging the frame combs hence pure and standard honey can be produced. Production rate of honey from frame hives depends on the availability of forgeable floral, weather conditions, bee types and application of proper bee management which include migratory beekeeping, and the skill of beekeepers. In some parts of Ethiopia, using this hive about 25 to 45 kg of honey can be produced per annum. Good beekeepers can have even more production merits.

From frame hive beeswax production is also possible. However, it’s production capacity is not as good as the traditional hive.

The other best advantage of using frame hives is the possibility of inspection, supering, reducing supers, simple checking, and provision of fixing foundation combs for the quick start of nest activities, and for the control of possible intruders, pests and enemies of bees.
Like other beekeeping, practices both traditional and frame hives can be transported with bees from one place to another. But there is a slight difficulty in transporting transitional hives. Practice of migratory beekeeping would help to double or triple production per year.

In general from beekeeping practices, one can produce or harvest several bee products of economic values from the hives owned:

**Honey bee products**

- Honey and beeswax
- Pollen grains
- Bee brood
- Bee venom
- Royal jelly (bee milk)
- propolis.

Economic values of bees and beekeeping are very rewarding. Besides the produce indicated above, honeybees are very good pollinators of crops, fruits, and vegetables. However, in Ethiopia the importance of honey bees in improving the yield of agricultural products is not well recognized. Through bee colonies migration programmes, the works of bees in pollination can be effectively implemented.
15. Beekeeping tools and equipment

Where ever and regardless of beekeeping types, organizing and improving beekeeping tools and equipment is a prerequisite. Besides the training programme to be rendered to up grade the skill and knowledge of the beekeepers, the following tools and equipment are very essential to start and continue year round operation plans. Development tools and equipment, honey harvesting and processing tools and equipment and honey storage tanks and dispatching tools and equipment are among the essential materials needed to be procured and be ready for use.

In addition, frame hive beekeeping requires special tools and equipment like casting mould, honey extractor, frame wire, queen cage, hive chisel, uncapping fork, water sprayer, wax extractor, solar wax extractor, bee brush, honey strainer, feeder frames, hive fastening belt, bowel, and ladle.

Detail Description of the tools and Equipment

1. Development Tools and Equipment

Bee hives. There are three types of bee hives namely traditional, transitional and frame hives (Fig 27).

Fig 27: Different types of hives
Casting mould

Helps in the formation of comb cells so that the activities of bees in the hive would commence quickly (Fig 28).

Frame wire

The wire (Fig 29) would be fixed on the wooden frames, and then the foundation sheets would be on the wire in order to keep the sheet in up straight position.
Foundation Sheet Fixing Devices

Fixing the foundation sheet on to the wire can be done by running hot embedder (Fig 30-a) along where the wire is touching the foundation sheet. Any hot iron sheet or local knife can do the purpose. Electrical transformer (Fig 30-b) of 24 volt or so can help to fix wax foundation sheets on frame wire.

Fig 30- a: Embedder  

b ) Transformer

Queen excluder

It is a device that allows worker bees to pass through the holes excluding the queen and drone bees. Putting it in frame hives is a normal practice. It is also possible to place it inside the transitional hives to undertake similar purposes. This device can be produced from plastic, flat iron sheet or from wire. But the best and well accepted queen excluder is produced from aluminum and stainless steel metals (Fig 31).
Bee Brush

It is made out of soft sisal thread so as to push away worker bees safely during hive operation (Fig 32). It is most useful to get away bees from the working areas of operation.

Beekeeper's Protective Clothing

Keeping the body from being stung by bees is one safe way of hive operation. Some people may be allergic to bee venom, some cannot tolerate the irritation of the bee venom and to this effect using protective tools would help to properly under take the hive operation or the
business. The bee veil is used to protect the neck and face parts, hand gloves are used to cover the active working parts of the arms and fingers, the overall (beekeeper suit) helps to protect the entire body part from shoulder to base foot, and the boots protect the legs (Fig 33).

![Fig 33: Clothing's](image)

**Smoker**

It is a device (Fig 34) that produces smoke to be smoked on bees so that they should not attack beekeepers and others. Too much smoking during honey harvest is not recommended, because honey flavor and aroma would be spoiled.
Bee Hive Chisel

This is an important tool of the beekeeper. Without it, nothing can be done properly. Many times it is called beekeepers hand tool ((Fig 35). It is used to open the hive, clean frames, pick frame, remove unnecessary things, prepare combs, and foundation sheets by cutting, collect propolis, etc.
Bowel

It is used to melt both crude and pure waxes as needed.

Ladle

This is a tool used to pour melted wax on casting mould in an attempt to form foundation sheets.

Water Sprayer

Water sprayer (Fig 36) is mainly needed during bees transfer. It is used to spray water on cluster of bees, swarming colonies, and disturbed and nervous bees ready to attack.

Fig 36: Water sprayer

Feeder

There are many times when bee colonies are in need of food assistance. For feeding individual colony, feeders are vital. To place the food inside the feeder and then to put the feeder inside the hive to feed needy ones is one way of good bee management practices. For common feeding of bees any big container made out of either plastic or metal can be used ((Fig 37).
There are belts (Fig 38) used to tie super hived colonies while transporting frame hives from one place to another. It is also possible to use locally produced plastic ropes or ropes made out of different materials.

Solar wax Extractor

It is a box like device (Fig 39) made out of wood but the top surface is completely covered with glass air tight. However, the inner layer is painted black it would get warm quickly when placed under the sun's heat. Therefore, this device would help to melt crude wax with the help of solar ray and collect the melted wax in a collection jar.
Queens’ Cage

It is a useful tool to keep or confine the queen bee until the necessary task is to be accomplished especially during transferring, transporting and rearing of bee colonies (Fig 40).
16. Honey Harvesting and Processing Tools and Equipment

Bees Escape Board

This device is placed between brood and honey chamber. The board has one hole at the centre with additional device that allows the bees to go down to the brood chamber and protects them not to go up to the honey chamber. In some frame hives top lid or cover at the corner, there are holes that allow the bees to go out of the hive and protects them from getting in. After two days or so the bees would totally go out of the honey chamber (Fig 41).

Fig 41: Bee escape

Blower

This device helps to avoid the bees from working areas in the hive particularly during the harvest time (Fig 42). It requires additional devices that generate air for the purpose.

Fig 42: Bee blower
Honey Extractor

Honey extractor is a device made from stainless steel. It is used to extract honey by centrifugal force without the application of moderate heat. There are hand drive and electrically driven extractors (Fig 43). Ripened honey combs are placed inside the extractor for extraction. The smallest extractor can hold three honey combs to extract at a time, while the biggest holds 10 to 20 comb frames or so. Electrical device rotates more faster than hand driven ones when there are many comb frames.

![Stainless steel honey extractor](image)

Fig 43: Stainless steel honey extractor

Honey Presser

In most cases this equipment is made from aluminum sheet. Honey presser (Fig 44) is used to extract comb honey harvested from traditional and transitional hives. Any crushed honey is placed in small cloth bag then can be placed in the honey presser to extract the honey out by the application of force as done by turning or rotating the disc down.
Uncapping Tools

It is like a hair comb. It is used to open cell capping or uncap sealed honey combs before extraction. Ripened honey is usually sealed or capped by wax and this is done by bees inside the hive. If this tool is not available, put a knife on fire and when it gets hot run on the sealed comb to melt the cappings. There are many other devices like electrical uncapping knife, and uncapping fork, etc which are rather cumbersome.
Honey strainer

During uncapping and harvesting honey unwanted materials like broken comb layers and pieces of wax and bee's larvae can be extracted. These unwanted materials must be removed from pure honey by using honey strainer (Fig 46), a sieve like device made from stainless steel can serves like filtering cloth.

![Honey strainer with double sieve](image)

Honey Containers

It is a device used to store different types of honey before use (Fig 47). These containers can be made from metal, plastic and wood. But all types of containers must have lid that can be tightly closed during the storage period. Containers are of different capacity from one kg to 300kg and even more. There are large containers to be used during honey exportation. To maintain the organic quality of honey the storage device and packaging system do play a major role in the business world.
Honey Filtering cloth

Honey filtering cloth is simply used to clean the honey from any other impurities mixed while harvesting and handling honey. Wax particles, pollen pellets, dust particles and other materials usually get into the honey while processing. So honey filtering cloth is helpful in this regard. There are special honeys filtering clothes that have different sieve sizes. Using honey filtering clothes made out of nylon and plastic fabrics will decrease the food grade value of the produce.

Uncapping Table

This table has a groove in the middle to run the honey dropped while uncapping comb honey harvested (Fig 48).
Honey Scrapper

It is a plastic device with the size of a palm and relatively sharp end used to remove the left over honey on the walls of any container.

Honey Melter

This device has an electrode that helps to warm and melt crystallized honey kept in containers (Fig 49).
Homogenizer

When honey is kept in a container would dry and become solid. To maintain honey in liquid state, using homogenizing device is very essential. While using the homogenizer, honey yeast would be destroyed. The killing of honey yeast would help the honey to stay in liquid state for longer time. Homogenizing temperature adjustment is essential to keep other properties of honey normal.

New Bee Products Production Devices

It is very essential to learn other devices that help to maintain bee products of importance like as follows:

Pollen trap

1. Pollen trap (Fig 50) is a small device to be placed at the edge of hive entrance so that the pollen loads would be trapped from the hind legs of worker bees coming in from outside without endangering them. The device has several holes that allows worker bees to pass through and trap the extra load they carry. It can be made from plastic, metal or from thin wood.
2. Pollen Drying Box

It is possible to dry pollen collected by pollen trap under the suns' heat. But during the rainy season an electrically installed box can be used for the drying purpose. Using the temperature of 40 degree centigrade is preferred.

3. Pollen Cleaning Device.

Some impurities can be mixed with the pollen during the collection. In order to maintain food quality as human diet, a device was developed to clean all unnecessary impurities from the pollen (Fig 51). The device is well built with electrical installation. The overall function of the device is to separate the edible and non-edible pollen.
4. **Pollen Cups**

Pollen is one of the nutritious foods to humans and bees. Pollen jars are essential types of containers that help to maintain the quality and safety of the users. Glass jars are safe to store pollen. It is of different sizes mainly made from plastic and glass.

5. **Propolis Trapping Device**

Propolis trapping device helps to collect propolis from the inside of the hive. The device is like queen excluder with nylon nets and with visible holes, and can be produced from wooden boards. (Fig 52). The device can be placed under the lid (cover) of the hive and in between the frames in the hive. In the attempt of bees to close the holes of the device, they would plaster it using propolis. When the holes of the device are sealed with propolis, one can remove the device and extract propolis after placing it in cold room or refrigerator.

![Fig 52: Propolis collection device.](image)

6. **Bee Venom Collection**

African bee races have various difficult behaviors to undertake venom collection. Nevertheless, to collect this material a square or
rectangular framed device made from glass or from any stainless steel can be used. However, on thee device place 4 or 6 mm wire thickness in lines until evenly cover the top surface facing. This wire must have high electric resistance conductivity to electric current of 24 to 30 voltage used. When worker bees are poured on this device they would be shocked to release their venom without losing their life or normality.

7. Modern Queen Rearing Devices.

Now a day's many countries have developed different working tools and equipment for rearing and multiplication of queen bees. Some of the most common devices appropriate for queen rearing are the following:

7.1 Queen Cell Cup

It can be formed from pure beeswax and/or from plastic manufactured (Fig 53). This cup is used to confuse worker bees so that they accept it as if naturally made cups. It is not a complete cell cup produced. But this is simply half the size of the normal cup even sometimes smaller than expected. The worker bee s can enlarge the cup along with the development of queen's larvae.

Fig 53: Queen cup made of molten beeswax
7.2 Cell Cup Forming Stick

It is a device with appropriate dimension that helps to produce cell cups from melted beeswax (Fig 54). Its length is 7 to 10 cm, with one cm or less in diameter. It should be of smooth surface made from wood.

![Cell cup forming stick](image)

7.3 Grafting Needle

It is a special device made of metal and plastic with rubber cover at the handling spots. At the end of the sharp corner, there is a curved needle that enables us to pick fresh bee larvae from the inside of the comb cells and then transfer the fresh larva to queen cell cup formed (Fig 55). One larva is picked at a time. The device is in use during grafting method of queen rearing. Before the development of this technology, most beekeepers were using bird's feather, straw and metal hooks as grafting needle.

![Grafting needle](image)
7.4 Cup Holder

It is a sort of bar that fits to the frame of a box hive, but removable in most cases. It is possible to have three to four of such bars so that more than 30 cell bases would be plastered on it (Fig 56).

![Cup holder](image)

**Fig 56 cell cup base**

7.5 Queen Packaging Cage

Now a days, one could buy queen bees from market. Sometimes the queen for sale could be with small number of bees say up to 20 worker bees or so. Other times a colony with large numbers of bees and queen packaging bees. However, in every situation the queen would be placed in a special cage while transporting. The cage can be made from plastic or metal.

7.6 Packaging box

Bred queen bee and few worker bees would be out for sale. In the packaging box a sort of feeding cup would be placed while transporting. So the packaging box is used for this purpose. The packaging box could be square or rectangular in shape having
different dimensions. But two walls of the box are fitted with mesh wire in order to allow proper ventilation while transporting

7.6 Nucleus box

In any rearing programme, different sizes of boxes are used depending on the growing population of worker bees. The types of nucleus boxes are many. All developed countries have their own types. In order to keep the young queen with small number of worker bees, warm and comfortable small box hives with two or three or four frames are used. The frame size could be small or equal to the frame size of big box hives. Usually nucleus boxes are small hives.

Conditions to Undertake Beekeeping Development

The need of undertaking any development intervention is to be profitable and achieve successful benefits not only for a period but for years to come. However, conditions that help end results of beekeeping development to be profitable are the following:

- **Basic Knowledge**

Anyone who has the desire to be engaged in beekeeping development must have basic skill and knowledge of the sub-sector. One has to learn at least the science of honeybees, bees and plant relationship, population growth and decrease of bees at various seasons, the effect of drought and rainfall, realizing honey calendar, searching for manuals, advises, and meeting experienced
beekeeper to learn more on the practical aspects of bee management.

- **Availability of Bee Colony**

  The honeybees should be available when needed. If we observe absence of any honey or availability of an ample green biomass in an area, one could expect that the wild bees were either poisoned by pesticide or totally taken by beekeepers to some other places for better use. Bee colonies like any other useful insects can be transported from place to place within the country. While doing this, care must be taken, as bees are dangerous when touched and mistreated. Moreover, while transporting or moving the hived colony from place to place the upper position of the hived colony rested during the old nesting site should remain in the same position during the movement (Fig 57). This would help not to damage the vertically erected combs in the hive.

Fig 57: Colony transportation
• **Working Tools and Equipment**

Arrangement or making available of working tools and necessary equipment prior to the onset of the development programme, is very essential and a wise step.

• **Beekeeping Working Site or Apiary**

The primary task to start beekeeping development is the selection of a suitable area. The bees are free living things on earth. They have the ability of selecting an area that favors their nesting activities. But, if forced and moved to a place where the beekeeper is forming an apiary, the site should at least have naturally grown or planted flowering honey plants (Fig 58). Moreover, the presence of water, good weather, free from pesticide pollution, and the absence of dangerous bees enemies is of paramount importance.

![Appropriate beekeeping site](image)

Fig 58: Appropriate beekeeping site

Where and how to place hived colony is another question and yet to be properly addressed during implementation. Highland and extreme lowland places are not good to establish an apiary. Bees by nature require warm areas and hate cold places.
• **Supervision and Inspection**

The site to be in use must have access to road possibly during the seasons of the year. Honey harvest and any operation in beekeeping usually done at night. If there is no access to roads, supervision, inspection and routine hive operation cannot be done as desired. Considering accessibility of roads to the working site is very essential.

• **Hive stand**

Hive stand can be constructed from timber and be erected in a place selected. To avoid the invasion of ants and other bee enemies several devises were installed but none of them were effective. In Ethiopia, there are many bee enemies that attack hived bees at any time of the seasons particularly during honey flow time and in dry periods. As shown in Figures 59, 60,61 and 62 construction of hive stand to protect the colonies from the invasion of big animals, insects and birds is one of the best beekeeping management practices to be applied.

![Four legged hive stand](image-url)
Corrugated iron

Wooden stand

Inner tube

Fig 60: One legged hive stand with ant protection

Conically shaped sheet metal

Fig 61: Bed type hive stand with ant protection

Circularly Fixed sheet metal to protect ant invasion

Fig 62: Hive stand with ant protection
- **Construction of Bee Shade**

  Bee colony shade can be constructed from cheap and locally available materials. To avoid heat stress, cold weather effect, and rainfall, the shade is helpful for the bees and brood development (Fig 63)

  It is not always necessary to construct the shade and to put all the colonies of bee inside. It is possible to keep hived bees in open site where no unfavorable conditions are prevailing.

![Fig 63: Hive sheds Open shade and closed bee house)](image)

- **Apiary Site Fencing**

  This is simply to secure the advantages, ownership, and protection of properties properly. Fencing can be done by erecting treated poles and barbed wire. Fencing can be done by planting multipurpose trees all around so that the bees would get advantage of fodder collection from nearby later on. The trees can also serve as protection so that other living things cannot be attacked by bees. The plants can also serve as wind break and shade for the bees.
• **Cleaning Apiary Site**

Areas where bee colonies are kept should be clean, and free from growing leafy plants and from any unfamiliar or alien materials. In order to meet the international standard for organic honey, the site must be free from home wastes, animal dung, and washed cloth flashes.

• **Beekeeping and Public Service Areas**

It is not advisable to establish apiary near to schools, hospitals, dairy and poultry farm sites, and market places. The Ethiopian Proclamation of Apiculture Development and Protection indicates the possibility of developing beekeeping sites in big cities provided that proper care and management is applied. If one wants to establish small apiary with bee colonies in cities, putting long fence around it would minimize the incidence of bee attack.

• **Chemical pollution free zone**

It is an appropriate idea to establish an apiary in areas free from application of chemicals, and from intensive emission of industrial smokes in order to minimize the risk of bee death and maintain the quality of honey to be produced.

• **Bee forage development**

According to a widely accepted exercise in bee management operation plans, it would be necessary to provide bees with nectar and pollen for their survival and development. The best suitable
apiary to establish is where the natural flowering plants are grown in the areas without the interference of humans. But when the naturally existing plants would not satisfy the needs of colonies introduced, bee forage development is an option of good practice. In the tropical countries like Ethiopia, there is long dry period where many flowering plants do not provide nectar and pollen. Therefore, the flowering plants planted during the varying seasons would help for the availability of feed to bees.

17. Transfer of bee colony from local hive to frame and to transitional hives

One cannot place either frame hive or transitional hive on tree branch in an attempt to trap swarming colonies of bees. For such tasks local hives can be hanged on tree to trap swarming bees. Few farmers can hang frame hives on tree branches where theft is not a problem. Nevertheless, the most common practice is only after the bee colony has been trapped by local hives and then would be possible to transfer the bee colony either in box or transitional hives.

During the transfer of bee colony from local hive to either frame or transitional, the entire bees and brood are removed from old nest and transferred to new nesting hive. Bees that are transferred to new nesting hives would be confused and would have feeling of insecure and discomfort for some time until they are used to the changing environment. Before they are removed from their old nest, the conditions of the new nest must be so attractive to bees so that they can quickly accept and settle well.
Preparations for preconditions are many. These include:

a. The bees in the local hive should be placed on the spot where permanently designed to place the colony after transfer. Keep the bees in the old nest for at least three days.

b. Fencing the apiary site is very important prior to the establishment in areas where predators are existing.

c. The beeswax to be used for foundation sheets must be pure and free from any chemical and different adulterants.

d. Prepare wax foundation sheets. While making the foundation sheets, make the layer very thin and transparent because the bees like such foundations.

e. Melt beeswax cakes with or without water added to it. Since it is the cause of great fire hazard, it is advisable to pay much attention so that the beeswax will not exceed the above mentioned melting point and not catch fire. So, before one sees melted wax produce foam like substance, remove it from the melting bowel immediately.

f. Prepare lubricants to help smoothing the pressing machine called casting mould while making wax foundation sheet,

   i. clean casting mould with fresh and clean water

   ii. put two small plastic bowels to place fresh water in one and lubricant mixture water in another.
iii. It is wise to be sure before selection whether a certain lubricant is accepted by bees or not. Some lubricants such as detergents (as they are bee repellants) and perfumed soaps must be avoided. It is recommended to use normal soaps made for cloth wash and some others free from perfume and colouring materials.

iv. Take away melted wax from any heating stove and allow to get cool slight before making foundation sheets or pressin.

v. Sequences of forming or making the wax foundation sheet is as follows:

   a. On a cleaned casting mould, put lubricant with wet water on ladle full and then close both sides of the mould, so that both the base and lid would come in contact with the lubricant.

   b. Then as the presser is close decant the lubricant into lubricant container, then

   c. Open the presser lid and pour on the melted wax half ladle or full ladle and try to spray over the presser evenly and then close it quickly (Fig 64). Push or press down the lid or the upper cover of the casting mould by hand in order to have the comb design is properly molded.
d. Before opening the presser to remove the foundation sheet formed, pour cold water on the presser just to cool it down.

e. Then open and remove wax foundation sheet formed.

- Arranging wax foundation sheet for fixing on frames

  g. First, have the box frames with frame wire fitted
h. Cut the foundation sheet according to the internal frame size where the wire is fitted. But in order to create bee's walking space between frames, and within cut the wax foundation size less in size by two or three cm. from both sides and from the bottom side of the frame (Fig 65).

i. It is not advisable to have the foundation sheet larger than the frame size..

Fig 65: Cutting foundation sheets

- Frame wire and fixing foundation sheet on it

The size and kind of metal to be used for fixing on frames is different from any ordinary copper wire and the like. It should be a type of wire that has high resistance to electrons of electric power. The size of the wire with four, five point five or six mm. thicknesses is preferred. Insertion of the wire through frame holes and tightly stretching the wire like guitar string (Fig 66) is needed so that the foundation to be fixed on it would not be loosely attached (Fig 67).
Fixing procedure:

Two types of tools or equipment can be applied:

a. Use of hot iron or embedder (Fig 68)

b. Use of transformer with 12 to 24 volts. Capacity.

Use of hot iron or sickle to fix the foundation sheet is the most common practice in Ethiopia particularly in areas where electric power is not available. While fixing the foundation sheet on frame wire bring foundation sheet pretty close to top bar of the frame leaving no space in between top frame bar and wax foundation sheet.

While using embedder, get the head of embedder hot and roll on wire attached to the foundation wax. See the figure.
Prior to any operation, the box hive and frames must be cleaned, properly dry and free from any odor or smell. Some farmers or beekeepers smoke the hive before transfer just to attract the bees and settle quickly. Known smoking materials that can be applied in the area and if one is working with farmers, it is better to allow them to use smoking materials according to their choice.

Preparation of transferring site.
This site preparation is for temporary use. Nevertheless, certain preparation is so necessary to properly achieve end result of the intended tasks leading to success.

a. The site to be used should be a little away (20 to 50 meters) from where the bee colonies are so that safe operation in transferring would be done.
b. The ground should be free from grasses so that bees can be seen easily if fall down on ground.

c. It is preferable to transfer bee colony from local to box hive or to transitional hives during day time. But in most instances where backyard beekeeping is practiced it is better to do the transferring after 5 p.m. During the transfer, the ground selected for the purpose should be near bushy tree branches just to trap the bees if gone out fiercely. Transferring under big trees is not advisable because if the bees move away and rest on big tree branches then it would be difficult to reach and catch them.

d. It is recommended not to select transferring site that are near to roads that are frequently used by pedestrians and animals.

- **Materials required during transferring**

The following important lists of materials are properly arranged and ready for use during the transfer and to be placed at transferring site.

1. The type of hive that was ready to put new colony in.
2. Make ready smoker and the materials to smoke
3. Bee brush
4. Water sprayer (but not critical)
5. Bee hive chisel
6. Knife
7. Collection pan for old combs and another one for smooth honey combs
8. A sort of carpet, mat, or any other flat material to be placed on the transferring ground.
9. Wagon for transporting unused materials
10. Wire or rope
11. Queen cage
12. Feeder frame with sugar paste
13. Needle and rope
14. Complete technician protective materials

- Possible transferring time

If the transferring place is away from the reach of people and animals, it is quite possible to do the transferring during day time starting from morning to late afternoon. If the operation of transferring is near resident areas or at backyard, the possible and safe operation time is after all animals, school children and other walking living things are under their respective shelters. It is not advisable to do transferring alone. Two or more people can do better jobs and safe.
Transferring bee colony from local hive into frame hive

1. Put the mat or flat material prepared on the transferring ground

2. Prepare the smoker with smoking materials inside and place near the edge of the mat

3. Put bee brush near by

4. Have water sprayer with water, good if you make it available

5. Bring the new nesting frame hive and place it on the mat having the size of 120 to 130 cm (Fig 69).

6. Open the cover(lid) of the frame hive

7. The entrance of the frame hive should be towards the wider areas of the mat.

Fig 69: Transporting colony for transferring
8. While bringing the old hived colony, do not roll or change the original position of the hive. Keep its position as it was until reaching the transferring place.

9. As seen in the Fig 70 hold local hive in the inclined position or as seen in Fig 71

10. Put the new nesting frame hive near and on operation mat.

11. The transferring has to be conducted with a steady and gentle manner of operation. This is mostly to avoid the magnitude of committing error in damaging the queen bee and minimizing jerking movement during removing combs from old nest.

Fig 70: Holding hive in inclined position

Fig 71: Placing local hive on stand for ease of transferring
12. The operation would start by opening the local hive lid.

13. Smoke around the edge of the hive soon after opening the lid. It helps to clear or move away the bees from working areas.

14. Whenever removing combs (Fig 72) look for the queen bee on both sides of the comb and place it where appropriate. The brood and the honey comb are to be placed separately.

Fig 72 : Removing combs from local hives

15. Use bee brush now just to clear the bees from the combs removed.

16. If the queen bee is discovered by chance soon after the operation started, then catch the queen bee and put her in a cage and place her in the new frame hive. Then continue the operation. However, this time onwards, there is nothing to worry about the mood of working, but
the operation would continue faster than expected (Fig 73).

Fig 73: Searching for queen bee

17. At any time of operation after the queen is caught place her in queen cage and then put her in the new nesting frame hive.

18. Cover the frame hive now after placing the queen bee in

19. During the operation if the queen bee is not discovered immediately, the work should continue but in a gentle manner until no comb is left in the old hive.

20. During the operation in cooperation with other people, fix brood combs removed from old nest on frames of frame hive with the appropriate head position of the removed combs correctly upward. Use rope and needle to tie brood combs on frame top bars accordingly
21. When everything from the local hive is removed, hold the local hive with both hands up and forcefully knock down on the mat so that all the bees inside the old hive would fall, then search for the queen bee carefully. See picture 73

22. Make sure that no bees are left in the old local hive. Then take away the old local hive from the working site.

23. Allow the bees or indicate the direction of the hive entrance to run to where the queen bee is. Most of the time worker bees would search and reach her quickly.

24. There are rare incidences missing the queen bee during transferring. She may go with the swarm bees in to the new frame hive unseen or she may be out of the working areas resting on technicians' body or on tree branches or on other places. If its wings were clipped, it may fall down on the ground. If the queen bee is not in the new nesting hive, the worker bees are reluctant to join her going to the new hive. Even after the transferring has been successfully conducted, it is essential to check the remaining situation. So sometimes watch carefully to exploit the unexpected situations. It is possible to find two queens while transferring.

25. After completion of the transfer, place the new frame hive with the newly transferred bees in place of the old hive.
26. Finally clean working areas and materials that were used during the transfer.

- **Transferring of bee colony from local to transitional hives.**

  In most cases, transferring method and material requirement indicated in frame hive colony transfer can be applied to transitional hive transferring method as well.

  But in the case of transitional hive transferring, there is no need of making and fixing comb foundation sheets on bars as done for frame hive. There is also no need of inserting frame wire. However, preparations required before the transfer is as follows:

  a. Clean and assure the presence of all top bars required

  b. If beeswax is available, melt and smear on the inner middle surface of the top bar just to indicate the start of building the comb.

  c. Fix brood combs removed from the old local hive on the top bars of transitional hives

  d. Prepare transferring mat and other materials required as indicated in frame hive transfer method.

- **Transferring procedure**

  1. Bring transitional hive first and place it on the mat
2. Next, bring the local hive with bees and place it near transitional hive but in the inclined position and then open the lid to start removing the combs.

3. Smoke on bees to avoid them from working sites.

4. When ever remove the combs, look for the queen bee on both sides of the comb.

5. Brush the worker bees down into the transitional hive from the top bar that is temporarily picked.

6. If the queen bee is found at the first operation that took place before removing all the combs from the local hive, then put her in a cage and place her in the base floor of the transitional hive. The work then after would be simple and quick. If not found quickly, continue removing the combs in a very careful and gentle manner until the queen bee is found. When she is seen while removing the combs, the lead person of the operation should take out off the hand glove and catch the queen bee with bare fingers (Fig 74). This is simply to safely handle the queen bee the most important individual of the colony. See picture 76.

7. If the queen bee is not found until the end of removing the combs from the local hive, knock down the local hive on mat after holding with two hands and this helps to remove all bees remaining inside. Search for the queen bee, catch and introduce her to the transitional hive after placing it temporarily in a cage.
8. Brood combs removed from local hive should be placed inside the new transitional hive by tying the combs with rope on top bars.

9. Place all the top bars in place. Direct the swarm bees to the new hive entrance (Fig 75).

10. When this operation is finished, look and investigate for unforeseen things around and then place the new transitional hive in a place where the former local hive was.

Fig 75: removed combs from traditional hive and placing into new transitional hive
11. After the colony has settled well, try to check for the old combs introduced if not placed in order.

If there are old combs removed during the transferring time but not in use two important things to consider:

- Save these combs as they are by placing in a safe bag for later use
- That same day, or shortly afterwards, melt and collect pure beeswax before it is attacked by wax-moth.

- Follow-up and support for settlement of colony transferred

After the transfer is done, starting next day, inspection of conditions to working bees is an important task. The bees unless irritated with materials in the hive they will start resuming the normal nest activities quickly. Bees going out of the new hive and coming with pollen load is a good sign of settling. If the transferred colony did stay in the new hive with no sign of movement, and if no bee is going out or coming in, then there would be a danger rather have the intention to escape to unknown destination. Some beekeepers in such a case would provide them with more food. Instead, close watching is important.

Some bee colonies when they are disturbed after transfer, they mostly crawl around hive entrance. Therefore, smoke at them and drive them to go into the hive again.

If the bee colony starts cleaning the hive, this is a good indication also that the colony has settled in the new nesting hive. The bee colonies have the behavior to remove all unnecessary things from the nest quickly.
If one is sure that the bees have resumed nest activity, releasing the queen bee from the cage mostly after one to two days is good for her to be acquainted with the new environment inside the hive.

All old combs removed from local hive and placed into the new nesting hive, whether it is in frame or transitional hives, should be removed after the bees have settled well and start constructing their own new combs.

Another and most important aspect of transferred colony settlement to new hive is that the start of queen bee laying eggs and larval development when seen in combs cells. On the other hand, in the presence of newly constructed comb if no eggs are laid and no larval development is seen, then, there is a danger of losing the queen bee at transfer time or then after. Such colony can be called queen less colony.

As a coping mechanism worker bees lay several eggs of their own in one cell which is not done by queen bee. The queen bee would lay only one egg per comb cell at a time.

During such unfavorable situation, where the colony is without queen bee, instead of losing the entire colony the best option of surviving the colony is to insert or place brood comb with fresh uncapped larvae by bringing from other colony so that they can develop queen bee from the fresh larvae introduced. This has to be done before worker bees lay their own eggs.

At any time of the seasons, apiary inspection and application of best bee management practices is a rewarding job leading to sustainable end results.
18. Inspection and proper validation of bee management
Among methods of improved bee handling, follow up of external and internal conditions of colonies is a major and important activity. External inspection is follow up of the external conditions of a colony. Opening of a beehive to detect the internal conditions of a colony is internal inspection. So, colony inspection can be divided into two parts namely, external inspection and internal inspection.

❖ **External Bee Colony Inspection**

External bee colony inspection is an observation of the condition of a colony from outside without opening the beehive. In external inspection, the strength or weakness of a bee colony can be determined by observing at the entrance of a beehive to find out the number of worker bees that move in and out. During a flowering season, by looking at the worker bees that carry pollen grain balls by their legs into the beehive, it is possible to determine whether the colony has a queen bee and eggs. If workers do not carry pollen grains into the beehive, it can be an indication of the death of a queen, dearth period causing lack of forgeable food or due to unfavorable conditions they faced inside and outside the hive. If many bees cluster at hive entrance, this could be an indicative of one of the following: the internal temperature of the beehive is higher, or the beehive is congested and the bees need more space or it is a hint that it is time to harvest honey. Inspecting the surrounding where the beehives are placed helps to find out if there are ants and other predators. If so the necessary corrective measures should be taken. Therefore, inspecting the external conditions of each bee colony before doing any internal inspection assists to discover and gather information that is helpful to internal inspection.
Internal Beehive Inspection

Internal beehive inspection is conducted to assess the condition of the bee colony, to verify the accuracy of information gathered during external inspection, to identify and take corrective measures of any problems observed and to determine what to do subsequently. The following are some of the major areas to be focused on during internal inspection.

1. Observe if the beehive is too big or too small for the colony
2. Make sure that there is enough feed
3. Observe whether or not the colony is ready to swarm
4. Check if the colony is attacked by disease, animals or pest
5. Check if it is time to install queen excluders
6. Check if honey is ripened enough to be harvested, if not, determine the time for harvest.

Pre Inspection Preparation and Care

Depending on the type, strength and season of the year, bees are aggressive. Necessary preparations should be made and care should be taken before opening a beehive.

1. Prepare a Complete Protective and Safety Gear

After a beehive is opened for inspection bee stings and other inconveniences should not interrupt work progress. Protective and safety gear that have been used for previous colony inspections may carry the scent of bee venoms that bees can smell from a distance. This makes bees to react causing disturbances. Always, gear has to be washed after use
and should be free from such smell. In addition, the color of protective gear should not be black or red. These colors irritate bees. Instead, white and off white colors are preferable.

2. **Wearing Protective gear properly**

It is necessary to wear heavy clothes under protective dress and to make sure that zippers run all the way through. Wearing light clothes will enable the bees to sting through. It is also necessary to make sure that bee veil is not too close to the body face and strings are tied tight. Smoke prepared for the inspection has to last through operation time.

3. **Determining Time and Weather Conditions of Inspection**

It is necessary to choose a convenient weather condition to undertake inspection. Backyard beekeeping should be done at night. Beehives should be opened when it is not windy, cold or rainy. Wearing perfumes or other cosmetics sprayed clothes on inspection days is not advisable. Body and foot odor can also irritate bees and cleanliness is necessary.

4. **Caring for People Stung by Bees**

When people are stung by bees, the venom causes reddish body swell. After some hours the swelling subsides. Trying to pull out the sting from the body by holding with fingers would aggravate severity of the situation. The attempt enables the venom in the sting to spread more into the body. This causes more swelling. Instead, finger nails should be used to pressure out the sting by pressing the surrounding part of
the body. If finger nails are short, needle like objects can be used to pull out stings. If available, holding ice on the body helps to reduce the pain.

People with minor allergy to bee stings show symptoms of higher level of itching, body swelling, breathing problems and vomiting. In those who are seriously allergic to bee the venom spreads throughout the body in a very short time. In additions to the above symptoms, they will have higher heart beatings and body sweating. A single bee sting could also be fatal. Hence, such people must be extremely careful. They should not even attempt to participate in any beekeeping activities. If they are stung by several bees, they should be taken to hospital immediately.

5. Avoiding Loud Voices, Disturbances and Fast Movements

When someone is around bee colonies and apiary, fast movements and loud voices should be avoided. During opening and closing of beehives, when adding or removing super and frames, the movements should be very gentle; bumps and noises should be avoided. This will not only calm the colony but also minimizes accidental death of the queen and the bees.

6. Using Standard Beehive Opening Procedures

To do any internal inspection, the top cover should be removed. The following steps should be followed to do this.

Stand on the side of the beehive (Fig 76) and blow smoke into the beehive through the bee entrance. Wait for 2-3 minutes.
Stand on the side or behind the beehive and use a chisel or a knife to pull up the cover. Lift the cover a little and blow smoke on the sides and into the beehive and wait for 2-3 minutes. One should always stand on the side or behind the entrance to do any inspection. Working in front of the entrance blocks the in and out movement of the bees and forces them to change their flying direction. If they do, this disturbs the colony and makes them aggressive.

Remove the cover completely and blow smoke to move the bees to the base. Turn the beehive cover up-side-down and put it away. If the inspection is on the base of a beehive, the cover should not lean on the hive. Then proceed with the inspection.

7. **Avoiding the Exposure of larvae or brood from Draft and Sunlight, and Avoiding Honey from Robber Bees**

When doing internal inspection, the larvae or brood should not be exposed to draft and sunlight. If inspection is conducted during day time, bees from one beehive can rob honey and nectar from another beehive. The cover removed for inspection should be placed back as
soon as possible to avoid such problems. During such inspection, a colony should be observed if it is ready to split and swarm and if so queen cells should be identified from each comb and should be carefully avoided. Taking time to inspect the beehive frame by frame is not required.

❖ **Order of Conducting Inspection**

Beehive inspection (Fig 77) should start from weaker and end with stronger colonies. Stronger colonies have more workers. If weaker colonies are inspected after strong colonies, workers of strong colonies will disturb and rob the honey and nectar of the weaker colonies. It becomes more inconvenient to conduct inspection. If colonies in the apiary have equal strength, it is preferred to start one from each corner and then go to the middle. Inspection should be conducted only when it is necessary to perform required duties and solve problems. Unnecessary repetitive inspection should be avoided. Repetitive inspection may result in weakening of colony, forcing colony to consume honey they made and finally in colony absconding. Specially, in drought seasons, repetitive inspection is not recommended.

![Fig 77: Inspecting colony](image-url)
19. Methods of Beekeeping Based on Seasonal Calendar

Based on the weather condition of the area, rain distribution and flowering conditions, there are times that colonies get stronger or weaker. A colony weakens when there are no honey flowers. In hot areas and where there is scarcity of rain, a little rain enables in many plants to flower in a short time. This creates conducive conditions for colonies to become stronger. In such areas, the dry season is the time when bees get weaker. On the contrary, in colder and rainy areas, the rainy season is the time colonies get weaker. In such areas, when the rain stops, in the dry season, honey flowers start blooming and colonies get stronger. With some exceptions, such seasonal changes happen year after year.

Care and handling of colonies at times when they are weaker or stronger is similar in both dry and rainy areas. Implementing methods of handling assists to strengthen weaker colonies and helps to control absconding, helps to keep colonies in good health, and generally methods of handling help to maximize benefits obtained from beekeeping development and increases productivity.

Seasonal colony handling can be looked at from two categories referred to as handling conducted when colonies are weaker and when they are stronger. With some exceptions in the traditional and transitional beehives, the methods are applicable to all types.
**Handlings Strong Colonies**

1. **Handlings of strong Colonies in frame beehives**

When honey flowers of an area bloom, newly transferred colonies, existing but weak colonies, strong colonies, worker bees of all colonies start to collect and store a big amount of nectar and pollen in a very short time. Realizing the conducive situation, the queen starts to lay thousands of eggs a day to strengthen the colony. Thus, the population of bees increases in a short time and this causes space constraint and overpopulation and eventually colony splitting. Beekeepers and beekeeping professionals should monitor the situation and analyze information obtained from internal inspection and need to implement methods appropriate for the season. Some methods are increasing the size of beehives, installing queen excluders, controlling reproduction and splitting and harvesting honey in time.

2. **Increasing Beehive Size (Supering)**

During flowering seasons the colony size increases quickly. Bees are overcrowded and more beehive space is needed. In such situations, bees prepare to split and swarm. If colonies split, honey harvest decreases. Increasing beehive size controls the splitting and swarming of colony. In addition to this giving more space to colonies will give them an opportunity to lay eggs and to increase colony size and produce more honey.
If the colony in the base is overcrowded, supering at the proper time is necessary. There are indications that show when the base is overcrowded. External observations indicate a big number of bees going in and out of the beehive. In the evenings many bees cluster at the entrance of the hive. This may indicate lack of space. Internal inspections show frames fully covered by bees. Out of the ten frames five are filled with eggs. When there are such indications in a colony, it is time to immediately add boxes. Supering is of no use if it is off season. If the amount of honey flowers decreases the colony size will not increase.

3. **When to Decide Supering: Adding a first and a second Box**

Indications above suggest supering. There need to be more inspections, however, to decide supering on the base box, opening the cover of the base box and observing whether the colony is really overcrowded or not is vital. If the base box need additional space upward, supering is a must. This is called first box supering.

If the base and the super box are crowded with bees it is time to super. Another box should be placed on the existing super. Before doing so, availability of honey flowers should be considered meeting the future need of increasing population of bees. Only when foraging plants and florals are available supering should be conducted. If the season is when honey flowers are diminishing or fading and if it is honey harvesting period, adding another box is not recommended. If so, the colony will consume the honey in the beehive, and it may not even produce honey at all. So, supering in
the wrong season should be avoided. At this situation, frames should be inspected and all queen cells should be destroyed. In addition, 2-3 frames with eggs should be removed and be replaced by a new foundation without eggs. The frames with eggs can be placed in a weaker colony. Such proper management of colony controls splitting and swarming of colony which results in higher volume honey production. Thus, not supering when necessary or supering when it is not necessary has adverse effects and decisions should be made carefully.

❖ Procedure of Supering

When internal inspection shows the strength of a colony at flowering season, and supering is suggested, the procedure can be conducted in two ways.

Open the cover of the beehive which needs supering. On top of it, place another box which contains newly prepared wax foundations and align it properly.

Take out 3-4 frames which contain eggs and young larvae from the existing box and place it in the newly added box (Fig 78 Fig 79) in such a way that there is one frame with eggs and young larvae in the middle of eggless frames. When frames with eggs and young larvae are placed in the newly added box, bees need to go up to the new box to take care of the eggs. This process will familiarize the bees to the new box and they will eventually get used to it. When they do so, they will quickly start building combs. However, if the colony is weak, the bees may not climb up to take care of the eggs and this harms the eggs. If eggs do not get the necessary care, they may rot.
Therefore it is wrong to add boxes with the assumption that bees will necessarily follow eggs placed in the new box.

Fig 78: Supering hive

Fig 79: 1st and 2nd supering
a. Installing Queen Excluders in Frame Beehives

Timely and properly installing queen excluders is one of the activities conducted in flowering seasons and when the colony is strong. Installation of queen excluders is required to arrest the queen in the egg lying area so that eggs and honey do not mix up and there is pure honey harvest.

Many professionals suggest that it is possible to get pure honey without installing queen excluders. It is true that if there are good extended flowering season workers bees quickly fill the combs. This reduces the egg lying space of the queen and results in less eggs and better and more honey. But this situation is not common and may not happen in many colonies. Some colonies have a tendency of working towards having more eggs than more honey. They use produced honey to feed the growing pupa which decreases the amount of harvest. In addition, many combs may have half honey and half pupa which makes pure honey harvest difficult. Installing queen excluders properly and timely will minimize the above problems and some studies show that installing queen excluders has positive impact on honey production and basic quality of beehives.

b. When and How to Install Queen Excluders

Many beekeepers leave installed queen excluders in beehives. This is wrong and should be corrected. During flowering seasons, the queen should get enough space to lay eggs to strengthen the colony. If the queen is restricted by the excluder all the time there will be negative impact on honey production. Hence, the installing and uninstalling of queen excluders should be determined by the seasons. The need to install queen excluders varies depending on the condition of the environment and the strength of the
colony. Some beekeepers install excluders when they super. This restricts the queen from laying eggs in similar places.

In hotter areas and where the flowering season is shorter, because the gap between the supering and installing excluders is short, some beekeepers carry both activities at the same time. This practice may not work in all conditions and should not be taken as an alternative practice.

To those colonies who had two boxes all season and to those colonies to which a new box has been installed the average time of excluder installation should be three weeks before harvest time.

c. To Install Queen Excluders

Follow proper procedures to open the top cover, and then use smoke to drive the bees to the base.

Remove bees from the frames and take each frame at a time and put them out of the box. After taking out the frames, brush down any remaining bees in the upper box to the base. Remove the empty box and place it at the top of the box cover.

Next, from the frames placed outside, select those which contain honey, nectar and sealed pupa and leave these to put in the upper box. Select those frames which contain pollen and pupa which is not sealed and place them in the lower box. From the lower box, select frames which contain honey, nectar and sealed pupa, brush off the bees and substitute these in the place of the frames selected and moved to the lower box.

Sealed pupa are placed above the excluder so that as soon as they are hatched, they start working to fill the comb with honey. After selecting frames which are determined to be placed below the excluder and after
placing them properly, the queen excluder should be aligned and placed correctly. Similarly, the empty box which comes above the excluder should be aligned and placed correctly. Place each frame selected to be placed in this box and put back the top cover. After honey harvest, the excluder should be removed immediately.

20. Bee Reproduction and Bee Swarming
During a flowering season 10-15 new queens can be hatched. When each queen swarms a few worker bees follow it. This can result in the weakening of the existing colony resulting in product decrease and there may not even be any honey harvest and the colony could disappear. Improved beekeeping practice emphasizes the control of bee reproduction and colony splitting.

Steps to Be Taken to Control Bee Reproduction and Colony Splitting

1. Add boxes at the right season.
   Substitute old foundation wax and those not being used by the colony with newly prepared ones.

2. Place 3-4 frames with larvae in weaker colonies.

3. When overcrowding colony is observed, inspect the beehive every 10 days and avoid queen cells developed.

21. Honey Production: Harvesting and Processing
Indicatives which assist to determine the readiness of honey harvest.

- There will be honey aroma in the air near the apiary.
• The number of bees getting in and out of the beehive decreases. This is because they have enough honey and they do not need to work.

• In the evenings bees cluster at the entrance of the beehive.

• Readiness of harvest can be determined by opening the cover and visually observing the honey comb.

If two thirds of the frames are sealed it is time to harvest. If harvest is done post flowering season, it is necessary to leave some honey combs for the colony. If it is still flowering season, it is possible to harvest all the honeycombs as the bees can still produce honey to feed themselves. If ripe honey is not harvested in time, the bees will stop working and start to consume it. When honey is harvested, care should be taken so that the quantity of smoke used to drive away bees does not affect the quality of honey. The amount of smoke should be minimal and brushes should also be used to remove bees. Honey harvested from traditional, transitional and frame beehives should be extracted and filtered immediately. Colony tends to weaken after honey harvest and this requires care and follows up.

22. Handling Colony in Transitional Beehives during Flowering Seasons

a. Increasing the Size of Beehive Space

It is necessary to follow up the activities and strength of bees and add space to colony which has been recently transferred to a transitional beehive. Transitional beehives are not like frame hive on which a box can be added to increase size. However, when transitional beehives are
manufactured, they are made to have the size of two frame boxes. To accommodate space size in times of colony weakness, there is an installed barrier which can slide to increase or decrease space. When the colonies get weaker and there is too much space the barrier slides to narrow the size of the beehive and when the colony strengthens the barrier slides back in reverse to accommodate the required space. If there is any suspicion that the colony may get overcrowded resulting in colony splitting, old foundation combs should be selected and be removed, and 2-3 bars which contain pupa should be taken out and be placed in beehives with weaker colonies. It is necessary to inspect colony, and destroy queen cells to minimize the risk of splitting.

b. **Installing Queen Excluder**

To enable installation of a queen excluder in a transitional beehive, first the beehive must be manufactured in such a way that it accommodates a queen excluder. The excluder should be manufactured in such a way that it fits the beehive. The method of excluder installation in the transitional beehive is similar to that of the frame hives. One difference is that in transitional beehives, smoke is applied from the end corner so that the bees move to the entrance of the beehive.

All top bars up to the middle of the beehive which contain honey should be taken out and in the process, with soft brush and smoke bees along with queen should be pushed upfront to the empty space. Place and/or insert queen excluder through the opposite grooves of the hive wall. Then place top bars which contain honey, nectar and sealed pupa behind the queen excluder.
c. Honey Production

Strong colonies produce a lot of honey during honey season. The readiness of honey for harvest can be checked the same way as the frame hives. It is, however, necessary to leave enough honey to take the colony through the season.

23. Handling Colonies in Traditional Beehives during Flowering Season

a. Increasing the Size of Traditional Beehive

Some measures to be taken to solve overcrowding in traditional beehives

- Prepare beehives which have similar circumference and plug that into one end of the existing beehive. Increasing the beehive size should be conducted pre harvesting time, and only if the number in the colony exceeds the size of the beehive. Plugging in another beehive provides more space which enables them to perform their routine functions.

- Before new pupa are developed, unutilized old combs bees should be avoided.

- Part of the beehive installed to narrow the space so as to maintain warmth should be moved to the sides proportional to the size of space required.

- Installing Queen Excluders
It is possible to install and use queen excluders in traditional beehives. This, however can be implemented only if space has been allotted for the queen. Experienced beekeepers are exercising this and their experience can be popularized. The only inconvenience in this is that sometimes bees build honey comb on the excluder.

- **Harvesting Honey**

  Similar to the other types of beehives, in the traditional beehive, harvesting should be conducted after making sure that the beehive is ready. Strictly following the harvesting season may result harvesting honey which has excessive moisture which results in inferior quality and this is not advisable.

- **Handling Weaker Colonies**

  Colonies start weakening starting from the time of honey harvest. This is because the honey they produced has been taken away at the same time the flowering season ends creating shortage of pollen and nectar. Such periods make the queen to down size its egg lying volume. As a result, the size of the colony reduces tremendously. Thus, the number of bees in the colony dwindle. Reducing the size of the beehive and feeding the colony are vital measures that should be taken at such times.

- **Additional care When Colony is Weak**

  It is necessary to assist weaker colonies to withstand forage shortage and wet seasons. One method to do so is to provide them
with feed. Moving colonies to where honey flowers are available will also enable them to produce more honey in addition to strengthening colony.

- **Feeding Colonies**

Providing feed to weaker colonies is one of the improved methods of beekeeping. When the dry season is longer colonies get weaker and this is the time necessary to provide them with additional feed. This will prevent absconding and death of colony due to hunger. Feed provision will enable colony to withstand the shortage period and be ready to reproduce quickly during the flowering season and this will enable to harvest good amount of honey. Feed provided to colony should be good enough to replace what they would naturally consume. Honey that they require for energy would be replaced by sugar. The pollen they use to build their body would be replaced by pulse and cereal flours. It is possible to leave enough honey during harvest to enable the colony to withstand the situation. However, if the price of feed is cheaper than honey, providing them with forage would be more profitable.

- **Feeding Sugar**

Although other feed can be supplied to colonies, their first choice is honey. When honey is not available, sugar can take its place. Syrup can be prepared by adding sugar to warm water. This will substitute nectar. If it is affordable, one kilogram of sugar is added to one liter of hot water. This can be fed to colonies when it cools down. One to two kilograms of honey can be given to a colony, depending on their size of the colony. The feeding frequency is determined by the
severity of the shortage. However, a colony should not be provided with feed more than it can consume. If given, the feed may accumulate in the interior of the hive and mixes with the honey they produce. The sugar syrup can be placed either out of or inside the hive.

- **Outdoor Feeding**

  It is possible to feed colony by placing forage, (honey or flour) out of the hive. Sugar syrup should be placed in a wide and flat container. Floats of grass or leaves should be placed so as bees may land on them so as they should not be drawn in to the liquid while trying to feed. Depending on the size of the colony, feed should be placed in two or three containers so as to avoid overcrowding. To attract bees to the place where feed is placed, feed may be sprinkled starting from the entrance to where it is put. To prevent feed spoilage by rain or sunshine it is advisable to place the feed in a shade. Such provision of feed externally has its pros and cons. Because many bees can feed at the same time, it saves time as opposed to opening each hives to place the feed. When feed is placed inside hives, there is a tendency of stronger bees from other hives to come and rob and in the process, they kill each other. External feeding prevents this. The disadvantage of external feeding is that bees from stronger colonies take bigger shares at the disadvantage of the weaker ones. In addition, when bees with diseases go out to collect feed, they pass their disease to the healthy colonies. Thus, in cases where there are weak and sick colonies, it is not advisable to place feed out of hives.
Sugar cane, mangoes fruits and such plants may be used as feed and can be chopped to pieces and placed out of beehives and this can enable bees to use the juice. The skin of mangoes and such fruits can be pealed and placed on containers so that the bees can feed on them. To avoid evaporation of juice, such feed should be placed away from direct sunlight.

- **Indoor Feeding**

Syrups and liquid feed is placed in locally available containers or material specially made for such purpose. Enough amount of straw should be placed in the containers so that bees can land on it and this prevents drowning of bees. Some place is allotted in the hive to place the containers. To create space in the hives to place the containers, depending on the type of beehive, three to four frames or bars can be removed. In frame hives, it is possible to place an empty spur and in it can be placed containers with the feed. If the container is a pail specially manufactured for this purpose, the cover of the container lets feed out and thus the container should be placed up-side-down so that it lets feed down. If the syrup is very thin, it may spill and this may attract robber bees. To prevent this, the syrup should be thick.

Indoor feeding enables to regulate the amount of feed to be given and thus weaker colonies may be given more feed. The spread of disease is also minimized. However, such feeding may result colonies robe and kill each other and may encourage absconding. To minimize this, feed should be placed after dark. Spilling should be avoided as this may attract robber bees. Supers and hive covers should be placed tightly; the entrance should not be too wide as all
these may encourage robber bees.

- **Preparing Pollen Substitute**

Pollen has high protein content and bees use it to grow brood. If there is no sufficient pollen, the amount of eggs the queen lays and the number of worker bees decrease. This weakens the colony. When there is a shortage of pollen providing feed that substitute it prevents weakening of colony and decrease harvest. Substitutes may be prepared from pulse and cereal flours (beans, peas, soya beans, cheek pea, barely etc.). Pulses and cereals are first roasted and ground to change them to flours. Adding spices when grounding would assist to attract the bees. The flour may be put near the hives in a wide and flat container. It should be protected from rain. The quantity to be placed should be enough to last two to three days. Depending on situations more flours may be given. If the amount of flour given at a time is too much bees may not use it in time. This may affect the aroma of the flour. Moisture may also affect the flour making it difficult for the bees to transport it.

- **Migratory Beekeeping**

Although it is not common in our country, some beekeepers practice migratory beekeeping. When the flowering season of an area is over the colony is moved to a place where there are honey flowers. This enables the bees to produce additional honey and bee products. The time to move is after honey harvest when the flowering season is over and pollen and nectar supply is dwindling.
• **Colony Swarming and the way of Preventing It**

Swarming is when a colony fully or partially leaves its places. Colony swarming is categorized into two: full and partial.

• **Partial swarming**

Partial swarming is a result of reproduction and occurs only in flowering seasons. In those seasons, worker bees collect abundant nectar and pollen. The queen is able to lay 1500-2000 eggs. As a result the number of bees and the size of the colony greatly increase creating space constraint. When the size of the colony is large bees may not be able to detect the pheromone the queen produces. This makes them prepare queen cells. The queen lays eggs in the cells. When the eggs hatch, bees feed them with royal jelly so as to prepare a queen. Although the number of queen cells depends on specious and colony condition, there can be 10-15 queens reproduced in a colony. A day before the first queen is hatched; the old queen with some of its workers leaves the colony and migrates. Up to two thirds of the colony may follow the queen. Every queen that hatches continues to migrate with some of the remainder of the colony. It is possible that the swarming reduces the size of the colony in the existing hive to the point that the colony may not be able to produce any honey and in serious cases the colony may be totally destroyed. The swarming continues with every queen that hatches. On the other hand if the first hatched queen or if the existing older queen is strong, it may sting and kill the growing queens before they hatch. Sometimes, queens fight resulting in one killing the other.
Control Methods of Partial swarming

Partial swarming may result in bee colony weakening, and this reduces harvest. It is essential and possible to prevent it. This prevention is one of the practices of improved beekeeping. Ways of such prevention depend on the type of hives.

a. Methods of Control in Traditional Hives

One way controlling partial migration is to use wider and longer sized hives in order to have enough space for the colony. Some honey combs can be removed and a similar sized hive can be aligned and plugged into the existing hive to crate enough space.

Methods of Controlling of Partial Swarming in Transitional and Frame Hives

Partial swarming occurs due to over population. It is necessary to observe the size of the population and to provide bee colony with hive space it requires. During seasons when swarming is expected, it is essential to make internal inspection so that queen cells can be identified and destroyed and this helps to abort potential swarming. Before destroying queen cells it is important to identify as to whether the queen cells are meant for partial swarming or to replace a dead queen. If the queen in a bee colony dies because of different reasons, the colony prepares queen cells for replacement. Queen cells ready to replace a dead queen can be identified and the number of cells prepared in such cases does not exceed from five to eight Fig 80. The cells are also found in combs around the area where the queen laid its eggs last. Queen cells prepared for partial migration are found at the edges of honey combs and the numbers
are 10-15 and even more (Fig 81). This helps to identify the purpose of the preparation of queen cells, as to whether it is meant for partial migration or to substitute a dead queen. Partial migration can be aborted by identifying and destroying queen cells prepared for the purpose.

Fig 80: Queen Cells constructed for replacement

Fig 81: Queen Cells constructed for swarming

In cases when queen cells are prepared to substitute a dead queen, two cells which are strong and good should be selected and left to develop while the others are destroyed. Leaving two cells gives an alternative queen if it happens that one is accidentally killed.
24. Total Migration of Bee Colony

Total migration is when a bee colony totally leaves its hive. Total migration is divided into two: Seasonal migration and absconding.

As the title implies, seasonal migration occurs in particular seasons. It occurs when the honey flowering seasons are over and when weather conditions are not appropriate for colony. At such times some or all colonies leave their hives and migrate from the area to better places with more honey flowers or better weather conditions. Usually migration is changing places from hotter to cooler or from cooler to hotter areas. As bees make themselves ready for seasonal migration, they do not prepare honey, nectar, pollen or brood in their hives. Those bee colonies that migrate to other areas during a season return to their original places during honey plant flowering seasons. Although causes of seasonal migration are numerous, the following are the major ones:

- Character and specious of bee colony, shortage of feed, wild fire, excessive hive internal temperature and shortage of water.

Seasonal bee colony migration is a result of colony character and the effect of difficulties imposed on a colony. Such bee colony migration can be reduced considerably by providing feed in times of forage shortage, by regulating excessive cold or hot temperature and by providing colony shelter in order to protect the colony from rain.
25. **Reasons of Absconding and Methods of Controlling**

It is difficult to correctly identify causes of bee colony absconding. Among possible reasons are repeated attacks of a colony by predators, inconveniences caused by the bee keeper by exercising excessive internal inspections, and leakage of rain water into the hive. If bee colony absconds for the above reasons or for reasons which are not identified, it is possible to get honey, pollen, nectar or brood in the hive. Absconding can take place suddenly or even during the flowering season. If the reasons for any absconding are not clear, it will be difficult to suggest methods of controlling it. It is however, possible to minimize it by removing bad odors from the surrounding, by controlling predators and by avoiding excessive internal inspections.

26. **Methods of Queen Rearing**

**Natural Bee Queen Rearing**

Under natural conditions, bee colonies rear queens for one of the following reasons:

- **To replace a queen which gets old or which dies or disappears suddenly**

When die during internal inspections or killed by predators, worker bees select fresh larvae in the broods, or select eggs older than 48 hours and start taking care of the process of growing queen cell cups. In this process, worker bees build the cell cups wider and bigger. Then they feed the brood with enough royal jelly until it is capped. Such cell cups are eventually hatched to queen bee after 16 days of complete metamorphosis. Such cell cups are referred to as emergency queens and they are built in the combs.
and their number ranges from five to eight. When such cells cups are discovered, it is necessary to place them in a queen cage or in nucleus boxes prepared with young worker bees and leave them there until they are hatched. This is human interference to produce more queen bees.

- **To Produce Superseder Bee Queens**

When a queen is very old it cannot produce pheromone to harmonize the colony or it cannot lay eggs and won’t be able to properly carry out its duties. It becomes unable to lead the colony. In such situations, workers bees in a colony start preparing superseder queen. In such cases, a colony builds less than ten queen cells cups at the periphery of a comb. Overcrowding or strength of colony may not be observed in such occurrences. When superseder queens are reared, two cells are left to rear while the others can be placed in nucleus boxes to finish emergency.

- **Reproductive Rearing**

Like all living things, bees reproduce. In such reproduction process, they rear quite a few queens. Colonies reproduce when they are strong and during seasons when there are enough honey flowers. When hives of bee colonies are overcrowded and when there is no enough space in the hive, they are forced to reproduce and swarm. The reproductive swarming cell cups are mostly constructed at the periphery of a comb and the queen cell cups can be 10-15. It is possible to keep these queen cell cups to increase colony number. It is important to discover the reasons as to whether or not colony builds queen cell cups for reproduction

27. **Limitations of Natural Queen Rearing.**

A. The number of queens which rear in a natural process is limited and
may not provide the required amount of queens.

B. Bee keeper, without knowing the exact hatching time, may lose the queens.

C. Some bee colonies may not reproduce naturally, and it may not be possible to get queens when needed.

28. **Artificial Queen Bee Rearing**

Artificial bee queen rearing has been used by beekeepers for a long time. The following are advantages of artificial queen rearing:

- to increase colony number,
- to replace aging queens,
- to produce emergency queens,
- to improve quality of species and to replace bee colony with better ones and
- to earn income by selling bee colonies.

29. **Preconditions for Artificial Queen Rearing**

Even though it is possible to use different methods of bee queen rearing, certain preconditions should be taken so as to be successful in rearing productive and sufficient queens. The following are some of the preconditions:

1. **Conducive environment**

Know how and finance by itself cannot make one successful in the apiculture business. Queen rearing requires environment which has honey flowers sufficient to feed the colony. Worker bees use nutritious feed produced by nurse bees to feed the rearing queen and nurse bees are obtained when the bee colony is strong and have enough bee population. Use to feed the
rearing queen with nutritious feed produced by nurse bees and these nurse bees are obtained when the colony is strong and have enough bee population.

2. **Conducive Rearing Seasons**

It is not possible to rear bee queens in all seasons of the year. Presence of abundant feed and drone bees are the preconditions necessary for proper queen bee rearing.

3. **Availability of Material for Queen Rearing**

Materials which fulfill the requirements of the method of queen rearing must be available. Most of the required equipment is listed under beekeeping equipment/materials.

4. **Presence of Drones**

There must be enough quantity of drones before the rearing of queen's starts. This is a necessary precondition to make sure that drones mate the reared virgin queen which should take place in less than a week after the queen hatched.

5. **Sufficient Brood**

It is essential that there are broods of different ages in an attempt to rear queen bees. To start rearing, there need to be at least enough frames of broods at different stages of development.

6. **Two Sites for Queen Rearing**

In the process of queen rearing, bee colony which is splitted in to two nuclei colonies need to be kept in a second site so that they do not go back and
join the parent colony they are splitted from. The distance of the second site should not be less than three hundred meters and not more than a kilometer.

7. **Select and prepare for rearing colonies which have better performance and yield**

The presence of record of each bee colony is so important that there is adequate information. If the system of recording is not there, it should be started. The recording system helps to identify and rear colonies which are not aggressive and which are better in production.

8. **Feeding Colony for rearing programme**

In bee queen rearing, certain colonies should be selected for the task and they should be provided with good quality and enough feed. This will assist them to be in good conditions so that they can build quality and sufficient brood. Feed should be provided three times every fifteen consecutive days before and after the flowering season. The feed should constitute a lot of pollen and it is preferred that the bee colonies themselves produce it. The presence of pollen encourages the bee colonies to grow more brood. Any pollen or honey to be given as feed must be checked in order to be sure that it is free of disease and is also provided by healthy colonies.

9. **Strong Colonies**

To rear bee queens, strong and developed bee colonies are required. If the rearing is to be conducted in frame hives, the colony should be strong and has to develop to the point that it should fill both the base and the super. If the rearing is done in a transitional hive, the colony should fill all or more than half of the hive.
30. Adequate Knowledge about Brood Development Stages

To conduct bee queen rearing practices, it requires to have knowledge of the differentiating developmental stages of broods and experience in bee keeping.

31. Methods of Artificial Queen Rearing

For about a century, there have been trials by many researchers in many parts of the world to rear multiple bee queens from a colony by imitating the process colonies follow naturally. These improved research methods are now implemented as effective queen rearing methods. Hundreds of queens can be reared at a time through these methods. It has to be noted however, that the effectiveness depends on which method should be applied to which bee types, at what developmental stage of the apiary and so on.

Some methods are simple enough to be implemented to all types of bee colony and to all levels of farm development and a limited number of queens may be reared. Other methods require additional inputs and they enable to produce hundreds of queens at a time.

In artificial queen rearing, the methods are divided into two major groups: simple queen rearing and commercial queen rearing.

a. Simple Queen Rearing

There are different types of simple queen rearing out of which the major ones and those which can be easily implemented is colony splitting and overcrowding. It is possible to rear 10-20 queens and even more at a time by using these methods.
• **Splitting Method**

It is possible to rear many queens by splitting a strong colony into two or three. For best results however, the recommendation is to split a colony into two. When a colony is split, fresh larval brood and honey should be placed in each frame. One split will still have a queen while the other remains without a queen. The colony sensing the absence of the queen starts building itself. In the meantime, bees select fresh larvae that are 48 hours old and develop queen cell cups and feed the larval with royal jelly.

There are two alternative methods to split a selected colony. In the first method, prearrangement is made as to where to place the queen among the two splits.

In the second method the split is done randomly. If it is not known in which split the queen is then the colony, the eggs, the brood and the honey must be carefully and equally split into two. After the split half of it stays where it is while the other half should be moved at least 300 meters away so that the split colonies do not merge again. As one of these splits is without a queen, it starts the process of developing queen cell cup. This random method saves time and energy in that it relieves the beekeeper from the extra work of identifying in which split the queen is.

• **Colony Splitting in Frame Hives**

To split colony in the pre arranged method, the arrangements of frames should be done some hours before the splitting process. The queen should be confined in the bottom chamber and then a queen excluder should be installed. Care should be taken that the queen
stays in this chamber. Most of the frames having eggs, brood with duration of less than 48 hours, pollen and honey should be placed in the upper chamber as the queen is confined in the lower chamber. Next day, most of the bee colony should be driven to the upper chamber by blowing smoke through the entrance and immediately after this, splitting of colony should be conducted. In the process, colony in the upper chamber should be divided into two. The queen less split should be placed at the top of an empty base chamber. The new group is taken away to the new place so that the colony does not reunite. Since the queen less split contains most of the frames it has the potential of rearing many queen bees.

It is recommended that light sugar and honey syrup be given to the splits immediately. On the third day, inspection should be conducted on the progress. On the ninth day, queen pupa should be harvested, caged and incubated in the same or different colony. As soon as the queens are hatched, every queen is placed with a small colony of worker bees along with two frames which contain honey and this starts forming a nuclei colony.

Nuclei colony can be formed before the queens are hatched. The matured queen pupa is carefully collected. Space is allotted in the nuclei colony. The matured queen pupa is carefully attached with thread or wire to the assigned frame so that the worker bees take care of it.

- **Splitting in Transitional Hives**
  As in frame hives, it is possible to rear queens by splitting colony in transitional hives. The hive from which colony is to be split has to be
specially manufactured so that queen excluders can be installed in it.

The method of splitting is similar to that of the frame hive and the splitting can be done randomly or can be pre arranged. A second hive with the same bar number and a nuclei box is needed.

- **Pre Arranged Splitting**

Select the colony. Use standard procedure to open the hive. Using smoke, drive the bee colony and the queen to the entrance of the hive. Remove every bar, after removing bees from the bars, select those bars which contain eggs, brood, pollen and nectar and put them back up to the location of the queen excluder. Install the queen excluder in place. Care should be taken that the queen remains arrested and there is no space which can let her out.

It is acceptable to place top bars which contain young broods, pollen and honey before the queen excluder. This will enable the queen to lay eggs on them which strengthens the colony and it is always possible to move these bars away from the reach of the queen (out of the queen excluder). Finally, bees are brushed down from the top of the hive and when the top is cleared the hive cover is placed back. If the queen has moved out along its worker bees during the process, care should be taken so that it does not occupy space meant to be queen free when it returns to the hive. All openings should be secured to prevent this. Some smoke and soft brush can be used to drive back the queen. After the queen is secured worker bees can be pushed into the queen area to protect the broods.
Next day, a similar transitional hive is brought and kept close to the original colony arranged for splitting. The original hive is gently smoked through the entrance to drive the bees behind the queen excluder and allow the bees to settle on the comb for at least 10 minutes. Then uncover the hive. Remove all the top bars with combs behind the queen excluder without disturbing the bees and place them one by one into the empty hive. If the bees are disturbed fine water can be sprayed to calm them in the hive. Following this bees that are left on the walls and bottom of the hive where they removed from are scooped and given to the transferred combs. At last put the lid of the hive on its place.

The newly splitted hive which is a queen less is allowed to stay on the same stand and position of the original hive while moving the queen right colony to other site at least 50 meters far from the original location. Placing of the queen less bees on the same location allows the home-coming bees after foraging to enter in to the hive and strengthen the new split. Both hives should be warmed by putting a piece of used cloth or straw mat and given honey or sugar syrup to stimulate and strengthen. Inspect the splitted hive on the third day to identify construction of queen cups and similarly examine on the ninth day the pupae of the queen ready for harvesting (Fig 82).
Harvesting Matured Bee Queen Broods in cells

It is possible to collect matured bee queen cell cups and keep them in queen cages till they hatch. This requires preparing queen cages and holders. If such implements are difficult to find, bee queen cell cups can be collected and can be attached to honey combs and be placed in nuclei hives. Because there is a possibility that some bee queens may not hatch, the chance of rearing queens can be increased by placing two queen cell cups per nuclei box. If one cell cup aborts there is the second one. Extreme care should be taken when queen cell cups are collected and attached to honey combs. Queen cell cups can be accidentally crushed and destroyed. In the process of cutting part of the comb which contains the queen cell cups, it is advised that enough space is left around the area the cell is placed. Using fingers can accidentally damage the queen cell cup and it would be advisable not to use hands and fingers when handing the queen cell cups. Knives and sharp utensils can be used to cut queen cell cups.
When two queen cells are found close to each other, the comb can be cut in one piece containing the two cells and the piece can be attached to the rearing hive together. Sometimes there may be just two queen cell cups in a comb. In such case, the whole comb with all its contents can be placed in the nuclei box. When queen cell cups are removed from a comb, the last two can be taken together and can be placed in the same nuclei.

- **Attaching Queen Cell cups to Combs and Transferring to Nuclei boxes.**

As explained in the methods of frame hive queen rearing, queen broods should be cut and plugged or attached to combs present in the colony. To do this, the cell cups should be carefully cut and removed from the source hive. It is then taken to the receiving hive, and is aligned and attached to the designated frame and comb with thread, string or wire. The whole thing is then placed in a nuclei box that contains worker bees. If the worker bees in the nuclei box are not strong enough to take care of the queen cell cups, more bees can be taken from the hive and added to the nuclei colony.
The nuclei box should be placed in the second site so that the bees in the nuclei box do not reunite with the other colony. There should be separating space of between three and four meters between the nuclei boxes so that the worker bees clearly identify their particular boxes. It is necessary to check the condition of a nuclei colony after fifteen days. If inspections do not show eggs and brood, this could be an indication that either the bee queen was not hatched or something might have happened to the hatched queen possibly during its flight to mate. This may be experienced occasionally and in such cases, colony in the nuclei boxes can be united back with the colonies or other queen cell cups can be placed in the nuclei boxes. It is also possible to confirm the presence of a queen in a nuclei box without doing any internal inspection by simply observing worker bees going in to the box with pollen and nectar. When they do so, it is an indication that the queen is there and it is laying eggs.

32. Over Crowding Method of queen bee rearing

Overcrowding is commonly observed in all types of hives when it is the flowering season. At such times, colonies start developing queen cell cups where the emerging queen bee is to emerge. As
part of their natural character colonies split and one or more of the queens migrate with part of the colony. It is possible to intentionally overcrowd colonies in all types of hives so that they prepare and rear queens. In frame hives, the super is removed or it is not added when the colony is overcrowded. In transitional hives space can be reduced by using a sliding mechanism which moves to decrease space. In traditional hives, colony can be transferred to a smaller size hive. In transitional and traditional hives, it is possible to prepare smaller size hives and when there is overcrowding, bees initiate the process of new queen development. Over crowded hives should be checked every other day to know whether queen rearing has started not. When there are queen broods, transfer procedure should be followed to place the broods in the appropriate boxes and hives.

Rearing by overcrowding is widely exercised in the Northern and Western part of the country namely in Amhara, Tigrai and Wollo regions. Colonies are placed in small pots or in circular water containers or in similar other materials. Beekeepers wait until the queen is hatched and then move the colonies to standard hives.

Overcrowding method has its own pros and cons. When a colony is overcrowded, the colony by its own initiative decides and prepares the rearing process. This natural process usually results in queens which are strong and effective. The weak points of the method are it is difficult to monitor some rearing processes as to whether the queen cell cups are built or not, or whether the cells have larvae and eggs or not, and to know the time the queens will be hatched and so on. It is also possible that the queens hatch and migrate before the beekeeper realizes it.
33. Commercial Bee Queen Rearing

This is one of the artificial methods which enables to rear thousands of bee queens in a single flowering season. The method is known as grafting method or Doolittle method. Doolittle is the person who first came up with the method. The method involves transferring of larva from a brood cell to an artificially made queen bee cup where worker bees feed and take care of it until it is hatched. The broods which are transferred using this system are 12-24 hours old. Some beekeepers, however, use up to 48 hours old broods which is not preferred because there may not be as many hatching queens. Grafting method can be used for small or big scale rearing depending on the needs and capacity of the beekeeper. If the beekeeper uses the method for own need, the scale may be smaller. But if the purpose is to make rearing a commercial venture, thousands of queens can be reared. It is strongly recommended that this system be employed by state and commercial ventures.

35. Grafting method

- Items Needed for Commercial Queen Rearing

box Hive
Queen rearing cups
Queen cage
Cutting utensils
Queen cage holder frame
Nuclei box

Artificial queen rearing cups

Artificial queen cell cup holder

Artificial queen frame holder

Pure beeswax

Artificial queen rearing cup manufacturing wood

Grafting needle

Magnifying glass

Portable table lamp

Table

Stainless steel cooking utensil and spoon

Stove

Water

Royal jelly

Grafting room

To conduct grafting, it is necessary that one has experience and skills regarding level of development of colony, the way of determining the age of the brood to be grafted, the transfer of brood from its cell to artificial queen cup and such issues related to grafting. Good hand dexterity and good eye
sight are very essential. It is essential to have the necessary skills and experience to be able to exercise the methods.

- **Preparations for Grafting**

Colonies selected for grafting must be of good species. The colonies are the source of grafting and are the ones who feed and develop the queens.

It is also possible that the colony from which grafting is conducted and the colony which feed and take care after drafting can be two different ones.

When it is determined to conduct grafting, the colonies selected should be provided with feed and be strengthened. Workers which take care of grafted brood must be kept in a queenless box before 24-48 hours. This enables the bees to know that they need a queen and prepares them to feed and take care of the queen brood.

The bee colony should also prepare bees that will mate with the virgin queen. The brood for such bees has to come from a colony of good harvest and character. The presence of adequate number of such bees is essential to minimize the chances of the virgin bee mating with bees from unknown colony. Larger amount of brood of drones from selected colonies should be placed in the nuclei.

- **Procedure of Commercial Queen Rearing**

First, the old queen bee present in the hive of the colony that is selected for commercial queen rearing should be removed before 24 hours or earlier. African bees including that of Ethiopia are very aggressive. Under such condition, identifying the queen at night is a very challenging task and demands a lot of patience. There are a number of ways to make the task easier.
The colonies have to be in box hives. The base (the floor) of the hive has to be free moving, meaning should not be attached, nailed or glued to the rest of the hive.

36. Methods of Identifying and Catching a Queen in a Strong Colony

First separate and remove all parts of the hive except its base (the floor) and place them on the base of a different hive. This is done without opening the cover.

Place an empty super on the first base. Install a queen excluder, align it correctly and attach the excluder with shoe nails. Place another empty super at the top of it. Bees can move up while the excluder confines the queen to the bottom box and this makes identifying and catching the queen easier.

Separate from the bottom and take back the box of the hive which was initially removed from the first hive. Place this box at the top of the super of this first hive.

37. Methods of Making Artificial Queen Cell Cups and Installation

After separating the queen from the colony, the next task is making artificial queen cell cups. The major items required are pure wax, mould for making queen cell cups base, dipping stick, cell cup holder bar and frame.

The dipping stick preferably should be left in soap solution for some time and then thoroughly washed.

The stick is dipped to the length of four to five mm in melted wax and is taken out and placed in cold water. It is then again dipped in melted wax and taken out and placed in cold water. This forms cup shaped wax at the tip of the dipping stick which becomes the cell cup. Carefully remove the cell cup
from the dipping stick. In the same way prepare as many cell cup bases as necessary. Attach these cell cup bases on to the bar designed for this. On top of each cell cup base, attach the cell cup at equal distance of two to three cm apart.

Fig. 85. Queen cell prepared

.Fresh larvae to be transferred are placed in these cell cups and then they are placed in queenless colonies. Artificial queen cell cups can also be made from plastic.

38. Identifying the Right Age of Brood and Transferring to Cells

Take three to four frames of young brood from a good colony. Identify broods which are watery white and very tiny lying at the bottom of comb cells. Use grafting needle to pick and transfer these larva to the artificial queen cell.

Identifying 48 hours old brood may be a challenge which requires a lot of experience. The following are tips that can help:

Many times the queen lays eggs in a row. The eggs are arranged in age chronology. Those at the periphery of the comb are 48 hours old.

The broods have different sizes and the smallest are the ones needed for grafting.

Another method is to take a frame with developed honey comb which has no eggs. Place this frame in a strong colony. Worker bees clean this comb in
the frame and let the queen lay eggs in it. Take out this frame on the fifth day. Broods in the comb are usually less than 48 hours old.

Take a frame with fully developed comb. Place a queen in it and install queen excluders on both sides of the frame to arrest the queen. The queen will be forced to lay its eggs in this frame. Mark this frame, and after 24 hours let the queen out and leave the frame in the hive. On the fourth day, check this frame. Many of the eggs hatch and become larval broods. These larvae are less than 24 hours old.

Before grafting is conducted the room should be organized and prepared. Necessary equipment should be in place. The room temperature and humidity should be regulated. If the room is very cold, it should be warm by electric heater or by charcoal heater. If the room is very hot, boil water in the room so that the vapor regulates humidity or splash cold water in the room an hour before grafting is done.

When it is time for grafting, take out the frame with artificial queen cell from the hive and carefully place it on the table. Bees should be brushed off before the frame is moved.

If there is some distance between the grafting room and the place of the colony, care should be taken so that the brood is not harmed by cold wind or excessive heat. It is advisable to cover the brood with wet cloth if the grafting room is far. The age of the larvae should be identified. Observe the comb. At the back and by the wall of the cell, insert the grafting needle. Without touching the inner wall of the cell, take out the brood and the royal jelly, one at a time. Extreme care should be taken so that the larvae are not harmed in the process. Then immediately place the brood in the prepared artificial queen cell. The larvae should be placed in the middle, not on the walls of the cell. Royall jelly, if available, should be placed prior to the brood. This helps
to lubricate the cell so that the larvae does not get stuck. If there is no royal jelly, water may be used instead.

After transferring is completed, the artificial queen cell cups should turn down or hang down, imitating the natural pattern as seen in Fig. 86.

Fig. 86. Cell cups position after grafting

This should be placed in the queenless colony or in a nuclei colony. If not, the bees may ignore the artificial queen cell and may develop queen cells from their own hives. Frames with adequate honey and pollen should be placed in the colony. In addition, the colony should be supplemented with syrup made of one to two kgs of honey or sugar. On the third day inspection should be conducted to check if the colony is growing the cells cups. On the ninth day, the sealed queen larvae should be placed in queen cages and put it in the colony they were taken out from. This will trap the queens so that they do not escape when they hatch. Some honey should be placed on top of the floor of the queen cage so that queens can eat soon after they hatch.
The amount of queens hatched depends on the strength, character, species of colony, as well as the skills of technicians who conducted grafting. The national success rate of grafting is less than 10-15% and this is mainly due to lack of skills in grafting practices. It is essential to develop necessary operation plans to popularize and train those involved in queen rearing.

39. Cares to be Taken in Queen Grafting

In simple queen rearing, if broods are of different ages, the sealed queen cells will also have different ages. Some may be ready to hatch while the others are still young. In the process of grafting, care should be taken so that the position of the larva does not change and that there is as little shake as possible. Sometimes cells grow in a position which makes working with them inconvenient and this requires extra care. The following are tips on precautions to be followed.

When using scissors, knives or such utensils make sure they are very sharp.

When the queen cell is placed in a queen cage, crystallized honey should be placed on the floor of the cage instead of liquid honey. This will prevent the queen from being stuck in liquid honey and die.
The queen cage should not let in worker bees. If worker bees can get into a queen cage, they may swarm it and eventually suffocate it, even kill it.

Queen cages should be supervised daily. Those hatched should immediately be placed in prepared nuclei boxes. Therefore, Preparing Nuclei before the onset of the rearing programme commenced.

Preparing nuclei colony and taking care of it until it is self-reliant is no less difficult than rearing a queen. The starting colony should be placed in a five frames nuclei box or a box with less frames. In each box should be placed one comb with sealed brood, one comb with honey or nectar and the other comb with pollen. In addition, there should be two combs covered on both sides with bees. If the size of the starting colony is small, it may not be self-reliant and it may finally abscond. It is necessary to place enough feed and enough bee size in a starting colony.

It is possible to take bees from strong colonies which are being used for queen rearing or any strong regular colonies. Queen excluders should be used to make sure that queens are not taken with startup bees.

Nuclei box should be placed in a dark room for 24 hours in a distance of over 500 meters so that start up bees do not return and join their mother colony. Nuclei boxes should also be placed farther from each other. They may merge together if they are too close to each other. The new queen in a cage should be placed in a frame in the middle of the colony for a day. This helps the colony to distinguish it and know it. If the queen is released immediately the colony may not recognize it.
40. Honeybee floral species

Bees collect their feed (nectar and pollen) from flowering or honey plants in order to survive, to reproduce and produce honey. Honey plants may be wild growing or cultivated crops, trees, shrubs, spices, grass, and agricultural plants.

Out of the total 7000 species of flowering plants estimated to exist in the country, only 1000 have been identified as honey plants. Most of these plants are found in the Western part of the nation. Nevertheless, there are some important honey plants in the rest of the country as well. Here are some of the following honey plants that are found in the country.

<table>
<thead>
<tr>
<th>Vernacular name</th>
<th>Scientific name</th>
<th>Plant nature</th>
<th>Bee fodder Supply</th>
<th>Additional benefit achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wanza</td>
<td>Cordial africana</td>
<td>Tree</td>
<td>Nectar&amp; pollen</td>
<td>Has edible fruit, timber for house tools, trapping wild bees</td>
</tr>
<tr>
<td>Besana</td>
<td>Croton macrostachys</td>
<td>Tree</td>
<td>Nectar&amp; pollen</td>
<td>Fire wood &amp; hanging local hives</td>
</tr>
<tr>
<td>Bhirzaf</td>
<td>Eucalyptus spp</td>
<td>Tree</td>
<td>Nectar&amp; pollen</td>
<td>Timber for construction, fire wood,</td>
</tr>
<tr>
<td>Getema</td>
<td>Schefflera abyssinica</td>
<td>Tree</td>
<td>Nectar&amp; pollen</td>
<td>Hanging local hives &amp; fire wood</td>
</tr>
<tr>
<td>Gerar</td>
<td>Acacia spp.</td>
<td>Tree</td>
<td>Nectar &amp; pollen</td>
<td>Animal fodder, firewood</td>
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<tr>
<td>Bottle brush</td>
<td>Tree</td>
<td>Nectar &amp; pollen</td>
<td>Fire wood, garden beauty</td>
<td></td>
</tr>
<tr>
<td>Kondoberberie</td>
<td>Tree</td>
<td>Nectar &amp; pollen</td>
<td>Flies replant, fire wood</td>
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<tr>
<td>Lukina</td>
<td>Leucena leucocephala</td>
<td>shrub</td>
<td>Nectar &amp; pollen</td>
<td>Fodder, used for soil conservation</td>
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<td>Kok</td>
<td>Prunus persica</td>
<td>Fruit tree</td>
<td>Nectar</td>
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<tr>
<td>Avocado</td>
<td>Persea American</td>
<td>Fruit tree</td>
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<tr>
<td>Mango</td>
<td>Mangifera indica</td>
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<td>Nectar &amp; pollen</td>
<td>Edible fruit, fire wood</td>
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<tr>
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<td>Carissa edulis</td>
<td>shrub</td>
<td>Nectar &amp; pollen</td>
<td>Edible fruit, fire wood</td>
</tr>
<tr>
<td>Kega</td>
<td>Rosa abyssinica</td>
<td>shrub</td>
<td>Nectar &amp; pollen</td>
<td>Edible fruit, fencing wood</td>
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<tr>
<td>Injury</td>
<td>shrub</td>
<td>Nectar &amp; pollen</td>
<td>Edible fruit, fencing wood</td>
<td></td>
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<tr>
<td>Plant Name</td>
<td>Scientific Name</td>
<td>Type</td>
<td>Products</td>
<td>Uses</td>
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<tr>
<td>Tebeb</td>
<td>Becium grandiflorum</td>
<td>shrub</td>
<td>Nectar &amp; pollen</td>
<td>Medicine, fire wood</td>
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<tr>
<td>Sekoru</td>
<td>Cirsium dender s</td>
<td>shrub</td>
<td>Nectar &amp; pollen</td>
<td>Hedge</td>
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<tr>
<td>Kessie</td>
<td>Lippia adoensis</td>
<td>shrub</td>
<td>Nectar &amp; pollen</td>
<td>Torch, fire wood</td>
</tr>
<tr>
<td>Ssoyemma</td>
<td></td>
<td>shrub</td>
<td>Nectar &amp; pollen</td>
<td>Torch, fire wood</td>
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<tr>
<td>Noog</td>
<td>Guizotia abyssinica</td>
<td>legume</td>
<td>Nectar &amp; pollen</td>
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<tr>
<td>Selite</td>
<td>Sesamum indicum</td>
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<td>Oil</td>
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<tr>
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<td>Helianthus annuus</td>
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<td>Bidens macroptera</td>
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<td>Sesamum</td>
<td>Herb</td>
<td>Nectar &amp; pollen</td>
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<tr>
<td>Plant</td>
<td>Genus</td>
<td>Family</td>
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<tr>
<td>kortobe</td>
<td>Plantago lanceolata</td>
<td>Herb</td>
<td>Nectar &amp; pollen</td>
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<tr>
<td>Koshoshila</td>
<td>Xanthium spinosum</td>
<td>Herb</td>
<td>Nectar &amp; pollen</td>
<td></td>
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<tr>
<td>phsilia</td>
<td></td>
<td>Herb</td>
<td>Nectar &amp; pollen</td>
<td></td>
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<td>Maget</td>
<td>Trifolium spp</td>
<td>Grass</td>
<td>Nectar &amp; pollen</td>
<td>fodder</td>
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<td>Fodder</td>
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<td>Grass</td>
<td>Nectar &amp; pollen</td>
<td>Fodder</td>
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<tr>
<td>bakella</td>
<td>Vicia faba</td>
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<td>Nectar &amp; pollen</td>
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<tr>
<td>Ater</td>
<td>Pisum sativum</td>
<td>Legume</td>
<td>Nectar &amp; pollen</td>
<td>Edible seed</td>
</tr>
<tr>
<td>shembera</td>
<td>Cicer arietinum</td>
<td>Legume</td>
<td>Nectar &amp; pollen</td>
<td>Edible seed</td>
</tr>
<tr>
<td>Tenadam</td>
<td>Ruta chalepensis</td>
<td>Spices</td>
<td>Nectar &amp; pollen</td>
<td>Medicine</td>
</tr>
</tbody>
</table>
As seen from the table above, different plants produce different amounts of nectar and pollen. Some plants like eucalyptus spp. produce high quantity of nectar while others like Acacia spp produce more pollen than others. Plants produce nectar have different levels of sugar content. Those plants which produce high quantity of nectar and pollen are called major honey plants under Ethiopian context. Whereas plants with small amount of bee forage production are called minor honey plants.

41. Other Uses of Honey Plants

Honey plants, in addition to providing nectar and pollen, may be used to make beehives. Hollow plants can be used to keep bees. Some plants are used to place hives to trap swarms. Leaves and barks of some plants are naturally bee repellent and are specially noticed when beehives are constructed with. Honey plants can be used as fences. Some may be planted to prevent soil erosion. Some plants are used as food for human beings and as feed for animals. Some are used as ingredients in traditional medicine production. Leaves which fall off on the ground fertilize the soil. Some plants are used for construction and others as cooking fuel for cooking. Honey plants play important role in environmental protection.
42. *Honey Plant Production and Protection*

In the last few years, natural and man-made causes have greatly reduced the population of honey plants. Human population growth and the need for more land for agriculture are major cause for the destruction of honey plants. This has resulted in the extinction of wild animals, imbalance of ecology, erosion of hills and mountains, reduction in agricultural productivity, climate change and desert expansion. Similarly, the reduction of honey plants has resulted in decline of colony number and amount of honey and wax production.

Recently, there is ongoing effort of mass tree planting. Mountains and arid land are being protected and there is good sign of rehabilitation. This brings with it the rehabilitation of beekeeping as well.

Beekeeping has no adverse effect on plants. It can be conducted alongside with covering mountains with plants and with other rehabilitation work. Developing honey trees in rehabilitation work has an added advantage in that such plants provide the necessary inputs for colony development and honey production. Honey production contributes a lot in family food security. Honey is used as an ingredient in traditional medication. Any surplus honey can be sold to earn extra income.

Beekeepers are stakeholders in forest development as they protect trees when they produce honey. They are willing to participate in tree planting. The existence of many trees keeps the ecology balanced and bees in their cross pollination assist the development of trees and the maintenance of the eco-system.
It is therefore necessary that all should participate in the process of honey plant development. This in turn protects the soil from being eroded by wind and water.

Developing tree plants which produce food for human and feed for animal has multiple advantages. Some trees mature quickly and developing them would give results in a short time.

In developing honey plants, it is advisable to start with such plants that can grow in the climate of the selected apiary sites. Honey plants in other countries that are known for their supply of pollen and nectar and those that can resist drought can also be introduced. Seeds for honey plants which can be used as human food can be obtained from the Institute of Ethiopian Agricultural Research and seeds for animal feed can be obtained from the Ethiopian Meat and Dairy Animals Development Agency.

Although cross pollination is carried out by water, birds and animals, Animal pollination is preferred in its effectiveness. Pollination by beetles, birds and bees is more effective. Bees are very effective in pollinating pulses, oilseeds, fruits and vegetables and animal feeds.

Bees are preferred as better pollinators for the following reasons.

- In the process of collecting their own food, large quantity of bees visit crops regularly
- Bees do not depend on one or two plants for their food source but cover wide range of plants
- Bees collect their feed all year round
- Bees perform better in collecting pollen
• Bees are many in number and can reach many plants

• When bees start collecting their feed from one plant, they cover all other plants of the same species hence they can conduct effective pollination

• With the exception of shortage seasons, bees prefer to collect their feed from those with high yield of pollen

43. **Bees for Conducting Pollination**

Bee pollinated plants produce higher and better yield. The seeds become uniform in size because bees distribute pollen to all proportionally. In developed countries, bees are more known for their benefit of pollination than their honey. Bees can pollinate numerous types of plants. Among those plants, avocados, oil seeds, mangoes, papayas benefit from bee pollination most.

![Fig 88 bees activity in pollination](image-url)
In less developed countries like Ethiopia the value of cross pollination by bees has not yet properly recognized activity of great importance. But recently, some researches conducted in the country indicate that there is an increase of 34% in *Nug* (Bracia spp), and 84% in onions when bees are used in cross pollination. After the finding, farmers have started to use bees for cross pollination and changes in quality and quantity have been registered. This trend should be encouraged and popularized.

44. **Honey Calendar**

Not all honey plants provide year round flowers for colonies. Some bushes and shrubs do flower all year round but the majority of plants flower in particular seasons. Rain-fed crops mostly flower starting from September up to October and the maximum they extend is up to November. Other fruit and vegetable plants flower in specific seasons.

Especially in nest places of the Central, North, North East, South West and South of the country, many honey plants like annual crops weeds and other permanent plants flower after the rainy season. A large amount of honey is harvested after the rainy season since bees collect a substantial amount of feed during this season.

Many areas in the South Eastern part of the country, however, are covered with forests. Most plants in the forests flower starting from the middle of March and honey is harvested in April and May. This season is known as the high honey production season. After this season, honey plants of lesser amount flower and lesser amount of honey is harvested. This season is called the low honey production season. In areas with natural forests, honey plants flower from March to May. In such areas, this season becomes the time of optimum honey production. Depending on flower coverage, distribution, and type, quality and quantity of feed natural forests and honey
plants provide, is some regions there are two and three harvests while in others it is just one.

Some plants like Vernonia spp. flower in the long dry season when there is shortage of bee feed. Although these flowers may not yield enough bee forage for honey harvest, they still provide feed to until the bees get through to the flowering season. It is however, possible to harvest honey during this season as well. Some crops which are planted just after the rainy season flower late and this assists bee colonies to get feed. Provided that they get minimal rain, some plants like bottle brush, black pepper, do flower all year round. They may not provide sufficient amount of feed to bees in order to enable them harvest enough honey but they do assist colonies to get strong and get through to the major flowering season.

Beekeepers should identify honey plant flowering seasons in their areas. Providing bees with additional feed in times of drought will assist colony to conduct their regular activities. Doing so minimizes the effect of the drought and there will be very little effect on honey production during the flowering season. When the flowering season approaches, preparations should be made that will result in high yield and good quality of products. Various activities at various parts of the calendar year need to be identified and implemented. Such management activities assigned in the various seasons of the year is referred to as beekeeping development calendar or honey calendar. Designing such a calendar makes colonies productive and develops harvest. An example of a honey calendar is given in the proceeding pages.

45. Diseases of Honeybee

Bee diseases are grouped into two depending on which age group the diseases attack: Adult honeybee diseases and Brood honeybee diseases.
Honeybee diseases are caused by bacteria, protozoa, fungus, viruses and parasites. The diseases transfer from the sick bee to the healthy ones through the following major ways.

1. When beekeepers inspect a colony which carries diseases and use the same inspection material to inspect a healthy colony.

2. When frames are taken from a colony that carries diseases and are placed in healthy colonies.

3. When beekeeping equipments whose origin is not clearly known are used or if equipments which have been used to handle colonies which carry diseases are used in healthy colonies. If honey and pollen which carry diseases are fed to a healthy colony.

4. If sick bees are drited by wind into a healthy colony.

5. If several colonies share the same feeding utensils.

6. If sick colonies are purchased and mixed with healthy colonies.

7. Colonies that are splitted from colonies which carry diseases.

Brood Honeybee Diseases

Studies conducted at national level have confirmed the existence of chalk brood disease. Chalk brood disease attacks three to four days old queen brood and worker brood. Chalk brood is caused by fungus known as
Ascosphaera apis. The spore of Ascosphaera apis can live up to 15 years and it is difficult to make sure that it is totally under control. The spore can be activated by suitable conditions and attack colony. Broods attacked by this disease first swell then shrink and dry. Worker bees take out these broods from the comb and discard them. Most dead broods look like chalk white. The disease takes its name from its resemblance with black board writing chalk. Some dead broods have gray color which gradually changes from light to charcoal black. Ascosphaera apis is transmitted to the bee colony through feed and water. The disease can also be transmitted through contaminated implements, equipment and infected queens. Worker bees spread the disease as well. Cold and humid conditions are conducive to the activation of the disease. If a colony which is attacked by chalk brood does not have adequate forage it will be difficult to put the disease under control.

Fig. 89 chalk brood

It is possible to control chalk brood by ventilating and cleaning the hive. Minimize contact, make sure to clean equipment before and after use, clean it with water and pass equipment (those resistant to excessive heat) through live flame repeatedly or use boiling water to sterilize before reuse. Do not use frames and hives which carry sick colony. Discard honey harvested from
such colonies and move the colony to a new hive. Improve the air quality of the brood comb area. Strengthen the colony and place it where it can get sunshine. Provide colony with feed supplements. Replace the queen with a new one. If colonies in an apiary are free from the disease, do not bring in new colonies from unreliable sources. Do not include new or captured colonies in the apiary. Remove combs of a colony with the disease and substitute it with fresh and new foundation combs.

45. Adult Honeybee Diseases

It has been confirmed that there are two types of adult honey bee diseases in the country: Nosema and amoeba. At the present condition, the amount of damage these diseases cause is minimal. The diseases affect bees when it is wet and rainy. When affected by the diseases, the size of colony diminishes, bee activities decline, and yield slightly decreases.

- **Noesma**

Noesma is caused by protozoa called *Noesma Apis*. Adult honey bees are infected when they ingest the spore. After ingestion, the spore reproduces in the intestine. When infected bees defecate in the hives, the spore that has reproduced in the infected bees passes on to the healthy ones. Healthy bees can also be infected when they clean the hive. This starts the cycle of the spore spreading from the sick to the healthy. Infected bees crawl on the floor, the entrance of the hives and on the frames. Some fall down and become unable to move. The abdomen of many such bees swell and eventually they die. Sick bees find it difficult to take care of broods. They become unable to feed the queen. If the queen is infected, the number of eggs it lays decreases and it finally dies.
To control and prevent the disease, colonies should be transferred to areas where there is enough feed. In order to strengthen bee colony, it has to be provided with feed and water and it has to be placed in sunlight. The old queen should be replaced by a new one. Old honey combs should be taken out and replaced by new ones. Fumagillin, a chemical fumigant can be used as treatment for the disease. Availability and affordability of the medicine are serious issues. The disease in not wide spread in the country. No major cases have been observed and it has not yet become a serious threat.

This disease is everywhere in the country and causes some problems to the colonies mostly in wet areas. The magnitude of its severity is understudy now. Nevertheless it is a killer disease even under tropical climates

- **Amoeba**

The disease is caused by amoeba called *Malpighamoeba mellifica*. It spreads through ingesting infected feed, water or contact with contaminated implements and equipment. It reproduces in the intestine. The infection cycle is similar to that of *Noesma*. Although there are particular symptoms of the
disease, yellow dysentery, and crawling around hive entrance are the visible ones.

- **Varroa**

The disease is caused by parasite called *varroa jacobsonii* or by *varroa destructor* and it affects both adults and broods. It is dark brown and its size is 1-1.5 ml. It is hairy, eight legged and looks like ticks and it is big enough to be visible. Although *varroa* is classified as parasite, if there are many parasites in the colony it is considered as a disease. It reproduces in brood cells especially in drone brood cells. It feeds by sucking fluids, hymolymph from broods, harming the brood in the process. Sometimes the brood dies or is disabled. It is the female *varroa* that attacks both the larvae and adult honeybee. The parasite sometimes positions itself in between the thorax and abdomen and around the head and feeds on these soft parts of the bee. Young honey bees are the most affected. *Varroa* has the capacity to reproduce in a short time and can cover a colony without being detected. It has the capacity to spread to healthy colonies. It weakens and damages its hosts and is considered to be a severe disease. It attacks just when the larvae cells are about to cap. When the capping are opened and observed, there are dark brown spots on the external body of the young bee brood. Bees attacked by the disease lose weight. Their legs, wings or both are partially paralyzed. They become unable to crawl or fly. The number of worker bees decreases and eventually the colony is disappears. In the first two to three years, the colony becomes very weak. Ten to thirty percent of the colony die. After three years the death rate grows from 50 to 100%. Some researchers indicated that Asian bee types are less resistant to the disease than European and African bees.
At the moment, there is some treatment to cure the disease. It can be both cured and controlled. Beekeepers in some African countries use tobacco smoke to suffocate *varroa* which makes it drop off from the bees and this can reduce its number. But there is nothing which can be done to control *varroa* sealed in the cells of the brood.

There have been successful attempts to stop the spread of the disease by disrupting its reproductive cycles. Preventing queens from laying eggs, and removing broods can stop the reproductive cycle of *varroa*.

### 46. Honey Bee Enemies

The major honey bee enemies in the country are ants, wax moth, beetles, termites and birds.

- **Ants**

At national level there are quite a few types of ants. Ants enter the hive and feed on honey, pollen and brood. Some of the ants feed on young bees. If there is a small he number of the invading ants, bees position themselves on the entrance of the hive facing outward, and flap their wings and drive the ants away. But the ants can outnumber and overrun the bees. This may result in colony death and those survived are induced to absconding.
Beekeepers in areas prone to ant attacks need to protect their bees. The following are some of the protective methods.

1. Hang the beehive with ropes or with other materials on trees or on poles.

Fig 91. Protect colony by hanging

Fig 93. Place local hive on tree branch
2. Attach a smooth and sliding metal sheet to the stem of the tree or pole.

Like rodent trap

1. Tie straw or grass to the tree or pole.

2. Plaster the hive stand with cone shaped smooth iron sheet or used inner tube of a tyre of a vehicle.

3. Place the legs of the hive in open tins filled with used engine oil.

4. Place a thick coat of engine grease on legs of the hive.

5. Sprinkle hot ash around the hive.

6. Spot the location of the ant colony, dig the area and destroy the queen, the eggs and all the brood.

7. Clean hive area and cut down grass. This enables to detect from a distance if there are any ants swarming.
8. Do not dispose any honey and wax around the hive as they can attract ants to enter the area and eventually to the hives. Bees wax attracts ants and doing so may attract ants to the area and eventually to the hives.

Among the suggested preventive methods, seven of them are temporary solutions while the eighth one is a permanent one.

b. **Wax Moth**

An adult wax moth resembles fire fly. There are two types of wax moth in the country: Greater wax moth (Galleria melloella) and lesser wax moth (Achoria grisella). Greater wax moth is 32 m.m. long, whereas the length of the lesser wax moth ranges from 16 – 20 m.m.

![Wax moth Diagram](Fig 95 wax moth)

Wax moth can reproduce only when a colony is weak. If a colony is weak, adult moth enters either through the entrance or looks for any opening into the hive. Since it lays its eggs in locations that are sealed would be difficult
for bees to attack it. The eggs develop to be broods, then they seal and hatch into wax moth. Bee less hives with waxes are major opportunities for the reproduction of wax moth.

Wax moth starts the damage at its larvae stage. At this stage, the moth larvae starts feeding on the comb of the honey, bee brood and comb wax. In the process the moth larvae starts moving around destroying the comb and its contents. Regular functions of the colony are disrupted when bees do not have the strength to protect themselves and if a colony is outnumbered, it absconds.

Fig 96 combs attacked by moth

There are signs to indicate the presence of wax moth in a beehive. The moth forms silken webs (funnels) along the midrib of the combs. Combs are disfigured and have holes in them. There are moth waste products, moth pupa on the walls and frames of hives and shells from which moths have hatched.

The following are ways of preventing wax moth.

1. Remove old and discolored honey combs. These create favorable conditions for wax moth.
2. Remove hives from which a colony has totally migrated. Collect and melt the wax from the hive and keep it away.

3. Do not discard pieces of wax around the apiary.

4. Remove combs infected by wax moth and melt the wax.

5. In post harvest seasons, feed colony and make sure they are strong enough to fight wax moth. Try to grow honey plants that flower during post harvest season so that they provide feed to the colony.

6. Remove super during feed shortage seasons so that wax moth does not enter the hive and start reproduction.

7. Repair any cracks in hives with wax or propolis.

8. To reuse hives that are contaminated by wax moth, deep them in boiling water and wash them thoroughly.

9. Use the traditional method of building bone fire in front of the hives. The light attracts wax moth and it usually burns itself.

It is also possible to use chemicals like sulfur dioxide smoke to prevent wax moth. The chemicals, however, may not be available when needed and it may be beyond the economic reach of the beekeeper.

c. Termites (Kuchach)

Termites are found in places that are free from ants. They prefer dry areas. Kuchach consumes honey and in doing so it moves inside the hives and this disturbs the bee colony.
d. **Small Hive Beetle**

Small hive beetle is mostly found in the Southern and South Western part of the country. It is a serious problem in these regions. Small hive bee keeper is not limited to consuming honey, but it disturbs the colony and reduces the capacity of the colony to produce honey. If the problem is serious, colonies abscond. Colony absconding as a result of small hive beetle interference usually happens in the beetle’s reproduction seasons. The population of the beetle increases making it difficult for bee colony to defend itself. Making hive entrance narrower helps to prevent beetle invasion. Some experienced beekeepers place queen excluders at the entrance of hives as this prevents entry.

e. **Honey Badger (mongoose)**

Honey badger is a long tailed animal which consumes everything found in hives. It pushes and brushes itself against hives until they fall spilling out their contents. It also inserts its long tail into the hive. In their attempt to defend their hive, many bees attack the tail. The tail is covered with fine long hairs making bee stings ineffective. When the tail is covered with bees, the badger starts eating the bees on its tail. Repeated attacks result in colony absconding.

Ways of controlling honey badger.

1. Fence and place thorns around apiary.
2. Some beekeepers use guard dogs to scare away honey badger.

3. Tie hives onto firm objects so that they do not fall when badgers push and brush against them.

4. Reduce the size of bee entrance so that a badger is not able to insert its tail.

5. Hang hives on a tree or on two poles.
6. If hives are on trees, place smooth iron sheet around the tree so as it is slippery and badgers are not able to climb.

7. Some beekeepers trap and kill honey badgers.

f. Bee Eater Birds

There are birds that eat bees. They do so when they cannot find other feed. Bee eating birds attack colony during the rainy season when bees have shortage of feed and are at their weakest times. The birds sometimes land in front of hives entrances and this enables them to capture and eat bees coming in and out.

It is possible to reduce the population of bee eating birds but very difficult to eradicate them. The following methods can be used to reduce their population.

1. Strengthen bee colony: when colony is strong, bees can fly faster. Birds cannot easily capture them.

2. Identify and destroy nests of bee eating birds around apiary. This may force the birds to settle elsewhere.

3. Use slings and whips (giraf) to scare and drive away the birds.

4. Prepare bird feed and place it further away from apiary. This gives alternative feed source and it diverts their focus.

5. Some beekeepers kill bee eating birds and hang the dead one in front of beehives. They believe that when the birds see the dead one, they fly away and settle elsewhere. This practice is not acceptable and is illegal. As it requires permit to kill birds.
There are other bee predators like lizards, bee lice and wasp. Mankind, being the biggest bee predator, takes and uses the honey produced by bees. Mankind, apart from using pesticides which kill bees and which have serious side effects, spreads bee diseases by using contaminated equipment, utensils and implements.

Bee lice are parasites. The parasites position themselves on the head and thorax of the bee and share its feed. The damage of the parasites is, nevertheless, minimal. The parasite become nuisance and disrupts normal function.

Tobacco smoke is used to control bee lice. Tobacco smoke does not harm bees but it suffocates bee lice and causes them to drop from the bees. Bees collect the dead insects and take them out of the hives. Beetles and wasps eat honey and brood. Lizards do not cause harm to bees except they disturb colonies and create inconveniences.

47. Poisons That kills and Affect Bees

There are two ways in which bees may be poisoned. The first the major causes are herbicides and pesticides and the second causes are poisonous plants.

- **Pesticides and Herbicides**

Pesticides and Herbicides are chemicals used to control plant pests and weeds. Bees are poisoned when they collect nectar and pollen from plants to which chemicals are applied. Water contaminated by the chemicals poisons the bee colony. Mostly, pesticides are spread by aircrafts and this has the most damaging effect. Mostly when pesticides are sprayed, many
bees are out collecting pollen and nectar are poisoned and killed. Bees poisoned by these chemicals show the following symptoms.

1. Many dead worker bees are seen in and around the hive.
2. The mouth mainly proboscis of the bees hangs out.
3. Dead broods are seen out of hives.
4. The colony size of a hive decreases suddenly.

Current studies indicate that the amount of damage on bee colony caused by unplanned and irresponsible yearly chemical usage is increasing. As a result of this the honey production of those areas that are formerly known as major honey producers, has decreased. In fact those who used to produce honey for their own in house consumption are being forced to purchase. The intensity of chemical usage is higher in areas that produce pulse crops, coffee and chat. The problem is aggravated more by those who are illegally involved in the chemical trading as they distribute huge amount of inappropriate chemicals. Another problem is many farmers have neither the skills nor the training on safe handling of the chemicals. There is chemical residue in honey harvested from areas that use a huge amount of chemical more than the set acceptable limit in the product and such honey cannot be exported to international markets, specially to EU countries.

It is essential to use insecticides and pesticides so as to increase productivity in agriculture. On the other hand, bees play important role in cross pollination which increases productivity. If using chemicals is unavoidable, a system should be designed to regulate chemical applications in such a way that they do not cause damage to bees. Users should be informed about when and how to use the chemicals.
Users of such chemicals should be obliged to cooperate with the beekeepers to safeguard bee colony. The Ministry of Agriculture along with those concerned are expected to come up with directives on ways of responsible usage of chemicals. Until such time, here are tips on measures to minimize chemical effects.

1. Avoid establishing apiary in areas that heavily use chemicals.

2. Agricultural support providers should coordinate information exchange systems between the chemical users and the beekeepers on the time and date of chemical use.

3. If spray dates are known, on such days make sure there is enough feed and water in the hive. Then arrest colony by covering it with mesh wire, wet cloth or wet sacks that allows free flow of air.

4. Shift location of bee colony until the chemical is neutralized.

5. Narrowing bee entrance reduces the damage to some degree.

6. Educate farmers on crop protection systems. Some trails in the country regarding this have shown encouraging results.

When bees are poisoned it is necessary to take some of the following measures.

1. Merge post damage bee colonies so as to make up for lost bees and to strengthen them.

2. The honey combs could be contaminated and need to be replaced by fresh ones.

3. Provide more feed to bee colony.
48. **Plant Poisoning**

Bees may, accidentally, collect nectar and pollen from poisonous plants and become poisoned shortly after. It is difficult to manage poisoned bees as there are no symptoms to indicate the poisoned bees. The problem of poisoned bees is known only when we are able to observe bees dying after contacting other bees which collect nectar and pollen from poisonous plants. If the poisonous plants are known they should be destroyed before they flower and this can be a preventive solution.

49. **Handling Bee Products**

**Bee Products**

- **Honey**

  **How Bees Make Honey**

Honey is made of nectar collected by bees from various flowers. It is a kind of feed that contains carbohydrate and minerals. Bees suck nectar of various flowers and store it in their honey sacks. They fly back to their hives, deposit the nectar out of their honey sacks into the comb cells and here enzymes are added to the nectar and the mixture brings about qualitative change in the nectar. Field bees sometimes pass the nectar over to worker bees in the hives. Worker bees in the hives put the nectar in comb cells, even the field bees can do that. Bees flap their wings and let 60% of the water content of the nectar to evaporate. They ferment the liquid and the moisture content to be reduced from 17% to 20%.
Honey Content

Floral honey is made of nectar from many different flowers. Accordingly, there are many components in it. The composition of honey depends on the type of flower and soil the plant grows on. It has been confirmed that there are over 180 elements present in honey. However, this does not mean that all types of honey have 180 elements.

Carbohydrates, water, acids, protein, minerals, starch and vitamins are the major components of honey.

- Carbohydrates

There are over 20 types of carbohydrates in honey. Some of these carbohydrates originate from nectars. Others are results of enzymes and acids in the fermentation and aging process.

Honey has the following major carbohydrates.

- Fructose 38.10%
- Glucose 31.29%
- Sucrose 1-3%
- Maltose 7%

Most of the time, honey carries more fructose than glucose. Some types of honey contain a high amount of glucose. Cabbage honey is one example of this. The amount of carbohydrate in honey determines the source plant as major and minor honey plants of the areas.
a. **Moisture Content**

Moisture is one of the chemical components of the honeys collected and ripened. Moisture content of honey plays important role in its quality. This is because it is only when the moisture content of honey is less than 19% that it can be stored for a long time. The international standard of first grade honey moisture content is between 17.5%-18.5%. At national level, Holetta Bee Research center had conducted laboratory measurements of moisture content using refractometer. Four hundred samples were taken and the result of moisture content test showed from 15% to 30%.

Three major causes which raise the moisture content of honey:

1. When honey is harvested before it is ripe,
2. When honey is stored in a container that allows cool air,
3. When the relative humidity is very high, above 60% or so,

b. **Enzymes**

Enzymes play important roles in caring out chemical reaction and the breaking down of the components of higher sugars in the nectar, while converting from disaccharide sugars to monosaccharide sugars referred to as carbohydrates.

Major enzymes in honeys:

1. **Invertase**

This enzyme converts the sucrose obtained from the flower to fructose or laevulose.
2. **Diastase**

It breaks down starch and sucrose.

3. **Glucose oxides**

This enzyme converts glucose to gluconic acid and hydrogen peroxide. Hydrogen peroxide is what gives honey its antimicrobial properties.

g. **Minerals**

There are several different minerals in honey. The mineral content of honey is between 0.02% and 1% and the average is 0.17%. Darker honey contains more minerals than lighter colored honey. The following are some of the minerals found in honey.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Potassium</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur</td>
<td>Sodium</td>
<td>Iron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlorine</td>
<td>Phosphorous</td>
<td>Manganese</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Minerals in honey are essential for the strength of bone and teeth and for the well function of the nervous system and muscle. They regulate the balance between acid and alkaline in the blood and enable blood to carry oxygen.

h. **Acids**

Honey is acidic in nature. The acidity of honey ranges between 3.6 to 4.2 PH. The acidity of honey is moderated by its sweetness and this blend gives honey its good taste and aroma. Honey gets its anti microbial properties from the acid it contains.
The following are some of the major acids in honey.

<table>
<thead>
<tr>
<th>Acid</th>
<th>Acid</th>
<th>Acid</th>
<th>Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formic acid</td>
<td>Gluconic acid</td>
<td>Benzoic acid</td>
<td>Citric acid</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>Propionic acid</td>
<td>Butyric acid</td>
<td>Malik acid</td>
</tr>
<tr>
<td>Acid</td>
<td>Lactic acid</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**i. Vitamins**

Although it is not in high quantity, it is proven that there are vitamins in honey. Some of them are vitamin b1 and b2, Nicotinic acid, Pyridoxine. Plants are source of vitamins.

**j. Protein**

Honey protein is made from pollen, nectar and bees themselves. There are about 18 different types of proteins (amino acids) in honey. The major ones are proline, lysine, aspartic, anmin, glutamic and cytine acid. These amino acids give distinct characters to the individual honey and it is the amino acids which differentiate artificial honey from the natural.

**k. Yeast**

Although honey has strong anti-microbial properties, there are some sugar tolerant yeasts which grow in honey. Yeast diminishes the shelf life of honey. It ferments honey and gives it sour taste. Yeast affects honey when it is harvested before it is ripe; when its moisture content is above 18.5% and when it is stored in yeast favorable temperature, 10-20 degree centigrade. Honey fermentation can be minimized by harvesting honey after it is ripe. Keeping honey in dry places and under 10 degree centigrade helps to prevent yeast growth.
50. Properties of Honey

- **Hygroscopicity**

Honey is hygroscopic. Honey (with its inherent physical properties) has the ability of absorbing moisture from the air and wet exposed surfaces.

The moisture content of honey increases if it is stored in a place with high relative humidity or if the honey container is left uncovered or if the container lets its moisture. This is the major cause for an increase of moisture content of honey. Higher moisture content ferments honey. To control this, honey should be harvested after it is ripened and it should be stored in containers which do not allow moisture. Containers of honey should be tightly closed. It is advisable to utilize the honey with higher moisture content as soon as possible. If left for a long period it ferments and it develops sour taste. Honey is also affected by odor. It should not be stored along with chemicals, fuel, pesticides, and the like. Honey adopts human odder as well.

- **Crystallization**

Crystallization is one of the properties of honey. The time it takes for honey to crystallize depends on the type of honey. The time for crystallization may take days or months. Some honey start crystallizing soon after being harvested. Foreign bodies in honey like solid pollen, broken combs, dust particles, air pockets or broken bee body parts quicken the crystallization of honey. If honey is free of such foreign bodies it has the potential of being stored for a long period of time remaining in liquid state. When honey crystallizes, its color changes and it reinstates when melted.
c. Color

Honey can have many colors. It ranges from waterish to bright red and black. The color is affected by the type of vegetation. Eucalyptus spp. honey is yellowish and coffee honey is blackish. Honey which has more minerals has darker color while the one that has less mineral is light in color. Honey can have darker color as a result of the following factors: when heated excessively, when stored for a long period, and when the honey taken the odor of its container or when harvested from old combs. The color of honey does not have any impact on its quality but people have preference to certain honey colors and as a result colors are graded and there is an international standard attached to its price.

d. Flavor and Aroma

In addition to its sweetness, honey has certain aroma and flavor. Aroma and flavor are very important for the quality of honey. Different kinds of honey have different aroma and flavor. Darker honey, for example, has stronger flavor. There are over 50 elements found in small quantities which give honey its aroma. These elements are very volatile and may disappear over time. To minimize this, container of honey should be tightly sealed.

51. Uses of Honey

- Honey as Food

Honey is the highest provider of carbohydrates. Honey is used as an ingredient in the preparation of many types of food. It is used in cakes, cookies, jams, marmalades and candies. Foods prepared from honey besides being soft and spongy, they neither crack nor become excessively dry and they also have good aroma. One major advantage of consuming
honey is that it is ready made to be absorbed by the body and there is no waste produced from it. Because of this character, honey is recommended for children, the old, sports persons and for those who undergo internal surgery.

- **Honey for Medication**

Honey is known to be effective in medication. Honey being combined with other elements, is used by traditional and modern mediation. Its antimicrobial properties can control even kill microorganisms. Its acidic character, its hydrogen peroxide and its ability to exert osmotic pressure to dehydrate makes it antimicrobial. Honey is used to dress wounds, to cover wound of internal operations, to dress fire burns, to make medicinal syrups, for intestine ulcer, for throat and mouth diseases.

- **Honey in Cosmetics**

Honey is used in the preparation of cosmetics like hand lotions and facial cream. Honey moderates skin cracks caused by strong wind and low temperature. Unlike many other creams and lotions, usage of honey has no side effect.

- **Honey in Factories**

Mostly honey is used in food industry as preservative. Factories like cigarette and candy use honey so that they retain the intended amount of moisture in them. The hygroscopic nature of honey helps to do that.

- **Honey in Beverages**

Honey wine and honey mead are very popular drinks in use in the country. Honey is used to make drinks at cottage level and mid size industries.
• **Honey Management**

Honey management covers all activities and process of honey production that are conducted before honey is harvested all the way up to the time the product reaches the final consumer. The management includes preparation of fresh honey comb, which will take the place of old combs that are removed. Such management enables to obtain honey with good flavor and aroma.

**52. Honey Types**

There are different ways of preparing honey.

**Liquid Honey**

Liquid honey is prepared by passing crude honey through different sieves and filtering devices. The honey in its liquid form is separated from other contents of crude honey. It does not solidify or crystallize. It freely flows from its container in a form of liquid.

**Fresh Honey**

Fresh honey is the one which is freshly harvested and which is still in the honey comb or extracted from the comb.

**Crystallized Honey**

This is when honey crystallizes after it has been extracted. It is in its solid form.
1. **Crushed Honey**

This is harvested crude honey crushed along with the honey comb. It is not extracted or filtered.

2. **Cream Honey**

This is filtered honey prepared to be soft and smooth. When it is processed to be cream honey, the honey can stay in such a state for quite some time.

3. **Comb Honey**

Comb honey is prepared from ripe honey. Honey is harvested and left in its comb. The comb is cut in a desired pattern and is then packed for use. It can be prepared from any type of hive. Comb honey is prepared from freshly introduced combs, and in preparing the product, old and dark honey combs should be identified and removed. Comb honey is very popular and can be sold for more prices.

4. **Pressed Honey**

Honey comb free of brood and pollen is taken fresh or after a while. If the honey has crystallized, it is heated indirectly (with jacketed water or sunlight) to melt. Then it is pressed with honey press and filtered.

Honey can be natural or organic depending on how it is produced.

5. **Natural Honey**

Natural honey is the one that is made from pollen and nectar of various plants. Bees combine the nectar they collect with their enzymes to prepare honey.
• **Organic Honey**

This is honey which is free of pesticides and insecticides. The plants from which bees forage must be naturally grown or without artificial fertilizers.

**53. Harvesting Honey**

It is a common practice that honey is harvested before it ripens. The water content of such honey is very high and this has a negative effect on the quality and price of honey. Therefore, it is necessary to identify, select and harvest honey which is ripe. Bees seal ripe honey with a new and thin wax layer. The whole comb may not be sealed, but when two thirds of it is sealed it is considered ripe and honey is ready for harvest.

To maintain the quality of honey, it is necessary to separate honey which is harvested from old and dark combs. In addition, honey should be harvested and processed by plant types. Mono floral honey has more demand and more price than multi floral.

Keeping the natural flavor and aroma of honey is essential. Excessive use of smoke affects the aroma and taste of honey and such harmful practices should be avoided. There should be minimum usage of smoke to drive away bees. Honey harvested in one apiary, irrespective of whether the hive is modern, transitional or traditional, comes from the same flora. There is no difference in the floral type, content or quality of the honey. Differences in the type of honey occur in the process of harvesting, storing and handling. Harvesting before honey is ripe, excessive usage of smoke, mixing pollen with the honey, using unclean containers and using coverless containers are some of the practices which adversely affect honey quality.
- **Harvesting Honey from Transitional and Traditional Hives**

As long as ripe honey which is pollen free is identified, selected and harvested, the honey quality from traditional and transitional hives is the same as that of modern hives. During harvest, new honey combs should be separated from old ones. Honey harvested from new honey combs is demanded for table honey and has higher selling price. It is necessary to separate honey in quality and set quality order classifying it into table honey, honey used for moderate honey wine and so on. Separating old honey combs and discarding them are done to be able to grade honey according to its quality.

![Harvesting from transitional hive](image)

**Fig 99 Harvesting from transitional hive**

Harvesting should be done from both sides of traditional hives. If harvesting is done from one side only and if the other side is left, the comb of the unharnessed side becomes old and bees stop using the comb. Hence, the comb stays useless for a long period of time. Contents of old combs, like honey that is not ripe and or dry pollen should be put together separated from the other harvest. This can be sold to honey wine producers.
- **Harvesting from Frame Hives**

It is possible to harvest honey from frame hives by using smoke and soft brush. Frames can also be individually taken out, bees are removed and honey is harvested. Bee escapes can also be installed 24 hours prior to harvest to free honey chambers from bees. Bee escapes work in such a way that bees can come down from the honey chamber to the base while they cannot go back because the bee holes are not visible from the lower side. Bee blowers may be used to blow down bees to the base. Either ways can be used to drive away bees from the honey chamber to the brood room. A chemical, bee repellent, may also be applied to a piece of cloth and placed under the cover and this drives the bees away. Bee repellents are not used by either natural or organic honey producers in order to avoid residue of the chemical in the honey.

Then a frame at a time from either of the corners is taken out using chisels. After bees are removed from the frame, it is placed in another empty frame box. If honey is going to be harvested from many hives, frames should be marked or numbered to identify which goes where.

**54. Extraction of Honey**

Honey should be extracted immediately after it is taken out of the hive. As soon as the honey is taken out of the hive, it is warm and in a liquid state and this reduces the extra work and it makes extraction easier.

To extract honey, it is necessary to prepare the required implements and utensils. Equipment to be used in the process should be clean and washed thoroughly and should be dry. The processing room should be free of dust and odor. If the processing is to take place at house hold level and if the floor of the room is dusty, the floor should be covered with plastic or mat.
For higher level processors, the room should have cement floor or the floor should be covered with plastic sheet. The wall should be painted with food grade paint and it should be white. Mesh wire should be fixed on the windows of the processing room in order not to let in insects and animals. There should also be water line so that workers can keep their personal hygiene.

Those companies that process and pack honey should build their plant away from areas of chemical dust, or gases and from industries that produce flour or similar other particles.

55. Processing Honey Harvested from Frame Hives:

Forks are used to uncap honey combs. Combs are placed in the chambers of the honey extractor. Commercial beekeepers can use electrically operated uncapping forks or even automatic uncapping tools.
The cover of the honey extractor should be closed to prevent honey spilling out of the machine and to let the honey retain its aroma. Impurities such as pieces of comb or bee parts should be filtered in order to have pure honey. To get honey that is free of unwanted materials, it should first be melt. Hence, the honey is put in a container immersed in water and is left in the sun to get indirect heating. Then honey is filtered with honey cloth and will left for a day to let foam float at the top. Scoop with spoon foam or any other floating particles. Sell such filtered honey as soon as possible before it crystallizes or close container very tightly and keep it in a cold room.

56. Methods of handling honey from traditional hives

1. Processing honey harvested from traditional and transitional hives
   a. Processing newly harvested honey

Place the newly harvested honey comb on a clean plate and break it to pieces using steering stick and place on the top of the container having strainers so that the liquid honey by its own gravitational force goes down and then collected in the bottom of the container. Different sieve sizes can be used. The course one helps to collect big particles unnecessary and the very fine sieve helps also to filter fine but unnecessary particles from honey. It is possible to use filtering clothes.
2. Processing Crystallized Honey

Honey crystallized on the comb is difficult to process. It takes longer time and sometimes it has a negative effect on the quality of honey. To minimize this effect, the honey is heated indirectly in the following way. Place a small cooking utensil containing honey in a bigger cooking utensil which contains water. Put cardboard or a piece of flat wood in the bigger utensil and place the smaller utensil on the cardboard or on the piece of flat wood. Place this on fire so that the water in the bigger utensil is heated and the water in turn heats the honey in the smaller utensil. This melts the crystallized honey and in the process, wax separates from honey and starts to float at the top. Stir the honey in the small utensil so that the honey will melt down by the evenly distributed heat. When the honey melts and becomes liquid, remove it from the heat and let it cool for 10-15 minutes. This lets the wax float at the top separating itself from the honey. Scoop the wax with spoon and remove it from the honey and place it in a different container. Use various sieve grades or sash or nylon cloth to filter the honey.
3. \textit{Extracting Honey with Honey Presser}

Using honey press is another way of extracting honey. Place newly harvested honey, or honey indirectly heated in a bag made of sash or nylon cloth. Tie the mouth of the bag. Place the bag between the two discs of the honey press. Place a container at the outlet of the honey press to collect the squeezed honey. Using its handle, tighten the press so that the two discs squeeze the honey in the bag. After checking that the honey is squeezed out, take out the wax from the bag and put it in another container. Repeat this until the extracting is completed. Check the extracted honey and scoop any foam floating at the top. Honey extracted by presser cannot be used as table honey mostly. It may be very strong and sour if eaten like table honey. Nevertheless, the taste is yours.

\textbf{Fig. 102} honey extraction using presser
4. Extracting Honey from Traditional and Transitional Hives Using Honey Extractor

It is possible to use frame hive honey extractor to extract honeys harvested from traditional and transitional beehives. This needs support that opens and closes in which the honey comb is placed. The support should be covered with narrow holed mesh wire. This will let honey spill out into the wall of the honey extractor when it starts rotating.

5. Handling honey clean and warm when needed

Honey is natural food. It should maintain its quality until it is consumed. When honey is harvested, processed, heated and stored it is possible to take the necessary care and precaution so that it retains its natural content till it reaches the consumer.

Although honey has a very high antimicrobial character, unless it is handled with proper care it is prone to spoilage. All equipment used to process and store honey should be very clean and completely dry. People who have direct contact with honey should be very clean and are expected to keep their personal hygiene. The processing room should be very clean as well. Honey should be free of any contacts with insects. Honey should not be touched with bare hands. Spoons or such utensils should be used instead.

Heating honey is not recommended as it destroys elements which give honey its aroma, flavor and medicinal value. But it becomes necessary to heat honey for several reasons: to filter it with honey cloth, to kill yeast in it and to melt crystallized honey and pack it in smaller containers. When it is
necessary to heat honey, care should be taken so that it does not exceed the required temperature limit. Here are some tips:

When honey is heated, the container it is in should be placed in a bigger container which is filled with water. The bigger container receives the direct heat and the honey is indirectly heated by the warming water.

During the heating process, the honey should be continuously stirred with a clean agitator.

The heating should take a very short time and the heating temperature should be very low, about 50 degrees centigrade.

- **Honey Storage**

Honey is a product which can be stored for a long time. It, however, easily is spoilt if not stored carefully and properly. If honey is not going to be marketed immediately, the following cares should be taken when storing it.

1. The moisture content of honey which is going to be stored for a long time should not be more than 19%.
2. The container in which the honey is to be stored should have tight cover and the container should not let in moisture.
3. The storage room should be cold and dry.
4. Honey adopts other odors hence it is not advisable to store honey in a room where honey wine (tej) or local beer (tella) is found.
5. Stored honey should not be exposed to sunlight.
6. The place where honey is stored should be cold.
7. Honey containers should be stainless, should have tight lid and should not let in moisture. Container used for other things like cooking oil, butter or gas should not be used for storing honey. Locally, containers like skin bag, clay pots and local beer pots are used and studies show that these containers affect the quality of honey.

8. Honey containers should be made of material which enable to maintain the quality of honey. Containers made of aluminum and stainless steel are preferred and recommended.

57. Beeswax

Beeswax is produced from four pairs of wax glands in the abdomen of the worker bee. Bees need to consume a lot of honey to produce wax. Bees consume over three kilograms of honey to produce one kilogram of wax. That is why foundation wax is provided to bees and wax is given to bees after honey extraction. This method, in addition to saving time, minimizes the time honey bees would need if they were to produce wax themselves.

- Characteristics of beeswax

Wax is dry and brittle when cold. When it is hot it is soft and malleable. When liquid wax solidifies it shrinks and the volume decreases by 9.6%. When wax is first produced it has whitish color and the color changes when it is mixed with pollen. The color of wax may be white, yellow or orange. Wax has its own distinct aroma.
Contents

Beeswax is a mixture of over 300 complicated elements. This makes it difficult to artificially produce wax. Beeswax is directly and indirectly used in medications and in cosmetic productions. This requires maintenance of quality and prevention of wax from adulteration.

Processing and Handling

Beeswax may be harvested from frame, transitional and traditional hives. Out of honey harvested from transitional and traditional hives, 8%-10% is wax while that of frame hive is 0.5%-1%. Most of the honey produced at national level is used for making tej and birz. Most of the wax is used in the process of making drinks and wax is obtained in the filtering process of the drinks. When colony absconds, wax can be harvested from the hives. Because there is no realization of proper harvesting and processing of beeswax, most of the wax harvested is not effectively used.

The following cares should be taken when melting beeswax.

1. Use low temperature which slowly melts beeswax.
2. Beeswax is inflammable and direct contact with fire should be avoided.
3. Add water to the beeswax or use the indirect heating method similar to that of melting honey.
4. Do not add water to melted beeswax.
5. Use any melting bowel to melt beeswax.
Processing

There are various ways of processing beeswax: Solar, evaporation, pressing and by simple melting using bowel and water.

Solar Processing

The energy from the sun can be sued to melt wax. Solar extractor box is used to convert sunlight to heat which melts the wax. Wax processed this way has the best quality in that it retains most of its elements. It may be difficult to apply this in the rainy season.

Fig.103. solar wax extractor

Processing Using Evaporation

This requires the use of evaporating unit. The unit has two different chambers for wax and water and processed wax is directly deposited in the wax chamber. The beeswax has no physical contact with water. Water is heated and when it evaporates, it melts the wax. The unit has a mechanism to compress the wax.
- **Processing Using Sacks**

Beeswax collected from *tej beverage cottage industries* and old honey combs are first separated from foreign particles. It is then soaked in water for 24 hours. This is done to remove pollen and to separate the wax form other particles. This is then washed and mixed with water and when all of it melts, it is placed in fiber sack. Container is placed to collect the wax which is squeezed out of the fiber sack. Two people, one from each edge, ho

Id the sack over the container and twist the edge of the fiber sack in opposite directions. This should be done while the wax is still hot.

![Fig. 104 wax extraction using sisal sacks](image)

If the volume of wax to be squeezed is big more people can be involved and they can use big sized sticks to press it down from the middle, assisting the ongoing squeezing process. Such squeezed wax should be left to cool down. The container in which the squeezed wax is collected should be narrower from its base and wider at the top. Impurities tend to collect at the bottom and such shape makes collecting the pure wax easy. Finally, take the solid wax and use knife or sharp object to scrap off impurities from the
base. The processed wax should be kept in a room free of pollutants and chemicals. Processed wax has a very long shelf life.

Fig 105 wax extraction methods

58. Uses of Beeswax

It has been over 5000 thousand years since mankind started to use beeswax. It has also been in the market as a commodity for thousands of years. Documents indicate that in Ethiopia, there has been marketing of wax for over three thousand years. Because beeswax is easy to carry and transport and because it has a long shelf life, beeswax was used as currency to purchase goods to pay taxes, compensation and for remuneration.

1. Beeswax in Cosmetics

It is one of the components in the cosmetic industries of the world. Hair cream, pomade, lipsticks, face-cream and the like can be prepared and distributed for use.
2. **Beeswax in Medicine**

Twenty five to fifty percent of all the beeswax produced in the world is used for pharmaceuticals. Wound lotions, medicated lotions, insect repellants, coating for pills and dental medicine are among those made with beeswax.

3. **Beeswax in Polishes**

Beeswax is used to make home and office floor and furniture polishes. It is also used to make shoe and car polish and in the making of different varnishes.

4. **Beeswax in Stationeries**

Beeswax is used to make writing carbon, pen ink and photograph printing ink.

Other uses of beeswax include its use in making chewing gums, candles, making explosives, threads, moulds and swimming goods.

It is good preservative of dead body of humans

59. **Propolis**

Propolis is a sticky and gummy resins material which bees collect from different plants. The colour of propolis ranges from light brown to dark blue.

- **Composition of Propolis**

At 25-45 degree centigrade propolis is soft, pliable and sticky. Under 15 degree centigrade it is in a solid state and is brittle. It melts at 60-70 degrees. It quickly dissolves in alcohol and benzene and is soluble in water.
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![Wax extraction methods](image)

**Fig 105 wax extraction methods**

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Twenty five to fifty percent of all the beeswax produced in the world is used for pharmaceuticals. Wound lotions, medicated lotions, insect repellants, coating for pills and dental medicine are among those made with beeswax.

3. **Beeswax in Polishes**

Beeswax is used to make home and office floor and furniture polishes. It is also used to make shoe and car polish and in the making of different varnishes.

4. **Beeswax in Stationeries**

Beeswax is used to make writing carbon, pen ink and photograph printing ink.

Other uses of beeswax include its use in making chewing gums, candles, making explosives, threads, moulds and swimming goods.

It is good preservative of dead body of humans

59. **Propolis**

Propolis is a sticky and gummy resins material which bees collect from different plants. The colour of propolis ranges from light brown to dark blue.

- **Composition of Propolis**

At 25-45 degree centigrade propolis is soft, pliable and sticky. Under 15 degree centigrade it is in a solid state and is brittle. It melts at 60-70 degrees. It quickly dissolves in alcohol and benzene and is soluble in water.
It has over 200 compounds in it. Propolis has many uses for bees and human beings.

- **Uses of Propolis for Bees**

Bees use propolis to cover holes and cracks in their beehives. When it is cold, bees use propolis to decrease the size of the entrance of their hives. They also use it to strengthen the firmness of honey combs. Whenever something dies in the hive and they cannot take the corpse out, they seal the dead body with propolis to control the rotten odor.

- **Uses of Propolis (for Human Beings)**

Propolis is anti bacteria and anti fungus and it serves to make various types of medicines and cosmetic products, creams and lotions. It is used in the treatment of different kinds of infections like that of the intestine, mouth, tooth and the throat.

**60. Methods of Harvesting and Handling of Propolis**

Propolis can be harvested from all types of hives. When hives are opened for inspection, it can be harvested along the way. It is many times found around bee entrances, at base and super junctions and between frames. With the intention of harvesting propolis, holes and cracks are made in the hives to make bees produce propolis for the purpose of sealing them.
In frame hives, it is possible to install materials with holes made just for the purpose. The materials are flat sheet metal, plastic sheet, mesh wire, and nylon cloth. When bees seal these holes with propolis, the material should be placed in a refrigerator or in a cold place. Propolis solidifies and it becomes easy to remove it.

In transitional beehives, it is possible to harvest propolis by placing bars that is wider than the bars with normal size.
Openings are made at the entrance of the traditional hives in order to harvest the propolis which is used to cover the entrance as seen in picture fig 108.

![Fig 108 propolis extraction method](image)

By initiating bees to produce propolis, it is possible to harvest annual average of 300 gm from frame hives and 200 gm from traditional hives. The amount of propolis harvested is determined by the type and amount of plants as well as the climatic condition of the area. Researches indicate that making bees produce more propolis has no negative impact on the amount of honey they make. When propolis is harvested it should be free of impurities like wood dust, wax, dust or dung. Harvested propolis can be packed with plastic sheet and stored in a cold place and can eventually be sold. Although there is no local market for it, products are sold to foreign markets. Propolis is the highest bee product sold to international market next to honey and beeswax.

61. Pollen

Pollen is the male part of a flower. Each pollen grain contains vegetative nucleus. Different pollen grains from different plants have different structures and colors.
• **Contents of Pollen**

Studies show that there are over 180 elements in pollen. Pollen is 35% protein and there are 22 types of amino acids in it. One unit of pollen has more amount of protein than one unit of meat or one unit of eggs. All vitamins known to date are contained in pollen. In addition, it contains 27 types of minerals, various carbohydrates, oils, enzymes and hormones.

• **Uses of Pollen**

Pollen is the main protein source of bees to grow their broods. Honey bee pollen has medicinal and food value. It is used to create resistance to disease, to prolong age, to moderate and enhance the health of glands and blood veins, to keep the heart, kidneys and the liver healthy. It is used as antidote for water, air and chemical contamination and poisoning.

• **Production and Storage of Pollen**

Pollen can be collected by pollen traps installed at the entrances of all types of hives. Traps to be installed at traditional and transitional entrances have to be modified to fit the particularities of the hives. Bees carry balls of pollen dust at their hind legs. The balls are removed by the traps and are collected in a container placed for the purpose.

In a good flowering season, a strong colony can produce an average of 100 gm of pollen. Studies show that initiating bees to produce more pollen does not have significant effect on the amount of honey the colony produces. The collected pollen is dried and put to use. Pollen should be stored in glass bottles or plastic bags until it is sold or used. Pollen can be mixed with honey or eaten alone. At national level, collecting pollen has started in some
62. Marketing Bee Products

At national level, honey, beeswax, hives and colonies are the ones available in the market. Honey takes the lion’s share. 97% of honey produced in the nation is marketed locally. The rest is left for house hold use, to be consumed or to be used for medication. Out of all the marketable honey, 99% is sold crude. Out of all the crude honey, 97% is used to make tej (the local honey mead).

Crude honey is marketed using local containers. Clay pots, skin bags, metal containers, hallow bamboo pieces are some of the containers. As the inside parts of some containers rust, these parts of other containers break and create dust particles. Some containers have drying effect and others pass undesirable aroma to the honey. One similarity between the local containers is none of them have tight covers. Honey in open containers attracts moisture from the air making the moisture content higher than it should be. This results in honey fermentation which obviously results in sour taste. Honey in open container attracts bad odder as well.

Honey is sold in rural shops. Customers are house hold users, honey traders and tej brewers. Honey purchased by honey traders is re-sold to the nearest towns and to Addis Ababa. The price of honey varies according to its quality its proximity to towns and cities and season it is put out to the market. Good quality honey has good price. In areas where honey consumption is high, the price goes higher as well.

The next highest marketed bee product is beeswax. Collecting, processing and marketing wax is not common practice in the country. Wax is discarded
after honey is sucked out of it. Those who collect and process wax, and thus have a bigger market share are tej brewers. The trend is changing now in that many are taking trainings and are getting into the honey and beeswax market.

Both beekeepers and those who are not involved in beekeeping produce and sell traditional bee hives. There are also increasing number of people who produce and market frame and transitional hives. Experienced beekeepers reproduce colony and earn income out of it. In some areas of the country, the price of a colony is 800 birr and higher.

Beekeepers have started organizing in cooperatives. This enables them to sell their products at better prices. Farmers cooperatives have also started organizing collecting stations and processing units. They process their honey and sell it to direct user and bigger honey processing companies, and they earn better profits for their products. In some regional states, beekeepers are organized in bee product marketing unions.

There are seven high level honey processing companies set up at national level. They have the capacity to process both honey and beeswax. They have started earning foreign exchange which is economically beneficial not only to the companies but to the country as well.

All bee products marketed by beekeepers and honey processors should be of high quality and healthy. If the bee product to be marketed is honey, it should be packaged attractively, with all the information written on the labels. The selling price should be determined by the quality and condition of the packing, and it should attract and retain customers.
63. Local Beekeeping Skills

There are wide scope beekeeping knowledge and skills in the country. Skills range from bee health care to methods of improved production. Integrating such local skills with scientific methods is bound to result in good quality and quantity of products. Here are some local skills presented as examples.

1. In the process of trapping swarming bees, particular plants which attract bees are identified.

2. Plants with particular aroma to smoke hives with are identified.

3. Beekeepers have local skills of attaching hives with the same circumference to another hive as increase hive size and this prevents colony splitting and colony migration.

4. Hives are kept in shelters to prevent them from excessive heat and cold.

5. Beekeepers use smooth iron sheet and straw to prevent ants from climbing to where hives are placed.

6. Beekeepers place hot ash around hives to prevent ant attacks.

7. Beekeepers use thorn fences and guard dogs to drive away honey badger.

8. To prevent wax moth from attacking colony.

9. They use bone fire to attract wax moth. Wax moth burns itself in the flames of such bone fire.
10. Beekeepers provide feed and water to colony during times of shortage.

11. They spot and follow hunting birds so that it takes them to places where there are forest bees and forest honey. Beekeepers share the honey they collect in this way and feed a portion of it to the bird which spots such locations.

12. To protect colonies from bee-eating birds, beekeepers paint trees on which such birds land with sticky fluids from particular plants. That way, they disable the mobility of the birds. They also use loud noise, like that of jiraf to scare away birds.

13. Beekeepers move colonies from place to place following the patterns of honey plant flowering season.

64. Types of Records and Methods of Keeping Records

In both small scale and big scale beekeeping, it is vital to keep records. Types of records differ according to the level of the business. Records should include information on colony character, types of honey plants in the area, vegetation coverage, types and quantity of bee feed plants provide, income expense balance sheet and so on. Every beekeeper at all levels should have the necessary information which enables to identify and retain colonies with higher yields. Colonies which do not give good harvest compete for feed against the productive ones and they should be removed. Keeping records lets the beekeeper to decide on which of the honey products to focus. Keeping records helps the beekeeper to evaluate progress make the right decisions.
65. Glossary

Honeybee colony: a social insect living harmoniously together in a hive containing one queen bee, a few hundred drones and thousands of worker bees. It also comprise broods.

Hive: manmade container provided to honeybees to reside for reproduction and honey production. It is made of locally available materials.

Cell: hexagonally designed single compartment on a honey comb used for rearing worker, queen and drone bees from egg to adult stage and is place for storing honey and depositing pollen.

Comb: a layer of cells constructed by bees from beeswax for rearing bee brood, storing honey or pollen. It is commonly known as honey comb.

Queen cell: a place used for rearing queen brood.

Cell cup: artificial or natural queen cell used as a base for queen rearing.

Beekeeper: a person who keep honeybee colonies in a hive.
Beekeeping: it is the art and science of keeping honeybee colonies in hives for production of honey, beeswax and other bee products.

Bee products: products that are produced by honeybees consisting of honey, beeswax, royal jelly, bee brood and bee venom.

Backyard beekeeping: keeping honeybee colonies in and around forest areas, bushes, or farm lands.

Forest or field beekeeping: keeping honeybee colonies in and around forest areas, bushes or farm lands.

Commercial beekeeping: keeping of honey bee colonies in large size in a permanent apiary site or by migratory beekeeping method where it suits to produce maximum and diversified bee products.

Migratory beekeeping: a practice of moving hived honeybee colonies from one nectar flow place to another for maximum honey production.

Honey hunting: searching of nests of wild honeybee colonies for removal of their honey.
Pollination: the transfer of pollen from the another of a flower to the stigma of the same or another flower of the same species.

Reproductive swarming: partial evacuation of a colony from its original hive to establish a new colony. The swarm contains a queen, worker bees and sometimes drone bees.

Life cycle: the four stages of development of a honey bee which include egg, larva, pupa and adult bee.

Organ: part of a body of honey bee.

Pupa: the third stage of development of honeybee is a stage for reorganization of different organs.

Grafting: the transferring or transplanting of young worker bee larvae or egg to artificially constructed queen cell cup for rearing of queens.

Nectar: sweet liquid substance secreted from nectarines of flower.

Pollen: the dust-like substance which is the male reproductive part of flowering plant collected by worker bees for feeding bee brood.
Pollen basket: area which contain stiff hairs on the hind legs of workers bees where they transport pollen and proplis to the hive.

Proboscis: organ used for sucking liquid food.

Royal jelly: hypopharyngeal and mandibular gland section of young worker bees for feeding bee brood and queen. Beekeepers call it as bee milk.

Pheromone: a chemical substance produced by worker bees for communication among the same bee species or races.

Propolis: sticky resinous material collected by worker bees from different parts of

Thorax the second and the hardest body segment of an insect (honeybee) that bears movable organs namely wings and legs.

Abdomen the third body segment of honeybee that contains honey stomach, wax glands and sting

In-hive-bee young worker bee that feeds the larvae and queen bee and responsible to perform all other activities in the hive. It is sometimes known as nurse bee.
Field bee  a bee that collects nectar, pollen, propolis water..etc from the field and transport to hive.

Queenless colony  a colony devoid of queen due to sudden crash by the operator or death by bee pests or poisoning.

Honey plant  a plant that supplies nectar or pollen or both for honeybees

Harvesting honey  a process of removing repined honey from the hive during the honey flow period.

Beekeeping equipment  equipment made from metal, wood, or other materials such as hive, honey and beeswax extractor, beekeepers clothings and others used for beekeeping operation

Honey comb  a comb stored with honey

Swarming  partial or complete evacuation of honeybee colony from its hive crevies and other nesting ground to other places to establish a new nest

Urban beekeeping  it is the art and management of keeping honeybee colony in urban areas

Indigenous beekeeping knowledge  knowledge and skill that has been acquired by a traditional beekeepers through long tim practice. It is still in use for its benefit.
Honey - a natural sweet substance produced by honeybees from the nectar of honey source plant which honeybees collect, transform and combine with enzyme added while on their way home to reduce moisture and repine.

Organic honey that the honeybees produce from honey source plants which have grown in areas free from use of pesticide and inorganic fertilizer.

Adultrated or blended honey: a blend of natural honey with artificial sugar or molasses or corn added and other raw materials or honey blended with honey obtained by feeding honeybees with excessive sugar.

Beeswax - a secretion of honeybees in purpose to build cells or honey combs which enable them rear brood, deposit pollen and store honey by their hives or in the habitat of their choice and it does not include wax extracted from plants, minerals or through artificial methods.

Crude beeswax - empty comb obtained from honeybees after processing of honey or comb devoid of honey, pollen and bee brood of dry comb that is out from the hive as it would not be used by the bees to do their job or byproduct that is collected after brewing tej (national drink) or its diluted form of brew called birz.
Refined extracted beeswax: a produce collected by separating beeswax from alien substances through melting crude beeswax applying moderated heat or solar or electric power and refining with various extraction methods.

Adultrated or blended beeswax: beeswax mixed or blended with other types of wax or with animal tallow or other alien things which undermine product quality.

Sefef: a mass of broken honey combs that constitute residuals or byproducts left after brewing tej.

Keskes: semi-processed beeswax.

Supplementary feed: food artificially prepared by beekeepers for feeding honeybees when they are weak due to scarce forage or other reasons.

Pollen substitute: prepared as bee food like toasted peas or barley flour toasted bean flour and the like with inclusion of 10% natural pollen.
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