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Modern beekeeping for sustainable

livelihood improvement in north eastern India

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Beekeeping is an agro-based activity which is being undertaken for producing honey and other hive products. It is considered as a non-land based income generating tiny industrial sector and it can be defined as a single job with several benefits. It supplements income and employment generation and nutritional intake of rural population. Modern beekeeping has developed significantly through the integration of technology; scientific advancements and sustainable practices. The beekeeping is one of the important sectors among various agri-entrepreneurs in the northeast hilly (NEH) region. It has been a part of the traditional agricultural practices in this region for centuries. It can promote economic growth and protect biodiversity. The NEH region of India with its rich floral diversity, ideal climate and traditional knowledge of beekeeping offers immense potential for this sector. Therefore, with sustainable practices, modern management techniques, and government initiatives, beekeeping can play an important role for sustainable livelihood improvement and entrepreneurship development in this region.

Keywords: Beekeeping, Entrepreneurship, Honey, NEH Region, Sustainable livelihood

BEEKEEPING is also known as apiculture involves care and management of honeybees commonly in artificial beehives, producing honey, and their by-products while promoting pollination. Beekeeping has been practiced for ages throughout the world. Honeybees were previously reared in traditional boxes composed of wood, bamboo, log hives, and clay pots. With the introduction of L. L. Langstroth's wooden hive and the invention of honey extractor marked the beginning of the commercialization of beekeeping in the 19th century. Scientific boxes with movable frames are increasingly being used with the aid of scientific understanding. Honey and other by-products from apiculture, such as wax, pollens, propolis, royal jelly, etc. are utilized extensively in the pharmaceutical, cosmetic, and confectionery sectors, among others. In addition to these, bees perform pollination, which is one of the most significant ecological services. Honeybees support the growth and survival of a variety of plants, promote sustainability and boost the quantity and quality of agricultural products by facilitating pollination. Beekeeping has spread throughout the world, with many beekeepers depending on honeybees for their livelihood. However in the recent years, beekeeping has faced issues such as pests, diseases, climate change, loss of habitat, etc. Modern beekeeping techniques have developed to address these problems with sustainable practices and technological developments. Modern techniques such as organic beekeeping methods, integrated pest management, selective breeding, hive monitoring systems, etc. have improved and made beekeeping more efficient. A comprehensive awareness of bee biology, skill, adherence to key principles and management practices are essential for a sustainable beekeeping. With the right support, training, and infrastructure investment, beekeeping can promote economic growth, protect biodiversity, and generate employment.

Advantages of beekeeping

- Less investment is required to start beekeeping
- Requires less time as compared to other ventures
- Uncultivable agricultural land can be used
- It does not compete for resources with any other agricultural enterprise
- Provide pollination services for terrestrial ecosystem

- It can be initiated by individuals or groups
- The market potential for honey and other by products area is high

Modern Beekeeping

Modern beekeeping has developed significantly through the integration of technology, scientific advancements and sustainable practices in beekeeping. The modern beehive with movable frames made of wood is an important innovation in beekeeping providing a structured and efficient environment for honeybee colonies to thrive. Modern beehives in contrast to traditional hives are designed to improve hive management, promote colony health and increase honey production. Traditional hives have been used for beekeeping since time immemorial. Bee colony management techniques have been handed down through the centuries, relying on traditional hives designs, cultural practices, and local expertise. Despite its benefits and cultural significance, traditional beekeeping has drawbacks, including low productivity, unhygienic extraction, destructive harvesting, vulnerability to pests and diseases, and poor shelf-life of the honey. Modern beekeeping methods, equipment, and knowledge can be used to alleviate some of these problems. Modern beekeeping has many advantages, including increased honey production, better pollination, and production of hive products, etc. which are discussed below:

Hive management: The movable-frame hives make it easier to manage and inspect bee colonies. This provides more control, increases honey extraction efficiency, and minimizes bee disturbance in comparison to traditional fixed-comb hives. Modern hive designs facilitates better ventilation and insulation which helps in maintaining temperature and humidity, essential for brood development and storage of honey. Bees also can be fed artificially during dearth period.

Honey production: Modern hives with moveable frames can produce more honey. The volume of the hive can be altered according to necessity. The capacity to produce honey can be increased by adding supers. High-quality honey is produced by separating pollen and brood combs from honeycombs.

Honey extraction: Mechanical honey extractors are used for honey extraction from the frames without damaging the combs which can be reused by bees leading to faster honey production.

Pest and disease management: Integrated pest management practices can be implemented for managing pests and diseases by putting into practice a combination of methods like monitoring, use of natural enemies, modifying hive management practices and need based chemical control aimed at minimizing harm to bees and the environment.

Pollination services: Transporting hives is made easier by their compact size. By transferring hives to different locations, modern beekeeping maximizes the benefits of crop pollination. The value of pollination services is much higher than the value of hive products as the production of many crops get reduced tremendously without bee pollination.

Table 1. Crop loss without honey bee pollination

Crop	Crop loss in percent	Crop	Crop loss in percent
Soybean	10	Asparagus	90
Tomato	10	Grape fruit	80
Peanut	10	Cabbage	90
Cotton	20	Pumpkin	90
Lemon	20	Vegetable seed	100
Strawberry	30	Almond	100
Lime	30	Niger	100
Watermelon	40–70	Rapeseed	100
Pear	50	Safflower	100
Carrot	60	Alfalfa hay	100
Cherry	60	Cucumber	100
Apple	70–100	Sunflower	100

Source: Morse and Calderone (2000), Sharma *et al.* (2015)

Components of a modern bee box

The modern bee box also known as the "Movable frame hive," is constructed from a wooden box. There are multiple frames hanging vertically inside the box which can be removed independently. The space between two frames is called bee space and it helps in movement of bees. The modern bee box consists of the following parts:

Basal platform: It is composed of one or two pieces of wood joined together to form the hive's floor.

Brood chamber: It's a rectangular wooden box with four sides and no top or bottom. It is kept on the basal platform. The purpose of brood chamber is to hold brood frames and provide queen with enough room to lay eggs and raise brood.

Super chamber: This chamber is meant for the storage of honey only. Its construction is similar to that of the brood chamber, and it is kept above it.

Frame for brood and super chamber: It is a structural component that keeps the honeycomb or brood comb inside the box. The purpose of the frames is to keep bees from affixing honeycombs to the hive walls and also to provide space in between them for bees to move.

Inner top cover: It is a board that is the same size as a brood or super chamber. There is a wire gauge-covered opening in the center. It is kept on super or brood chamber. Its purpose is to provide ventilation and prevent bees from forming combs on the hive cover.

Hive cover/roof: It is shaped like a box and has an opening at the bottom. Sheets of tin or zinc cover the top section of the box. The brood or super chamber is fully covered by the bottom open section that fits over them. For ventilation, there are two openings on the front and back sides. It protects the hive against rain and sun.

Other accessories

- ***Comb-foundation sheet:*** It is made of wax and is artificially attached in the frames to provide foundation for the bees to construct combs.

- **Queen excluder:** A metallic wire net is used as a queen excluder to keep the queen from moving from the brood to the super chamber.
- ***Queen gate:*** It is a piece of queen excluder sheet that is installed in the entrance gate's slot. It helps in preventing swarming and absconding by keeping the queen inside the hive.
- ***Hive stand:*** It helps to protect the bottom board of the box from rotting due to direct contact with soil.
- ***Smoker:*** It is an equipment used by the beekeepers to control the bees if they become agitated during inspection/harvesting.
- ***Bee veil:*** It is a cap made of cloth and wire net. It is useful for face protection against stings.
- ***Hand gloves:*** They cover the fore arms and useful for protection from sting bite.
- ***Brush:*** It is used to brush the bees from comb before extraction.
- ***Knife:*** Sharp steel knife is used for removing wax capping from the comb.
- ***Extractor:*** This equipment is made up of a cylindrical drum that holds the super frames in a rack or box inside. It is used for extraction of honey by the action of the centrifugal force without destroying the comb.

Management practices of beekeeping

Successful beekeeping requires thorough understanding of bee behaviour, hive management, and familiarity with nectar and pollen plants. The beekeepers must initially rely on local knowledge and traditions before progressively implementing modern methods. A beekeeper must be aware of the factors that can affect beekeeping through continuous learning, staying up to date with the latest research and best practices. The following key management practices are essential for successful beekeeping:

Site selection: The production and well-being of bee colonies depend on the apiary's location. The location should be well-drained open area, rich in plants that yield ample pollen and nectar with a reliable water source. Additionally, the site should be away from traffic and human or animal disturbance.

General apiary management practices: For bee colonies to remain healthy and productive, routine hive maintenance and inspection are crucial.

- At least twice a week, beekeepers should check the hive for diseases, mites, wax moths, and other pests.
- Keep the hives clean and well-ventilated.
- When the brood chamber is full and every frame is covered with bees, more frames should be added to the super chamber.
- During dearth period/food scarcity artificial feeding becomes essential. Prepare 1:1 sugar dilution in water and use for feeding. To prevent robbing, feed all the colonies in the apiary at the same time.
- Provide enough space, regular inspections to prevent and control swarming. Beekeepers can control swarming by clipping special queen brood cells and redistributing brood frames from strong colonies to weaker ones.
- Use honey extractor and strainers to remove wax and debris for honey extraction. Before extraction, brush off the bees from the combs and uncapped the cells using uncapping knife.

Seasonal management

Honey flow season: Provide sugar syrup before honey flow and build sufficient population to produce honey. Strong colonies can be split up into two or three new colonies if needed. A queen excluder should be used to keep the queen in the brood chamber and prevent her from laying eggs in the honey supers. Combs that are completely sealed or at least two-thirds capped with honey can be removed for extraction and put back in the supers after extraction.

Summer season: The hives should be shielded from extreme heat, which can be achieved by artificial structures or natural tree cover. Sprinkle water around the colonies in the apiary and cover top cover with wet gunny bags to increase relative humidity and reduce heat. Proper ventilation is also essential, and this can be improved by placing a small splinter between the brood and super chambers to enhance airflow within the hive.

Winter season: Provide winter packing for weak colonies, especially in cooler hilly places. New queen may be provided to the hives.

Rainy season: Keep the apiary site dry to prevent diseases and mold growth. Ensure adequate drainage.

Management during dearth period: Remove the

Modern beekeeping equipment

Apiary with modern beehives

Table 2. Different honey bee species and their yield potential

Species	Description
Rock bee, *Apis dorsata* (Apidae)	It is known as Giant honey bee. They are very ferocious and not good for domestication. They produced about 20–40 kg honey per colony per year.
Indian hive bee, *Apis cerana indica* (Apidae)	It is known as Indian bee. They are easy to domesticate. Average honey production of 3.6–4.5 kg honey per colony per year.
European bee, *Apis mellifera (Apidae)*	European bee or Italian bee has ability to acclimatize to even semi-desert tropics as well as to cold temperate zones; has made of more global in distribution. The average production is 20–25 kg honey per colony per year but yield may be increase up to 50 kg.
Dwarf bee, *Apis florea* (Apidae)	Commonly called as little Bee. They produced about 0.5 kg honey per colony per year.
Dammer bee or stingless bee, *Melipona irridipennis (Meliporidae).*	Two species of stingless, viz. *Melipona* and *Trigona* occur in our country in abundance. These bees are much smaller than the true honey bees. The honey production is 100g honey per hive per year.

supers and pack the brood chamber with all of the healthy broods that are currently available. Discard the old and dark combs that cannot be reused. If necessary, destroy drone cells and queen cells. Provide sugar syrup, pollen supplement and substitute.

Scope of beekeeping in NEH region

The northeast hill (NEH) region of India has a rich biodiversity consisting of agro-ecosystem, diverse forests, and flora. Beekeeping is one of the various agri-entrepreneurs in this region. It has been a part of the traditional agricultural practices in northeast India for centuries. It is deeply rooted in the culture and livelihood of the region which paved the way for the development as an agri-business. There are several factors that contribute to the scope of beekeeping in this region.

Floral diversity: The flora of India's north eastern states is incredibly diverse. A wide variety of nectar and pollen are available to bees. The region's abundance of wild and cultivated plants, such as a variety of fruit trees, flowering shrubs, and medicinal herbs, provides bees with year-round foraging alternatives.

Species diversity: Due to its rich floral diversity and ideal climate, the area is home to many different species of honeybees. Honeybee species such as *Apis cerana, A. dorsata, A. mellifera, A. florae* and stingless bees are found thriving well in the region. The native species *A. cerana,* is well adapted to the local environmental conditions.

Traditional knowledge: Beekeeping is an integral part of many tribes' cultures and tradition. Indigenous knowledge and customs have been handed down through the generations and are an invaluable resource for the development of modern beekeeping techniques.

Employment generation: Beekeeping offers various economic opportunities providing opportunities for self-employment. Employment can be generated in honey production, hive maintenance and pollination services, bee colony business, honey processing, and marketing.

Export potential: The demand for honey and other bee-related products is growing globally. Beekeepers can tap into this market, offering unique and high-quality products. A vast variety of premium honey varieties, including multifloral, monofloral (such mustard and litchi honey), and specialty honey, can be produced in the region.

Challenges faced by tribal beekeepers

Although beekeeping has great potential in the region, there are several challenges that affect the sustainability of beekeeping and well-being of bee colonies.

- The variations in the climate of the region with high rainfall and high humidity affect beekeeping operations.
- Most of the beekeepers still follow traditional methods. Lack of awareness about modern techniques, limited access to equipment and technology affects the quality and quantity of production.
- The lack of knowledge about pest and diseases of honeybees and their management results in colony losses and decreased productivity.
- Limited research and extension services specific to the northeast region, leading to a lack of region-specific knowledge and solutions.

Economics of modern beekeeping

The economic benefit of modern beekeeping for this region has been estimated based on local market prices and found that scientific beekeeping may be a profitable and lucrative agribusiness venture for the unemployed rural youth for this region. Under optimum weather and floral conditions, on average revenue of ₹ 2.5–3.0 lakhs/ year may be made from hundred modern bee hives of *Apis cerana* with proper scientific management practices in this region.

SUMMARY

From traditional methods to modern scientific methods, beekeeping has significantly evolved through the years. Beekeeping has been transformed by the introduction of modern beehives along with scientific management practices making it more reliable and sustainable. The role of honeybees in pollination assist in the growth and survival of a wide range of plants, encourage sustainability, and increase the quantity and quality of agricultural goods. The northeast hill region of India with its rich floral diversity, ideal climate and traditional knowledge of beekeeping offers immense potential for beekeeping. With sustainable practices, modern management techniques, and government initiatives, beekeeping can become a valuable livelihood source, a key contributor to economic development while supporting ecological balance and food security.

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