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Beekeeping: Sustainable Livelihood Option in Uttara Kannada, Central Western Ghats

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Beekeeping: Sustainable Livelihood Option in Uttara Kannada, Central Western Ghats

Summary

Beekeeping is a forest and agro-based industry, which is beyond the ordinary realms of industry, in the sense that the humans derive benefits from interaction between two living things like plants and bees without affecting adversely both. On the contrary plants, including many crops, prosper with the abundance of bees (as pollinating agents) and the bees, sheltered both by nature and humans provide mainly honey and other by-products like beeswax, bee-pollen, propolis and royal jelly. Bee-keeping, systematically adopted as a supplement to farming, can bring prosperity to the villages of Uttara Kannada, a district endowed with species rich forests and cultivation of a high diversity crops. Unlike intensive farming or fishing that can corrode the natural resource base, abundance of honey bees in a natural environment benefits both crops and wild plants.

Apis of family Apidae is the main genus of honey bee accounting for bulk of honey production, and the genus *Trigona*, also from the same family, is a minor producer of honey. Uttara Kannada has three species of *Apis* viz. *A. dorsata dorsata, A. cerana indica,* and *A. florea* and one species *Trigona* (*T. irridipennis*). In the recent times these bee populations suffered decline in the Western Ghats due to many factors, the major ones being poor management practices, epidemics such as Thai sacbrood, Nosema, and Foulbrood disease and pests like Varroa mites. Predator insects like wasp, wax-moth and some insectivorous birds like bee eaters, drongoes etc are minor causes affecting bee populations.

Beekeepers co-operative societies, formed under the Khadi and Village Industries Commission (KVIC) and the National Horticulture Mission (NHM) played crucial role in strengthening beekeeping activities in the district. Five beekeepers co-operative societies were established at Honavar, Kumta, Ankola, Sirsi-Yellapur and Siddapur of Uttara Kannada. In the current study the performance of beekeepers co-operative societies in the taluks of Ankola, Kumta, Honavar and Siddapur of Uttara Kannada was evaluated with regard to promotion of beekeeping and

honey procurement. The constraints for the growth of such societies are discussed. Honavar society had the highest number of members (992) in 2011, and Ankola society had the lowest (204). A glance through the growth in membership over the past 11 years of all these societies reveal only stunted growth. Although the potential of bee-keeping in Uttara Kannada, a well forested and horticulturally important district, is tremendous, the potential is hardly ever realized due to the lack of co-ordinated approach. Sirsi-Yellapur society had gone almost defunct compared to other societies. In a free market economy, with ever increasing demand for honey from local markets and cities, the bee-keeper's societies, instead of going redundant, can play important role in systematically nurturing bee-keeping through awareness creation and training programmes, foster the growth of bee forage plants and pave way for creation of employment for thousands of rural people.

Apart from studies on bee keeping made through the aforesaid society's primary data was collected from randomly selected 83 villages, through interviews with help of a questionnaire. Using the latter was collected the number of boxes the farmers kept, variability in honey production in relation to regions and climate, processing and marketing of honey and on important bee-forage plants. Problems and prospects of bee-keeping were also assessed. The study revealed that 105 bee-keepers whom we interviewed together owned 1453 bee boxes, at an average of 14 boxes each. The total honey production from the district, based on household surveys, amounted to 10,424 kg, during the year 2011, at a district average of 6.68 kg/per bee box. This figure does not include honey procurement by the societies, which is much lower, as most societies are not good performers and are passing through a waning phase. Average honey production/box ranged from 5.73 kg in Honavar, a coastal taluk, to 9.45 kg in Sirsi taluk of malnadu region. Of the other coastal taluks the average production of Kumta was 5.94 kg/box and that of Ankola was 6.72 kg/box. Siddapur and Yellapur in the malnadu had average production per box of 5.96 kg and 6.29 kg respectively. Even though we documented six apparent types of unifloral honey from Sirsi taluk (viz. from plants *Strobilanthes, Syzygium, Schleischera, Carallia brachiata, Sapindus, Glyricidia)* the consumers in general recognize only two types namely mixed honey and soapnut (*Sapindus*) honey. The demand for soapnut honey is high, despite its high prices ranging from Rs.700-1000/kg, due to its purported medicinal values, as compared to other honey, including mixed honey, where the prices range from Rs.150-300/kg.

The family sizes of bee-keepers in the study area ranged from 2 to 16 members at an average of 5.25 per family. Bee-keeping, evidently, was mostly a male dominated enterprise. Greater participation of female members is necessary to take better care of the economic and nutritional security of rural households. For attracting more people towards bee-keeping, an eco-friendly and high income generating rural enterprise, it is necessary to enrich the surroundings of villages with high nectar producing plants. Vacant lands, public premises, roadsides, estuaries and seashores should be enriched with suitable habitat-specific bee foraging plants. The genera like *Syzygium, Terminalia, Strobilanthes, Holigarna, Sapindus, Vateria, Lagerstroemia, Emblica, Dalbergia, Pongamia, Pterocarpus, Xylia, Strychnos, Careya, Vitex, Avicennia* etc. are some of the important foraging resources for honeybees in Uttara Kannada.

Chapter 1: Honey Bees and Apiculture

1.1. Insects for human welfare and environment

Insects as a group, with about 750,000 species described already, overwhelm all the other organisms on the earth constituting more than half of all living species (Primack, 1998; Steffan-Dewenter and Tscharntke, 2002). Their contributions to terrestrial ecosystems especially are immense as regards their diversity, life forms and in their roles as herbivores, pollinators, parasitoids and predators (Lasalle and Gauld, 1993). Terrestrial ecosystems would collapse but for the key ecosystem services like pollination and nutrient recycling rendered by the insect community (Ritchie and Olff, 1999). Most insects have heavy dependence on plant community for food and shelter, and in turn caused many plants to co-evolve to suit the needs of beneficial insects or to avoid damages from them through production of various defensive phytochemicals or other physical means such as increased hairiness on tender parts, thick cuticle, wax layers etc. Great majority of flowering plants, including agricultural crops are insect pollinated (Kevan, 1999). Among the insect community the honeybees render foremost service as pollinators. Native to the Old World, the honey bees were introduced into the Americas and Australia concurrent with European settlement. Honeybees constitute a group of social insects which are today widespread in the world in habitats that are suitable to them. Although honey continues to be an important product of honeybees, their most valuable service is pollination, the magnitude of which is yet underestimated by humans.

Apiculture (Latin *apis* = bee) is the study and practice of beekeeping. It is a forest and agro-based industry, which is beyond the ordinary realms of industry, in the sense that the humans derive benefits from interaction between two living things like plants and bees without affecting adversely both. Plants, including many crops, prosper and the bees flourish sheltered by humans, giving honey and different other products like beeswax, propolis and royal jelly are major by-products of beekeeping. Beeswax is used in carpentry, production of candles and cosmetics. Propolis is a substance made by bees from plant resin. It is used for cosmetics, medicine and food. Royal jelly is a nutrient rich substance from beehive. Bee keeping, though has roots in pre-

history, can play a very important role in uplifting the livelihoods of especially rural people in India while also benefiting the environment.

The quality and origin of the honey is a major factor in price setting. Whereas China supplies the lowest-priced honey, Argentina takes a middle position and honey from Mexico and Australia receives the highest prices. Light honey is more valued than darker ones because of the general preference for clear honey with a mild taste. Single floral honey is more valued than mixed origin honey. Honey infused with various flavours, such as of ginger, vanilla and cinnamon is becoming increasingly popular. The most common determinant of the flavour is the flora in the area where the beehives are kept (EPOPA 2006).

Majority of world production of honey is in the developing countries, barring USA among the developed countries, which are the largest consumers of honey. During the period 2002-2007, China, Turkey, Argentina, USA and Ukraine were the leading honey producers of the world accounting for 41.71% of the world production. Brazil, India, Tanzania, Ethiopia, Mexico, Kenya and Angola are other large producers of honey. Canada, Germany and Spain are large producers of honey from the developed countries, apart from USA. The largest honey exporters were Argentina, China, Mexico, Germany and Hungary, and largest importers were USA, Germany, Japan, the United Kingdom and France. The EU consumption of honey was around 305,000 tons in 2004- which was more than 20% of the world's honey production then. Of it 6,500 tons was organic honey. China's annual production of natural honey increased was 182,000 tons in 1995. It rose significantly to 298,000 tons in 2005, of which 201,090 tons was used domestically, by far the world's highest honey consumption by any country. China also produced 12,800 tons of beeswax, 1000 tons of pollen and 800 tons of royal jelly and is presently the biggest exporter of honey, beeswax and other bee products. The second and third largest producers Turkey and Argentina produced 82,000 and 80,000 tons, respectively during 2005 (EPOPA 2006; Michener, 2007; Denis et al., 2009).

Ranking seventh among the honey producing countries India has been exporting honey since 1991-1992. The quantity exported was around 8,000 tons until 1998, increasing substantially to 15,587 tons in 2009. India exports honey to approximately 62 countries, with Belgium,

Germany, Saudi Arabia, the United Kingdom, and the United States being the major purchasers (Sharma, et al., 2012). The major honey-producing Indian states are Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal. The average number of beehives in the world was estimated to be 72.52 million, of which India, China, Turkey, Ethiopia and Iran occupy the top five positions accounting for 40.69% of the hives. Despite having the credit of having largest number of bee hives in the world India ranks only seventh in honey production (Michener, 2007; Denis et al., 2009). A variety of factors may be responsible for this backwardness in Indian honey production in spite of having rich diversity of bees.

1.2. Global beekeeping scenario

Though honey has been used as food from time immemorial, prior to 1500 AD, there was not any notable development in the field, which was more a rustic exercise, hovering around little more than honey hunting, robbing it from established nests in nature. As early as 5000 BC, honey hunting was depicted in a rock painting at Cueva de las Aranas, Spain. The Philistines dabbled in beekeeping as did the ancient Egyptians, Greeks, Sumerians, and others. The worker honey bee of *Apis mellifera* was a symbol in ancient Egypt as early as 3100 BC. Although no written descriptions of bees or beekeeping are known from ancient Egypt, some depictions from excavations suggest that beekeeping methods reached a higher level there than elsewhere during the 2400–1400 BC period. The method used by traditional beekeepers in Upper Egypt today is not much different that depicted in 1450 BC. The same method was also transmitted westward along the North African coast and to Sicily, and some –but not all parts of it, reached Greece and Rome (Crane, 2004)

During 980 – 1037 A.D, Avicenna illustrated that 'king' of bees (probably referring to male bees?) were reared in extra large cells. Ibn-al- Awam (1100 A.D) stated that the smallest bees in the hive are females, which have a sting. Larger bees are males, which take no part in the preparation of honey. The 'kings' are twice as large as the bees that make honey, and Ibn-al-Awam knew that it was advantageous to the beekeeper to have only a small number of these in a hive. Even before the honeybee was introduced to the Americas, other kinds of bees were kept for honey and wax. The Inca and Maya of the New World cultured the stingless bees

(Meliponidae). There is a renaissance in this activity in the American tropics, but the term "beekeeping" has always been reserved for those managing the Old World western honey bee (*Apis mellifera*). From 1500 to 1851 (pre-modern beekeeping), knowledge about honey bees progressed significantly. The queen was discovered to be female in 1586. Drones were first identified to be males in 1609. Pollen was determined to be the male part of plants in 1750. Drones were shown to mate with the queen in 1792. In 1845 it was found that the drones parthenogenesis (origin without fertilization). The book *Bees and Apiculture* was first printed in Europe in 1459 AD. In Spain, volumes 2 and 5 of Gabriel Alonso de Herrera's (1513) compilation of writings on agriculture by earlier authors were devoted to writings on bees by ancient Greek and Romans (Crane, 2004)

After 1800 AD, with the increased availability of new scientific equipments and methods, studies on honeybees and their products increased rapidly. The modern beekeeping era began in 1851 when the Reverend L.L. Langstroth, considered as father of beekeepers in USA, realized significance of the "bee space," leading to the invention of the movable-frame hive. Major Hruschka produced an extractor in 1865. Moses Quinby invented the smoker in 1875 and published his first bee book in 1853. Comb honey production began with W.C. Harbison of California in 1857 (Ghosh, 1998). New bee foods, including high fructose corn syrup and the Beltsville Bee Diet were introduced in the 1970s. Honey became a world commodity in the 1980s.

During 1860, honeybee *Apis mellifera ligustica* was first introduced into the United States, and Frank Benton imported Cyprian and Tunisic stock in the 1870s. Many more introductions succeeded these first attempts. African honey bees (*Apis mellifera scutellata*) were brought to Brazil in 1957. *Varroa jacobsoni*, mite parasitic on *Apis mellifera*, (now known as *Varroa destructor*) was accidentally introduced into USA in the 1950's through its original Asiatic host *Apis cerana*. This mite had spread to all continents except Australia by the 1990s. The small hive beetle (*Aethina tumida*) was introduced from South Africa into the United States in 1998 (Capinera, 2008).

1.3. Beekeeping in India

Although information is scattered, the roots of organized beekeeping in India during the pre-Buddha period can be traced to the Hindu holy books. *Ramayana* described the existence of 'Madhuban' in Kishkinda maintained by King Sugriva. This Madhuban was maintained exclusively for rearing bees for honey. Bees were reared in hollowed logs open at one or both ends, broken gourds or earthen pots in many of our villages; but extraction of honey was by primitive method by squeezing the hive. This crude method does not yield pure honey, as it contains pollen, wax particles and extract of eggs, larvae and adult bees, and gets fermented soon (Ghosh, 1998). The early attempts for bee keeping on scientific lines in India using movable frame hives for *Apis cerana* were made in 1880 in Bengal and in 1883-84 in Punjab and Kullu Valley. However, these met with only little success. Foundations of modern beekeeping in South India were laid by Rev. Father Newton in 1890, at Shembaganur, near Kodaikanal, Tamilnadu, with the introduction of movable frame "Newton hive".

After independence the Government of India initiated rural developmental programmes with importance given to beekeeping, as an agro-based economic activity, providing employment and generating income, (*Wealth of India*, vol. 2, 1988). Swami Shambhavananda in the Coorg district of Karnataka, S.K. Kallapur and S.G. Shende in the Western Peninsula, and R.N. Muttoo in the Central Himalayan foothills pioneered establishment of beekeeping industries and initiated the rural population to adopt this income generating enterprise (Nair, 2003). All India Beekeeper Association was organized in 1938-1939. Beekeeping Research Station was established by the Indian Council of Agricultural research (ICAR) in Punjab in 1945. A second one was established at Coimbatore in Tamil Nadu, during 1951. Since 1950, ICAR has been funding various research projects on beekeeping. Thanks to the initiative of All-India Khadi and Village Industries Board in 1953 beekeeping captured the attention of rural masses. The Board paid considerable attention to the development of rural beekeeping programmes and management of beekeeping industry. This time witnessed beekeepers, bee hunters in the wild and part-time workers trying to keep bees in modern hives (Thakar, 1976). The programmes achieved only partial success as bee diseases and other problems that required practical training to cope up with curtailed the growth rates of bee-keeping. The National Commission on Agriculture has recommended the importance

of beekeeping industry in every village. Bee research was started in 1954 at Mahabaleshwar which later got reorganized as the Central Bee Research Institute (CBRI), with a broader scope of work, at Pune under the auspices of KVIC. These efforts strengthened the efficiency of native bees through improvement in bee forage, bee management and bee breeding through genetic selection and scientific processing of bee products. In 1980, ICAR started All India Coordinated Project (AICP) on Honey Bees Research and Training which at present has 8 centres throughout the country with administrative centre at Haryana Agricultural University Campus at Hisar in Haryana state (Sivaram, 2012)

1.4. Beekeeping in Karnataka

Beekeeping in Karnataka relied mainly on the Indian bee *Apis cerana indica* and the introduced bee, *Apis mellifera*. The introduced species constitutes only a minor portion of beekeeping in the southern part of state. The Western Ghats, clad in forests of varied kinds and other kinds of land uses, especially cultivation of a variety of horticultural crops, provides pollen and nectar sources almost round the year to both wild and domesticated bees, thereby providing rich opportunities for beekeeping. Before 1985 Karnataka dominated in honey production in India, producing 7, 50,000 kg of honey and about 6,000 kg of bees wax. The pollination activities of many crops by bees, obviously, increased the crop yields also. Thereafter the bee beekeeping industry suffered a collapse due to infection by "Thai sac brood" virus which made most people shy away from bee-keeping almost until 2000. The current century saw the Central and State Governments promoting beekeeping activities, resulting in beekeeping activities picking up especially in rural Karnataka.

Beekeeping industry is gaining increasing popularity in Uttara Kannada and is accepted as complementary activity to agriculture. *Apis cerana indica* is perhaps the only domesticated bee in this region as the introduced species such as *A. mellifera* were found to be not suitable, according to Dharmendra Hegde, of Kangod, Sirsi taluk, an ardent bee keeper. Central Western Ghats of the Uttara Kannada provides congenial environment for domestication of bees and organized beekeeping as nectar sources from wild plants are abundant. Some of the local communities of Uttara Kannada such as Siddis, Halakkivokkals, Krivokkaligas, Kunbis and

Kumri Marattis have special skills in wild honey collection that remained an enigma for most others. Before Indian independence, beekeeping practices were promoted though taluk level beekeepers cooperative societies. The first such society was started in Honavar taluk, of Uttara Kannada, in 1941. Five more such societies were established in the district, between 1945 and 1985. From 2004 -2005, the National Horticulture Mission encouraged beekeeping activities though "Suvarnabhoomi Yojana" programmes and also by giving subsidies for purchase of bee boxes. Many NGOs (Non-Government Organizations) involved in promoting village economy through a series of programmes also tried to popularize beekeeping along with poultry, cattle rearing, and dairying. For instance, Prakruthi Samsthe, of Sirsi taluk, selected about 20 villages and conducted practical training in beekeeping, along-with other such rural economy based activities (personal communication). LAMP Society of Yellapur is involved in educating and training of the Siddi community in wild honey collection and also providing marketing supports. Although beekeeping is picking up as an enterprise in Uttara Kannada, the public awareness on beekeeping, its significance to ecosystems and pollination services, especially for crop plants, are still lagging.

1.5. Honey: physico-chemical nature and uses

In Uttara Kannada four species of bees namely *Apis dorsata, A. cerana indica, A. florea* and *Trigona iridipennis* gather nectar from plants and prepare honey in wild. *A. cerana indica* and *Trigona iridipennis* are also domesticated by bee keepers and are the sources of 'box honey'. Both wild and domesticated bees gather nectar from plants and convert it into honey. This process involves combining nectar gathered from plants with specific kinds of secretions from the bees and dehydration of the ultimate product mainly through fanning by their wings so as to set up air currents. To produce 100 g of honey, a foraging bee must suck nectars from nearly a million flowers. The transformation of nectar into honey takes place within the cells of the comb. When the total soluble solids attain about 75% to 80% of the honey the bees cap each comb cell with a thin layer of wax secreted from their abdominal glands. When the hive is filled with honey, the bees are kept away by exposing them to controlled smoke and the combs are scraped off wax seals to collect honey.

The composition of honey depends on several factors like floral source, composition of nectar(s), climatic conditions, beekeeping practices and method of harvesting and processing. The nectars from different plants vary widely in the type and concentrations of their sugars. The total sugar content in the nectars varies from 20 to 40%. There are three patterns of sugar compositions found in the plant species such as high sucrose nectar, high glucose and fructose nectar and nectar with equal amounts of fructose, glucose and sucrose. For instance, the nectar of alfalfa has high sucrose while that of *Brassica* sp., has high concentration of glucose. *Trifolium* sp., contains more fructose than glucose whereas the nectars of legumes have equal proportions of the three sugars (Manjunath, 1999). Beyond sugars, honey contains numerous compounds such as organic acids, proteins, amino acids, minerals, polyphenols, vitamins and aromatics.

The physico-chemical composition of Indian honey has been studied extensively by several workers (Singh and Bath, 1997; Manjunath, 1999; Joshi, et al., 2000; Bogdanov, et al., 2008: Basavarajappa, et al., 2010; Kaur, et al., 2010). Balasubramanyam, (2011) studied important chemical parameters of honey samples of three different bee species from Uttara Kannada (Table: 1.1). Nanda et al. (2003) studied the physico-chemical properties and estimated the mineral content of honey collected from different parts of northern India. Similarly mineral variations of honey from different districts of Western Ghats, in Karnataka were studied by Balasubramanyam and Reddy (2011). Joshi et al. (1998) have made mellito-palynological investigations on *Apis* and *Trigona* honey collected in and around Pune.

Table 1.1: Chemical characteristics of honey[1] from Uttara Kannada district.

(Source: Balasubramanyam, 2011**)**

Sn	Parameters	*A.dorsata*	*A.cerana*	*A.florea*	F-ratio
1	Moisture (%)	21.45	20.87	18.64	7.10*
2	Total reducing sugar (%)	76.69	73.65	73.22	5.96*
3	Laevulose (%)	40.15	39.75	39.01	3.14**
4	Dextrose (%)	36.54	33.90	34.21	1.72**
5	L/D ratio	1.098	1.17	1.14	0.145+
6	Non reducing sugar (%)	3.85	2.70	3.08	1.05**
7	Ash (%)	1.49	1.22	1.12	0.732**
8	Acidity (%)	0.503	0.418	0.371	0.012+
9	pH	4.85	4.01	3.73	0.621**

(1= Sample size (39), * Significant at $p<0.01$, **Significant at $p<0.05$, +Non-significant at $p<0.01$)

1.5.2. Uses of honey:

Honey is a remedy for many common ailments. In Indian Ayurvedic system of medicine, honey has special importance and also recommended along with breakfast because of its richness in simple sugars (glucose, fructose etc.). These essential sugars are absorbed rapidly in the system. Also, honey contains high quantity of fructose which is insulin independent. Honey has been found to contain enzymes (glucose oxidase, catalase), many amino acids (ascorbic acid, flavonoids, phenolic acids and organic acids), carotenoid derivatives and proteins (Gheldof, et al., 2002). It inhibits the growth of micro-organisms like bacteria, fungi and virus. The antimicrobial effect of honey is due to hydrogen peroxide content; other factors, such as acidity, osmolarity, potentiation by metal ions, ascorbic acid, and non-peroxide factor are also contributing to its antimicrobial action. Honey as such is not bactericidal but bacteriostatic. It inhibits growth of many pathogenic bacteria like *Bacillus anthracis, Corynebacterium diphtheriae, Escherichia coli, Mycobacterium tuberculosis, Salmonella sp., Proteus sp., Vibrio cholerae* and many other pathogens (Molan, 1992; *Wealth of India*, 2004; Bogdanov, et al 2008). If bacteriostasis prolongs for a particular period the bacterium loses its capacity to recover. Gram

positive strains are first affected in 3-24 hours followed by gram negative strains which take up to 48 hrs.

Honey has property of inhibiting mutagenic substances (Trp- p-1) and regulates the mutations of the genetic materials. The anti-mutagenic activity of honeys from seven different floral sources (acacia, buckwheat, fireweed, soybean, tupelo and Christmas berry) against Trp-p-1 was tested by the Ames assay and compared to a sugar analogue as well as to individually tested simple sugars (Wang, et al., 2002).

The reduction of inflammation could be due to the antibacterial effect of honey or to a direct anti-inflammatory effect. Nearly all type of wound healing is attributed to honey therapy. Application of honey as wound dressing leads to stimulation of healing process and rapidly clears the infection. Honey has cleansing action of wounds, stimulates tissue regeneration, reduces inflammation and honey impregnated pads act as non adhesive tissue dressing. It has been used for the treatment of various ophthalmological conditions like lepharitis, keratitis, conjunctivitis, corneal injuries and chemical and thermal burns to eyes (Bansal, et al., 2005). Honey compared with dextrose caused a significantly lower rise in plasma glucose levels in diabetic subjects. It also caused reduction of blood lipids, homocysteine levels and CRP (C reactive protein) levels in normal and hyperlipidemic subjects. Hence, the honey plays important role in regulating body metabolism, increase immunity, balance the nutrient components and control diseases. Honey contains antioxidant components like hydrogen peroxide and non peroxide which inhibit growth of *Shigella*, *Listeria monocytogenes*, and *Staphylococcus aureus* helping in food preservation (Jeffrey and Echazarreta, 1996; Bansal, et al., 2005; Bogdonov, 2008, 2009).

1.6. Other products from beekeeping

Although beekeeping provides a number of valuable products apart from honey and wax, unfortunately, the Uttara Kannada farmers are unaware or negligent of the by-products, of which a brief account is given here.

- ***Bee wax*:** the young worker bees possess wax glands on the ventral surface of the abdomen from which is secreted wax which on contact with the air gets hardened. Bee wax consists of fatty acids, esters, alcohols, carbonyls and hydrocarbons. The wax is used by the bees to construct honeycomb cells, in which their young are raised. After removal of honey from the honeycomb, the wax is purified and used for many products, particularly for making candles, furniture polish, shoe polish, lubricants, and for treating skin ailments (Ghosh, 1998; Fujiyoshi and Nakamura, 2009; Capinera, 2008; Wealth of India, 2004; Hepburn and Radloff, 2011).

- ***Bee-pollen*:** Beekeepers install pollen collectors in front of hive entrances so that pollens can be collected by causing the pollens to be scraped off the hind legs when honey bees pass through holes only large enough to let them manage to get through. Pollens as they are moist and get infested with fungi, have to be dried immediately after collection. Pollen from bee hives is marketed as such for preparation of especially cosmetic and pharmaceutical products (Fujiyoshi and Nakamura, 2009; Wealth of India, 2004).

- ***Royal jelly or bee milk*:** This highly viscous secretion of the pharyngeal glands of the worker bees is used for feeding the larvae. It contains phenols, bee-wax, sterols, fatty acid, uronic acid, reducing sugars, proteins and vitamins, making up a highly nutritious food with well balanced contents of all nutrients, unlike honey consisting mainly of carbohydrates. In this regard, royal jelly can be used in disorders associated with old age. It is used for improvement of appetite, gain in body weight, reducing mental tension and to regulate blood pressure. It is added to cosmetic products as an ingredient having moisturizing effects (Wealth of India, 1998; Phadke, 2008; Fujiyoshi and Nakamura, 2009).

- ***Bee-venom*:** Honey bees possess a venomous sting and use it as the only arm against enemies. Venom contains amines like histamine, enzymes like melitin and phospholipase, and apamine as a nerve toxin. It is well known for its curative and medicinal properties, and possesses immunogenic properties; the dose prescribed should,

however, be many times lower than the toxic or lethal one (Wealth of India, 1998; Phadke, 2008; Fujiyoshi and Nakamura, 2009).

- ***Propolis or Bee-glue*:** Propolis is a mixture of resinous substance, balsam, wax and non-volatile components, prepared by worker bees from plants and their own grandular secretion. It is used to protect the colony from insects, moulds and other infections particularly during winter and early spring. It contains flavonoids and other essential elements like Ca, Cu, Fe, Mg, Mn, Ni, and Zn. It has uses for treating skin ailments in form ointments, and as lozenges for the inflammation of throat. It is used as a household remedy for wound and burns, and as a base of some antiseptic preparations used in the treatment of surgical cases (Wealth of India, 2004 and Phadke, 2008).

1.7. Pollination services

In agriculture, it is widely held that, maximum crop yield can be obtained by a combination of factors, mainly through 1: **agronomic inputs** using good quality seeds and planting material, and good practices such as good irrigation, manure and fertilizers and pesticides and 2: use of **biotechnological methods**, such as manipulating rate of photosynthesis and biological nitrogen fixation, etc. Despite using both these crop production at some stage reaches stagnation. The third and relatively less known method of enhancing crop productivity is through **managing pollination** of crops using friendly insects, which in the process of searching for food (mainly nectar and pollen) pollinate flowers and render invaluable service to agriculture. The Convention on Biological Diversity (CBD) has recognized pollination as a key driver in the maintenance of biodiversity and ecosystem function (Partap and Partap, 1997).

Unfortunately the enormous benefits that the humans reap from the silent services of honeybees towards crop productivity and to national income get only lesser attention and low priority, in spite of the fact that it needs low capital, it is non-polluting, needs less labour and is complementary to farming and forest ecosystems. The beekeeping industry is rarely put forth as a Key-Factor (Input) in agricultural production. Bees are the most effective pollinators of crops and natural flora and are reported to pollinate over 70 percent of the world's cultivated crops.

About 15 percent of the hundred principal crops are reportedly pollinated by domestic bees, including honey bees, and at least 80% are pollinated wild bees (Kenmore and Krell, 1998).

Honeybees and flowering plants are interdependent for their life cycle. In other words, apiculture and agriculture/horticulture are interdependent and cannot develop in isolation. Integration of apiculture and agriculture is necessary for mutual benefits of both beekeeper and the farmer. Warnings have been, however, sounded by environmentalists and scientists that excessive use of insecticides, monoculture, pollution etc., causing depletion of useful pollinating insects, are threatening to reduce our food production by 1/3 (Phadke, 2008). Bees, among other insects, are more effective pollinators than other insects because, because they are social and collect nectar and pollen for their own needs as well as to feed their young. Their body hairs help transfer pollen from flower to flower; they show flower constancy and move from one flower to another of the same species; and many species can be reared and managed for pollination (Partap and Partap, 1997). Research has shown that pollination by honeybees increases fruit set, enhances fruit quality and reduces fruit drop in apple (Dulta and Verma, 1987). Among different species of honeybees, the hive-kept species (*Apis cerana* and *Apis mellifera*) are of special value because they can be managed for pollination and moved to fields/orchards where and when necessary for pollination. Some of the estimates showing the value of honeybee pollination to crop production are given in the Tables 1.2. & 1.3.

Table 1.2: Estimates showing the value of honeybee pollination to crop production per year

Country	Value of honey bee pollination (in US $)	Reference
US	14.6 billion	Morse and Calderone, 2000
Canada	1.2 billion (Can$)	Winston and Scott, 1984
EEC	3 billion	Williams, 1992
New Zealand	2.3 billion	Matheson and Schrader, 1987
20 Mediterranean countries	5.2 billion	Cadoret (1992)
Developing countries	3.2 billion	Cadoret (1992)

Table 1.3: Impact of honeybee (*Apis cerana*) pollination on fruit productivity

Crop	Increase in fruit set (%)	Increase in fruit weight (%)	Increase in fruit size (length, diameter) (%)	References
Apple	10	33	15, 10	Verma and Dulta, 1998
Peach	22	44	29, 23	Partap et al., 2000
Plum	13	39	11, 14	Partap et al., 2000
Citrus	24	35	9, 35 premature fruit drop decreased by 46%, increased juice by 68% and sugar contents in juice by 39%	Partap, 2000
Strawberry	112	48	Misshapen fruits decreased by 50%	Partap, 2000

Source: FAO bee keeping.htm

1.8. Crisis in pollination

Pollinator populations and diversity have declined worldwide in the recent years mainly due to the following reasons (Verma and Partap, 1993; Partap and Partap, 1997; Partap and Partap, 2002; Chandrasekaran, et al., 2011).

- Decline in the habitat, with the accompanying decrease in their food (nectar and pollen) supplies as a result of decline in pristine areas
- Land use changes due to deforestation, extend agricultural land, urbanization, and industrialization.
- Increase in monoculture-dominated agriculture; earlier, farmers used to grow a variety of crops, which bloomed during different months of the year and provided food and shelter for a number of natural insect pollinators
- Negative impacts of modern agricultural interventions, e.g. use of chemical fertilizers and pesticides. Mono-cropping also requires increased pesticide use which led to the killing of many pollinators due to pesticides.
- Proper disposable of waste, especially paper cups for tea and soft drinks can act as sticky death traps of bees.

- Infestation by diseases and predators.

The decline in pollinator population and diversity presents a serious threat to agricultural production and conservation and maintenance of biodiversity in many parts of the world. In the Himalayan region, decline in natural insect pollinators, especially bees which are the most effective pollinators of crops and natural flora, reported to be pollinating over 70 percent of the world's cultivated crops, has been reported. About 15 percent of the hundred principal crops are reportedly pollinated by domestic bees, including honey bees, and at least 80% are pollinated by wild bees (Kenmore and Krell, 1998).

In the Himachal Pradesh, northern Pakistan and parts of China where despite all agronomic inputs, production and quality of fruit crops, such as apples, almonds, cherries and pears, were reported to be on the decline. Extreme negative impact of declining pollinator populations was seen in northern Pakistan where both farmers and institutions had failed to understand the importance of managed pollination. Disappointed with the very low yields and quality of apples as a result of poor pollination several farmers in Azad Jammu and Kashmir of Pakistan are reported to have chopped off their apple trees (Partap, 2001).

Many varieties of cash crops are partially or completely self-incompatible and cannot produce fruit or seed without cross-pollination of their flowers. Moreover, it is not only self-incompatible varieties that benefit from cross-pollination, but self-fertile varieties also produce better quality fruit and seeds if they are cross pollinated (Free, 1993). While other agronomic inputs, such as the use of manure, fertilizers, pesticides and irrigation are important, without cross-pollination desired crop yield and quality of harvest cannot be achieved.

1.9. Renting bees for pollination services

US farmers are reported to have taken beehives on rent (at $150 per hive) from honey producers. These hives are used to assist in the agricultural production to fertilise flowers in order to increase the output of other agricultural commodities (EPOPA 2006). Although some farmers in Uttara Kannada are aware of the pollination benefits from honey bees, they rear the bees mainly for honey, with isolated exceptions (see Box)

REAPING POLLINATION BENEFITS FROM BEES

Bhargav Hedge of Sihgehalli, an obscure village in Sirsi taluk of Uttara Kannada is careful about maintaining honey bee colonies in his house and gardens, primarily for pollination and not for honey. He proudly states because of bees *Apis cerana* and *Trigona iridipennis* the output and quality of betelnut, coconut, guava, jackfruit and sapota crops are higher. He takes special care of the tiny *Trigona* bees as he believes this bee can enter easily small flowered plants which *A. cerana* and wild bees from the jungle around find difficult (Plate 1.1 and 1.2).

Plate 1.1: Stingless bee (*Trigona iridipennis*) reared in wooden boxes and logs by Bhargav Hegde

Plate 1.2: *Trigona iridipennis* rearing on small wooden boxes and aluminum vessel

1.10. Need for promoting bee keeping in Uttara Kannada

Bee-keeping can be developed into one of the best developmental options for Uttara Kannada, as a major productive and employment sector next only to farming and fishing, but with favourable impact on environment and productivity, unlike intensive farming or fishing. More of apiculture better it is for environment due to following reasons:

1. Honey production does not require ownership of land and is ideal for employment generation, in rural Uttara Kannada, a wooded district dotted with farmlands producing fruits and spices, betel-nut and coconuts. The bee keepers, if they require, should be permitted to keep their bee boxes in the peripheral areas of forests, in areas designated by the forest department, so that the under tapped honey resources of the vast forest areas could be gathered without any damage to forests. On the other hand presence of more bees will promote pollination and fruit setting in the forest plants.
2. Rural economic activities will get elevated as such places turn into centres of honey production, purification and marketing. Such activities would be a deterrent for current trends in large-scale emigration to the cities.
3. The products like honey, beeswax and propolis are not perishable and can be stored for long periods and even exported.
4. It is ideal for generating employment for women and self-help groups.
5. The technology required bee-keeping is minimal and can be practiced with ease even by educationally backward segments of the society. No foreign technology is involved here and the equipments used are of low cost nature.
6. Transportation of honey is fairly cheap for unit volume unlike most other agricultural products, and being not perishable the transit need not be rapid and of high cost.
7. Bee keeping ideally practiced will dissuade locals from destructive collection of wild honey, so that bulk of the wild bees can be spared for performing the vital ecosystem services
8. All the necessary inputs are locally available and input required is very low compared to most other enterprises. Production cost of honey is very low compared to other farming activities or cattle keeping. Bulk of the nectar and pollen from a great variety of plants in

Uttara Kannada, predominantly a forested cum horticultural district, goes waste, or underutilized as the practice of be keeping is minimal as compared to the vegetational richness.

9. Being a tropical landscape the need for off-season feeding of honey bees can be minimized as a great variety of plants produce flowers during different times.
10. It supports agricultural activities through facilitating critical processes like cross pollination thereby enhancing food production.
11. Bee colonies can be transported from place to place to make best use of flowering by wild plants and crops at different times.
12. Dry areas with large water tanks/ponds covered with lotus can be made centres of producing lotus honey which is highly priced mono-floral honey.
13. Beekeepers do not burden on natural resources; there is no slashing and burning of forests for creation of grasslands or crop fields; digging up of soil or lopping of trees for manure are not needed for bee-keeping; there is no forest burning to create grasslands. Instead bee keeping helps to improve the ecology and food production through cross pollination.
14. Promotion of bee keeping in low rainfall areas like Mundgod in Uttara Kannada, through some special attention paid to the vegetational composition can be a great insurance against the unpredictability in rainfall.
15. Honey itself makes good nourishment, being rich in various nutrients and is used both in traditional medicine and in modern pharmaceuticals. Regular intake of pure honey is believed to increase immunity in humans.
16. It facilitates healthy linkages between biodiversity (insects and plants) towards sustainable livelihoods.
17. Bees are prey for a variety of insects, mammalian and bird predators thereby making themselves important links in the trophic networks operating in ecosystems.

Chapter 2 - Honeybees: Biology and Diversity

2.1. Organized society

Honeybees are social insects living in highly organized colonies with well defined roles. The bee colony functions like a single organism because of interdependence among the different 'castes'. A worker bee cannot reproduce; a queen bee cannot construct comb, collect food or even feed herself, her main role being propagation through laying eggs. The drone bee is able to accomplish only one task and that is to mate. All three castes, the queen, the worker and the drone, therefore can live only as part of a colony. The colony is in effect the organism, with the individual bees acting as the cells that make up that organism. The workers build combs of hexagonal cells having three main sections- the lowest or bottom section containing eggs, larvae and pupae, collectively termed the brood; the middle one used for storing pollen; and the upper section for the storage of honey (Wealth of India, 1988).

2.1.1. The worker

The worker bee (Plate 2.1) is an infertile female; she carries out various tasks inside and outside the hive. Young workers are called as **house bees**. Among the house bees are the **store-keepers** who receive the materials brought by the outdoor workers and store these properly in the cells. The **builders** construct wax cells, the **repairers** plug crevices between the cells, the **cleaners** remove dead and waste materials, the **fanners** ventilate the hive by beating their wings and the **guards** defend the colony with help of a sting. The older workers visiting fields are called as **field workers**; they gather and bring nectar, pollen, resin and water to the hive. Lifespan of worker bees varies according to the time of the year. During summer, the average lifespan is 15–38 days; in winter it can be 140 days or more, probably t environmental factors playing a decisive role. The colony may contain many thousands of workers – perhaps 60,000– 80,000 or more in a good colony. Worker bees start off with the potential to be queens, but diet change causes them to veer from this course and they fail to develop as queens.

Plate 2.1: Worker bees of *Apis cerana indica*

2.1.2. Drone

The drone is a male bee and it is only meant to mate with the queen bee (Plate 2.2). He is stingless and the workers have to feed him. In times of lack of food, drones are often ejected from the hive by workers. They are in size bigger than the workers and usually number a few hundred in a colony.

Plate 2.2: A drone bee of *Apis cerana indica*

2.1.3. Queen

The queen bee is a fertile female (Plate 2.3). Her sole duty is to mates with drones, and stores the sperm and lay fertilized eggs. She is fed on a special diet called as royal jelly and is perpetually waited upon by the workers; she can lays up to 2,000 eggs a day. She has a sting which she uses only to fight rival queens (Cramp, 2008; Seeley, 1995).

Plate 2.3: A queen bee of *Apis cerana indica*

2.2. External morphology

A worker bee is 11 to 15mm long and black or brown in colour, body is densely covered with hair bearing short lateral barbs, which entangle pollen grains easily (figure 2.1). The body, as in any other insect, consists of three main parts namely **head**, **thorax** and **abdomen**. The head is attached to the thorax by a flexible neck and the thorax to the abdomen by slender waist. Head has a pair of large and ovate **compound eyes** bearing un-branched hairs and placed dorso-laterally**.** The **olfactory pits** on the head provide the bee with a keen sense of smell. The mouth parts project from the lower narrow end and are of chewing–lapping type. A pair of **mandibles** is modified for manipulating wax and pollen. **Maxillae** and **labium** are modified into a long tubular **proboscis** for sucking nectar. The thorax has three pairs of legs and two pairs of wings. The abdomen has a **honey sac** in front and a **poison sac** with a **sting** towards the rear.

The **Queen** is 15 to 20 mm long. It has elongated tapering abdomen, short legs, small wings, short mouth parts and short sting. It lacks wax glands and pollen collecting apparatus. A **drone** is 15-17 mm. long, it has a robust body, very large eyes, powerful wings and truncate abdomen. It lacks wax glands, pollen-collecting apparatus and sting. Its proboscis is not long enough to get nectar. Hence it is fed by workers (Dhami and Dhami, 1990; David, 2010).

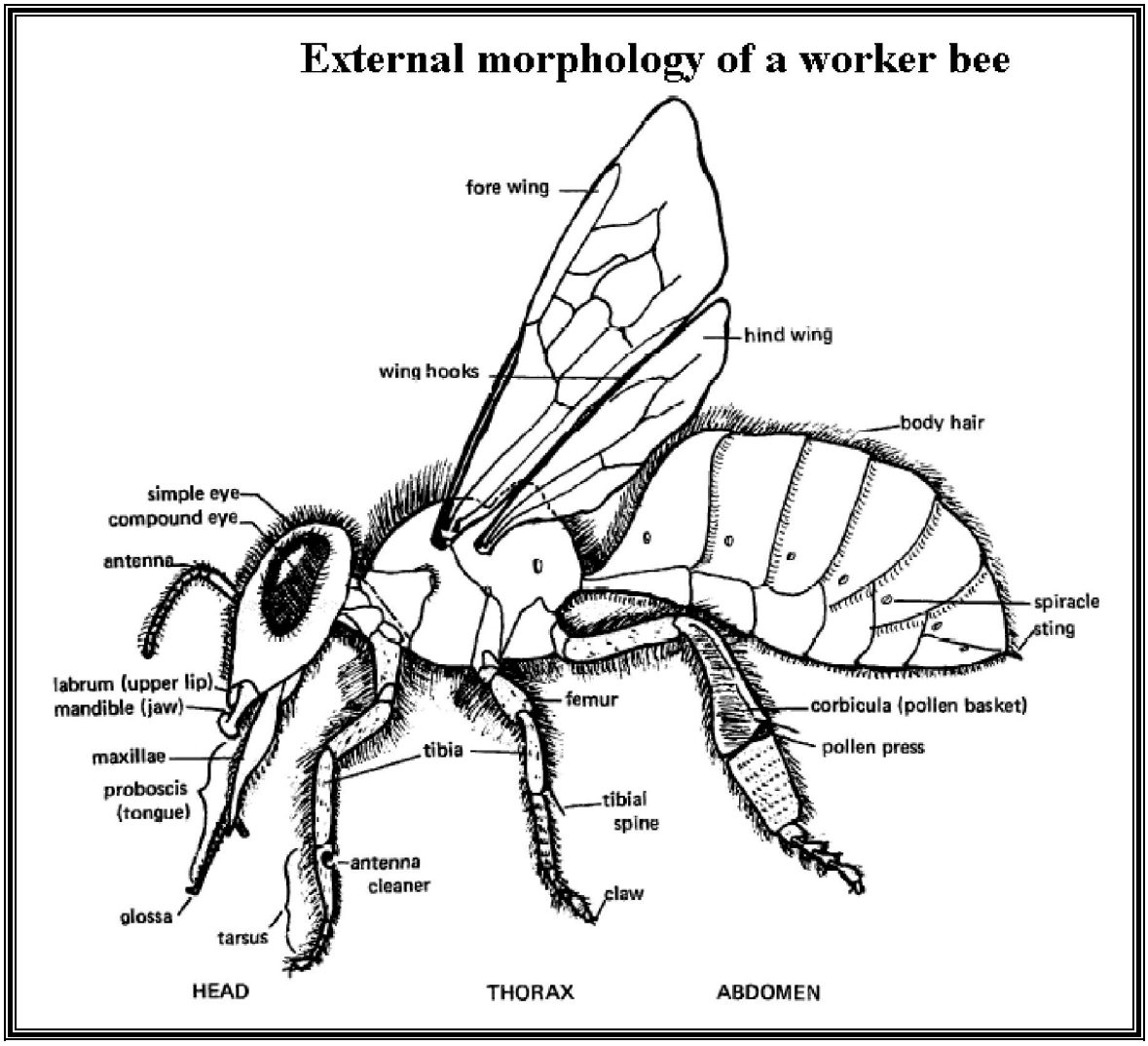


Figure 2.1: External morphology of a worker bee. (Source: Sammatara, and Alphones, 1978)

2.3. Developmental stages (Life cycle)

Life history stages and their duration for *Apis cerana* are given in the figures 2.2 and 2.3. Each type of bee begins life as a small **egg** laid by the queen in the base of a wax cell in the comb. After three days, the egg hatches into a **larva** in the open cell. The young worker bees feed it with **royal jelly** for the first three days and then on a mixture of pollen and honey (unless they are destined to be a queen bee, when royal jelly will be fed continuously). After another five days, (six for a drone bee), the workers cap the cell, and the larva spin a cocoon around itself and begins its **pupal stage** during which it gradually changes into an adult bee. The bee then chews through the capping of wax and emerges as an adult. Capped drone cells are usually in a cluster along the top part of a frame. These areas of drone cells are easy to spot as the cells are larger and of domed shape. A drone will emerge 24 days after the queen has laid the egg. Queens in their larger sized cells develop more quickly taking just 16 days overall and the beekeepers need to keep a special eye on queen cells to prevent the colony swarming (Cramp, 2008; Ghosh, 1998)

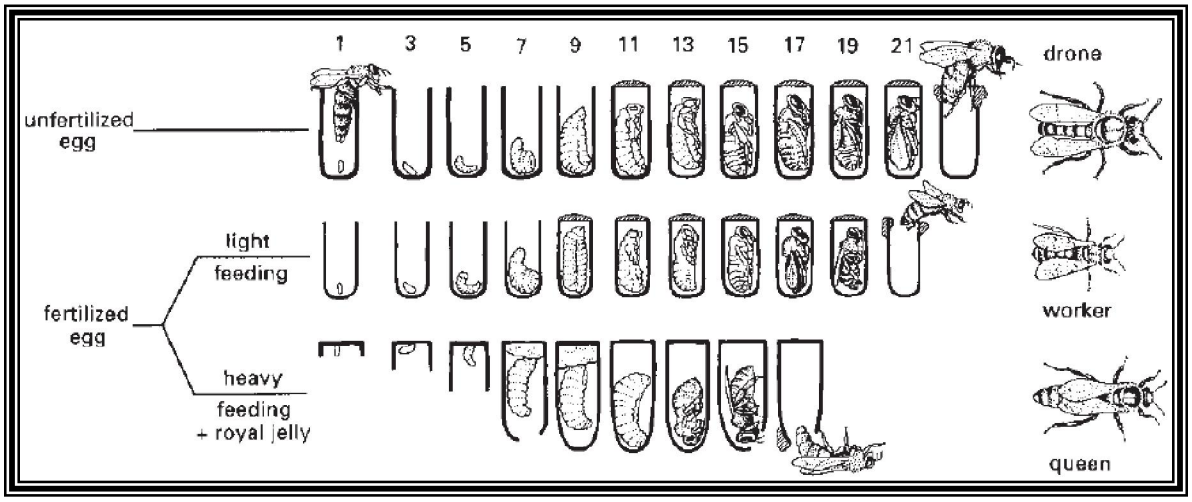


Figure 2.2: Duration of developmental stages of honeybees. (Source: Gullan and Cranston, 2010)

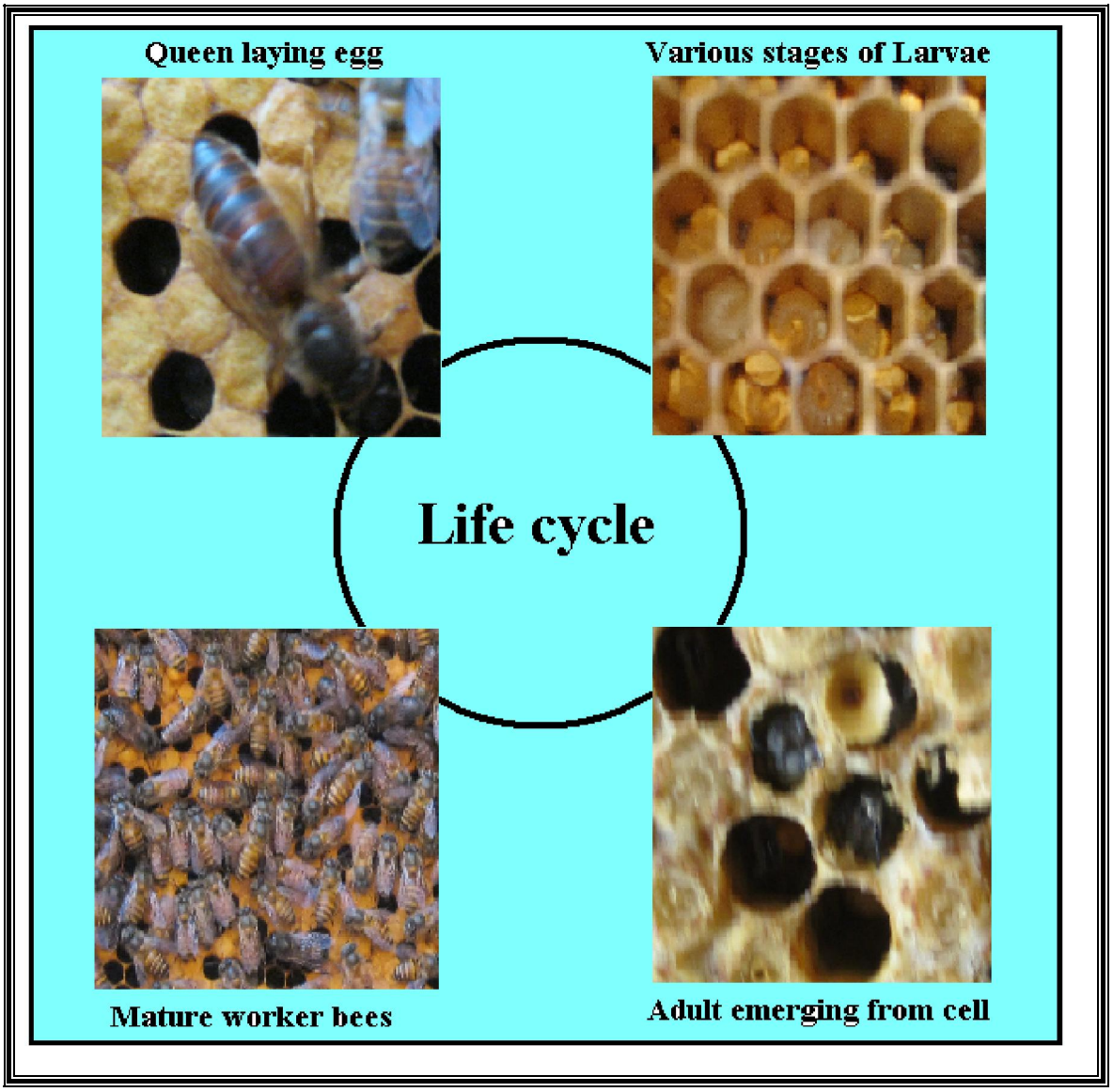


Figure 2.3: Life cycle pattern of *Apis cerana indica*

2.4. Diversity of honeybees in Uttara Kannada

Michener (2007) reported 17, 533 species of bees, grouped under 443 genera and seven families. Of these, 633 species in 60 genera and six families were reported from India (Gupta, 2003). The dominant honey producing bees belong to the genus ***Apis*****,** under the family **Apidae**. *Apis* is represented by five species in India. Among them four are native species *viz.* a) ***Apis dorsata*** (rock bee or giant bee), b) ***Apis cerana*** (Indian bee), c) ***Apis florea*** (little bee) and ***Apis andreniformis. Apis mellifera*** (European bee)*,* is an introduced species. In Uttara Kannada, three species of *Apis* sp. and one ***Trigona*** sp. are found.

2.4.1. ***Apis cerana*** (Kan: *Thuduve-Jenu*): Ruttner (1988) classified *Apis cerana* into subspecies based on the living habitats and genetical diversity; of these *Apis cerana indica* and *Apis cerana cerana* occur in India. In Karnataka, the subspecies *Apis cerana indica* is recognized into two morpho-types like 'hills bee' (black coloured) and plains bee (yellow coloured). The hill bee is distributed in the Western Ghat districts of Uttara Kannada, Udupi, Dakshina Kannada, Kodagu, Hassan, Chikmagalar, Shimoga and in parts of Dharwad, Belgaum, Mysore and Chamarajanagar (Plate:2.4). The plain bee is restricted to Haveri, Chitradurga and parts of Dharwad districts. The two colour morphs live in different habitats with varied temperature and rainfall. **Balck morph** is seen in moderate to high rainfall areas with moderate temperature, while the **yellow morph** is seen in areas with low rainfall and high temperature situation. Currently, the beekeepers prefer to rear plain bees because of their ability to withstand higher temperature and scarcity of food sources, a situation increasingly being felt in the district. *Apis cerana,* the Indian bee is medium sized, yellowish brown and comparatively quiet in nature. The radial cell of the forewing on the basal portion and apical portions have lengths 1.2 mm and 1.8 mm respectively. The length of labial palp is 1.8 mm.

Habitats: They are found in dry, shadowy and dark places viz. holes of old trees or dead trees, earthen pots, sunshade of buildings etc.; occasionally it also occurs in holes in the earth or in termite mounds. These bees are very suitable for apiculture by growing them in movable frames.

Habits and ecology: It is easier to domesticate *Apis cerana* because it is not as nomadic in habit unlike *A. dorsata* and *A. florae.* Stinging nature is medium but could be higher in swarming period. They build seven to eight **parallel combs** in a colony. The spaces between the combs are

double of their body size. Top of the comb, known as **honey comb** is meant for storing honey and pollen while the bottom where the queen lays egg to brood the new bees, is known as **brood comb**. These bees do not normally attack unless provoked. A colony produces 5 -15 kg honey/year. The honey is considered superior compared to other honey sources. These bees are good gatherers of honey and pollen. While collecting honey and pollen they also pollinate. This is the most widely domesticated bee in India. Being not migratory its domestication is easier.

Distribution: *Apis cerana indica* occurs across the plains of Central and Southern India, Sri Lanka, Bangladesh, Burma, Malaysia, Indonesia and the Philippines as a uniform population in this subcontinent. But in the higher altitudes of North India it is replaced by *A. cerana cerana*.

Black varieties of *A. cerana indica*

Yellow varieties of *A. cerana indica*

Plate 2.4: Black and Yellow varieties of *Apis cerana indica*

2.4.2. *Apis florea* (Kan: *Kolu-Jenu*): It is commonly called as Dwarf bee or Little bee, which is distributed throughout India from the eastern regions of the Arabian Peninsula, through southern Iran and Iraq to Pakistan and India as far north as the Himalayas (Plate:2.5). Large quantity of honey from *A. florae* is harvested from the Kutch area of Gujarat (Soman and Chawda, 1996). The quantity collected elsewhere is less and mostly consumed by the collectors themselves. The combs are single and similar to that of *Apis dorsata* in structure. The average body length and

height are 6mm and 3mm respectively. It has white stripes on the brown abdomen. In the drones (males), the "thumb" of the bifurcated basal-tarsus of the hind leg is much longer.

Habitats: *Apis florea* prefer to construct its hive on small branches from the tree trunk, in bamboo groves, forming colonies encircling the branches. A colony consists of only a single comb.

Habits and ecology: *A. florea* is more of a crop pollinator than a honey producer. It migrates very frequently between plains and adjacent low hills, depending on seasonal variations in forage availability.

Plate 2.5: *Apis florea* (source; Anita et al., 2009)

2.4.3. *Apis dorsata* (Kan: Kadu jen, Hej-jen): *Apis dorsata,* is commonly referred to as the "Rock bee," or "Giant honey bee" owing to its large body size. It is represented by three subspecies in India viz *Apis dorsata dorsata*, *Apis dorsata laboriosa* and *Apis dorsata bighami*. *A. d. laboriosa,* the giant Himalayan honey bee, is confined to the high altitudes (range 2,500 and 4,000 m) in the northern region. *A. d. bighami* is distributed in restricted areas of the North-East namely in Khasia hills, Sikkim and Meghalaya. (Roubik et al., 1985; Allen 1995; Otis 1996;

Thapa et al. 2001). *A. d. dorsata*, which constitutes the Karnataka subspecies, occurs at lower altitudes ranging from 0 to 1,500 m (Plate: 2.6). It is distributed from India to the east to the coast of Vietnam and into the Southeast Asian islands.

The combs of this species measure 1.5 to 2.1 m from side to side and 0.6 to 1.2 m from top to bottom. They produce good lot of wax and honey, and are migratory in nature. They are very ferocious bees and their stings are painful. These are not normally good for domestication. In Uttara Kannada spectacular development of this bee is seen in Yana rocks of Kumta and specially on the crown branches of the very large sized *Tetrameles nudiflora* trees (Plate: 2.8).

Habit: *Apis dorsata* have a well organized mass defense reaction. An intruder once marked by the odour or specific pheromone is chased for kilometers and stung. They are seasonally nomadic migrating to locations about 100-200 km distant every year. The timing of migration is correlated with the change in the season (rainy to dry period).

Apis dorsata* foraging on *Vitex negundo	***Apis dorsata* foraging on *Justicia simplex***
	

Plate 2.6: *Apis dorsata* foraging on *Vitex negundo* and *Justicia simplex*

Plate 2.7: *Apis dorsata* comb collected from forest for wax extraction

Plate 2.8: *Apis dorsata* hives on *Tetrameles nudiflora*

2.4.4. *Trigona iridepennis* (Kan: Misri Jenu; Eng: Dammer bee**):** Stingless or dammer bees are of smallest size compared to other honey-yielding bees. They belong to the family Apidae and sub family Meliponinae. It consists of two genera Melipona and Trigona. Meliponinae includes 8 genera, having 15 sub genera and more than 500 species (Wille, 1983). They bite for defense; their abundance in a colony range from hundred to thousands or more (Michener, 2000). *Trigona* is the largest group and most widely distributed from Southern Asia to Australia (Plate: 2.9). These colonies are entirely different from other honey bees of the genus *Apis*. They construct numerous elliptical cells for storing pollen and honey by using a special material made of wax and resin. Their domestication is easier but honey production is less. The honey is reputed to be of high medicinal valuable compared to *Apis* honey. Queen is distinguished from the worker by her larger size, mean body length of workers and queen measuring 4.07 and 10.07 mm respectively. Queen is golden brown in colour and has a pointed abdomen. The workers are black pigmented and with pale yellow. Mandibles in workers are smaller than that of the queen. The queen does not have pollen gathering baskets in her legs.

Habits & Habitats: Dammer bees gather plant resins (*propolis*) and use it together with wax, to construct their nest. The nests are built in trunks of trees, logs, wall crevices or under the roofs of dwellings. In the nest, there is a group of separate cells for brood rearing and another group of larger "sacs" for storage of pollen and honey. The dark and bitter honey is valued for its medicinal properties.

Plate 2.9: *Trigona iridepennis.*

2.5. Key to the Uttara Kannada honey bees (based on Engel, 2002)

5. Hind wing of jugal lobe is present; meta-tibial spurs and outer grooves of mandible are absent; arolia present..... 2
- Hind wing of jugal lobe is absent; meta-tibial spurs and outer grooves of mandible are present; arolia absent or reduced (Bumble bees; genus *Bombus*)..... Bombini
6. Forewing with reduced distal wing venation, marginal cell frequently open at apex; claws simple; penicillum present in worker; auricle absent; sting reduced (Stingless bees; numerous genera)..... Meliponini……6
- Forewing with complete distal wing venation, marginal cell long and completely bordered by veins (Fig. la); claws cleft; penicillum absent in worker; auricle present; sting well developed (Honey bees; genus Apis) ..... Apini……3
7. Distal abscissa of vein M in hind wing present; worker size variable, moderate to large, forewing length 7-15 mm (subgenera *Apis* and *Megapis*)..... 4
- Distal abscissa of vein M in hind wing absent; worker size small, forewing length 6-7 mm. (subgenus *Micrapis*)..... 5
8. Forewing hyaline; scutellum yellow-brown, rarely black; drone with tarsi unmodified; worker size moderate, forewing length 7-9 mm.(subgenus *Apis s*.) ……*A. cerana*
- Forewing fuscous; scutellum black; drone with dense frond-like setae on meso- and metatarsi; worker size large, forewing length 12-15 mm (subgenus *Megapis*)....*A. dorsata*
9. Meta-tibia and dorsolateral margin of meta-basitarsus with white setae; metasomal terga I -II reddish-brown; drone metabasitarsal process long, more than two-thirds meta-basitarsus length ..... *A. florea*

10. Hind wing commonly with cells R and Cu closed by at least weakly brownish veins; forewing with 1 or 2 submarginal cross veins usually weakly indicated, first submarginal cell usually recognizable; cell second Cu of forewing completely indicated at least by faint veins; vein M of forewing usually extending at least slightly beyond position of anterior end of first recurrent vein and angulated at end of that vein……..*Trigona* sp.

Chapter 3- Pests, Predators and Diseases of Honeybees: Prevention and Control

3.1 Introduction

As apiculture is capturing global attention the bee farmers many times get disheartened when pests and diseases wipe out bee populations en masse and ruin their patient efforts. Awareness on honeybee pathology is therefore very important to achieve sustained progress in honey production. This is a serious issue as India is reported to have the highest number of bee colonies in the world, but ranks only seventh in honey production. Here we discuss the problems in brief and recommend measures for mitigation of these maladies. Poor management practices in beekeeping weaken the bee colony increasing its susceptibility to pests and predators. The worker honeybees, which constitute bulk of the population, though are armed individually with a sting and poison and collectively strike fear on most of their marauders which attack the colony, themselves need assistance sometimes from beekeeper to defend against pests and diseases. Enemies of honeybees are those animals, which cause disturbances and nuisance in functioning of the colony and range widely in size from microscopic mites to large mammals such as bears (Gulati and Kaushik, 2004). The stings are, nevertheless, ineffective against the tiny mites or fungal, bacterial and viral diseases. The maladies of the bee colonies are divided into three categories like diseases (viruses, bacteria, and fungi), pest infestation (mite and protozoan) and natural enemies (mammals, birds, reptiles, beetles, ants and wasps). Of these, the virus diseases like Thai sacbrood and sacbrood causing chronic paralysis and deformed wings, have been posing major threats to hives of *Apis cerana* and *Apis mellifera* in different parts of world (Bailey, 1981).

3.2. Viral diseases

***Thai sacbrood virus (TSBV)*:** A collapse occurred in India in 1978, of *Apis cerana* colonies, because of Thai sacbrood virus, which affected nearly 95% of hive population and subsequently reduced honey production in India (Mishra, 1995; Devanesan and Jacob, 2001). The virus attack occurs early in the brood-rearing season when the ratio of brood to bees is high. Both worker and

drone larvae are affected. Pupae may be killed occasionally, but adult bees are immune to it. Dead brood is often scattered among healthy brood. Nurse bees are suspected of transmitting the disease by carrying the virus from cell to cell. Although the disease inflicts massive blow to the bee colonies, the beekeepers of Karnataka, including of Uttara Kannada, generally lack awareness on its prevention and/or control measures. Venkatappa R. Naik of Navilgon, Honnavar taluk, a bee-keeper in the trade for past five decades, owned once 40 bee boxes, of which only two boxes are today left with bee colonies. He stated even after the subsidence of Thai sacbrood epidemic he has not been able to rebuild his apiculture as preventive and control measures are still elusive.

Prevention and control: There is no measure yet to provide immunity to the bees from this disease. The disease can be avoided to certain extent by avoiding replacing or mixing bee colonies and hive equipments from TSBV affected apiaries. Regular monitoring of bee hives, keeping them in hygienic conditions, and screening good healthy colonies for proliferation of progenies would be of help.

3.3. Fungal diseases

***Nosema infection*:** *Nosema apis* is a unicellular parasite of the class of Microsporidia that is now considered to be a fungus (Sina et.al., 2005). Infected honeybees revealed two kinds of microsporidians namely *Nosema apis* (Zanter, 1909) and *Nosema ceranae* (Fries et.al., 1996). It is a very widespread disease of honey-bees and, when the adult bees of different castes like worker, drone and queen happen to feed on microsporidia, they germinate and invade the gut wall, causing intestinal swellings, and impaired digestion and spores pass out through the excreta of the insects. Seriously affected worker bees are unable to fly and may crawl about at the hive entrance or stand trembling on top of the frames. The bees appear to age physiologically: their life-span is much shortened and their hypo-pharyngeal glands deteriorate; the result is a rapid dwindling of colony strength.

Prevention and control: Infection is controlled by good management practices. Replacing combs regularly helps to reduce infection. In general no comb should be left in a hive for more that 3-4

years. If a colony becomes infected and dies, the combs and hive parts should be disinfected by fumigation with 80% acetic acid. The fumes kill the *Nosema* spores but not the larvae and the honey or pollen stores in the comb are not affected also.

***Chalkbrood disease*:** *Aspergillus flavus* and *Ascophera apis* are other fungal diseases, commonly called "chalkbrood", as infected larva gets filled with fungal mycelium and white spores giving it chalky appearance. Infection by spores of the fungus usually occurs in larvae of three to four days old. The spores are absorbed either via food or the body surface. It is a dangerous disease in US but not of any serious consequence in India. The spread of the disease is favoured by chill weather and poor maintenance of hives.

Prevention and control: Disease is prevented and controlled by adopting the following method: Preventing the entry of rain water inside the hive is very important. The box with holes and cracks has to be repaired or replaced so as to prevent the entry of moisture and drafts. Sanitation equipments have to be periodically changed to produce improved and healthy brood.

3.4. Bacterial diseases

***American foulbrood (AFB)*:** This is a bacterial disease of larvae caused by a gram-positive bacterium *Paenibacillus* (plate 3.1). It is highly infectious disease and can be spread by drifting bees, by robbing and by the beekeeper moving from an infected hive to others during inspections. Singh (1961) was the first to report its occurrence in India. Larvae up to three days old become infected by ingesting spores present in their food. Young larvae less than 24 hours old are, however, most susceptible and infected larvae usually die after their cells are sealed. The entire population of hive gets infected.

Prevention and control: Hive materials of the infected colony, are disinfected or destroyed by burning. The bees of the diseased colony are usually killed by poisonous gas such as the burning of sulphur powder. All the dead bees, the frames, the supers, the honey and the contaminated equipment are properly cleared. When all the material has been completely burned, the hole is carefully filled in, to prevent worker bees belonging to healthy colonies from robbing any remaining contaminated honey.

***European foulbrood*:** The disease is caused by *Melissococcus plutonius*, which infests the gut of bee larvae. It was first observed in Maharashtra in 1971 on *Apis cerana indica*. It is not very harmful compared to American foulbrood disease.

Prevention and control: If the infection is weak, the bee boxes are placed at a good foraging site or the bees are fed with honey or sugar water. An even better result is achieved if the individual combs are sprayed with a thinned honey solution. If the infection is stronger it makes sense to reduce the number of pathogens in the colony by removing the most infested brood combs and replace them with empty combs or healthy brood combs. Since the bees' healthy behaviour, involving foraging and other daily chores, is also genetically determined, replacement of the queen is also possible. 'Re-queening' with a healthier queen, with greater egg laying capacity, can strengthen the colony by increasing its resistance to the disease and interrupting the ongoing brood cycle giving the house bees enough time to remove infected larvae from the hive(Cramp, 2008).

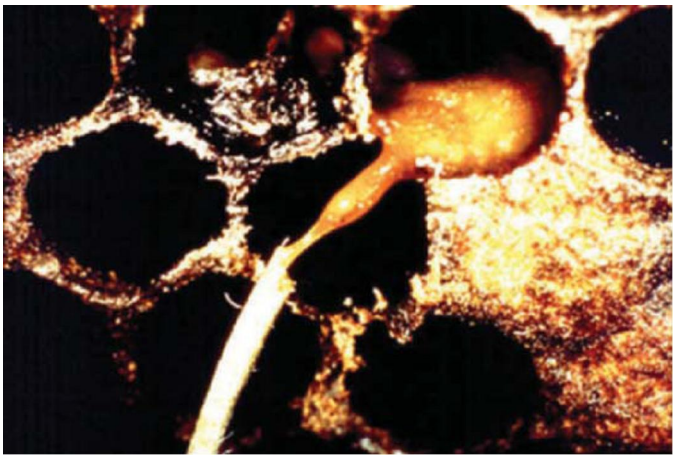


Plate 3.1: American foulbrood: the telltale rope of dead larva (Cramp, 2008)

3.5. Mites:

Parasitic mites are important enemies of honeybees found throughout India and also in the rest of Asia. Tewarson et al. (1992) provided the first insights into the life cycle of *Varroa destructor* on *A. cerana* in India. Mites that affect honeybees may be divided into four categories: a) Parasitic mites (Tracheal mite and Varroa mite) b) Predatory mites c) Phoretic mites and d) Scavenging

mites (G*lycyphagus sp.*). Varroa mites are native parasites of *Apis cerana*; it causes injuries to honey bees by direct feeding on them (Plate 3.2.). The adult female pierces the bees' soft inter-segmental membrane with its pointed chelicera and sucks the bees` haemo-lymph ('blood'). The adult bee, however, is only damaged if the infestation is severe. Varroasis is a brood disease. If more than one parasitic female mite infests the brood cell the brood decays or deformations occur including shortened abdomen or deformed wings. *Tropilaelaps clareae* is a brood mite that attacks *Apis dorsata* colonies in India. The mite attaches to the pupae and pre-pupae stages of bees; matured female mites attach on and suck the haemo-lymph from the larvae and adults. Scavenger mites are most abundant mites in a beehive and may reach very high densities in the hive bottom. These are attached on the debris of unwanted waste material and dead bees, which are major source for food to scavenger mites.

Control measures: Synthetic chemicals (Bayvarol, Apistan, Apivar, Check Mite and Apitol) are usually reliable and effective when the mites are not chemically resistant. Use of organic products like formic acid, oxalic acid and other essential oils, is reliable to varying degrees but, for good effect, they must be employed at the right time and in the right circumstances (Cramp, 2008). As Varroa mites mostly develop in the drone cells in the colony elimination of surplus drone developing cells from the chamber, is one of the best measures to prevent mite development and spread.

Varroa mites in the bee colony **Varroa mites attached on the larva of bee**

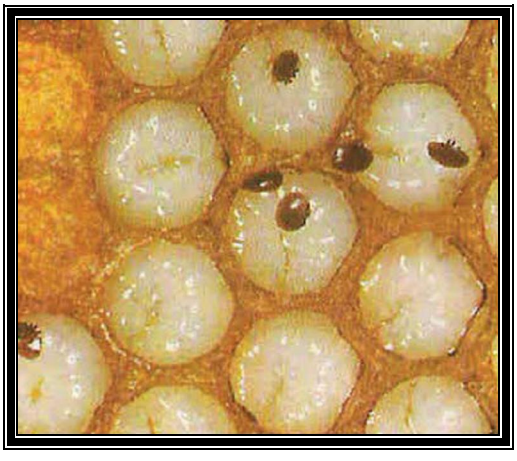


Plate 3.2: Varroa mite infestation on larvae and honeybee colony (source of photos: Clamp, 2008 and FAO United Nation Italy, 2006).

3.6. Predators

3.6.1. Insects:

There are several insect species (mainly wasp and beetle) that cause damage to bee colonies by feeding on them. In Uttara Kannada, the wasp *Vespa cincta* (Plate: 3.3) is major enemy of bees. The wasp feeds on entire adult bees for food and sometimes captures the prey and carries it to the wasp colony and stores it for nourishing its own young ones. During pre-monsoon season, the wasp proliferates and the young ones make new nests; the shortages of food for wasps during the rainy season make them attack bee hives for capturing their prey (Gulati and Kaushik, 2004). Several authors reported that wasps predate on honeybees causing severe damage to bee colonies and leads to loss of entire apiaries (Ghosh, 1936; Subbiah and Mahadevan, 1957; Adalakha and Sharma. 1975; Sharma and Deshraj, 1985). *Philanthus ramakrishnae* and *Palarus orientalis* are best bee hunters (Thakur, 1991). *Vespa tropica* is a fast flier wasp and mostly catches the forager bees (Garg and Kashyap, 1998).

Prevention of wasp predation: Destruction of wasp nests from the nearby areas, especially by burning of nest or spraying insecticide at night when all of them are in the nest, applying aerosols or fumigation by calcium cyanide etc. can reduce wasp predation (Gulati and Kaushik, 2004)

Plate 3.3: The yellow banded wasp (*Vespa cincta*) predates on honeybees

Wax-moth: Wax moths are found to infest hives of all species of honey bees. They do so for both food and developing their own young ones within the bee colonies, especially in Asian countries (Thakur, 1991; Gulati and Kaushik, 2004). They lay eggs in the bee hive and the larvae that emerge get covered in silken web. Such silken webs tunneling the moth larva inside are interspersed in the bee hive. The combs ultimately can be reduced to a mass of web and debris. Severe infestation leads to suspension in brood rearing, foraging activity and ultimately desertion of bee colony from the nest (Plate: 3.4).

Control measures: It is difficult to control max moth attack on beehives. The best defense, however, is to maintain strong, healthy colonies, compact and good hive and reduction of entrance size, which are effective control on wax moth. Some authors recommended eradication of wax moth from hive by treating with hot water, and through chemical treatments (Gulati and Kaushik, 2004). Chemical treatment should be avoided as much as possible so that the organic nature of the health food like honey is maintained.

Plate 3.4: Wax moth damages on bee hive

Ants: Ants are cosmopolitan predators of honeybees in tropical and sub-tropical regions. Some species (weaver ant, the black ant fire ants and Formica spp) enter bee colonies in search for food, mainly honey, or for establishing nesting sites. Damages to *Apis cerana* colonies have been noticed (Thakur, 1991; Gulati and Kaushik, 2004). Even though ants are not serious pests rarely disturbing the bees, these can be of nuisance to the beekeeper.

***Prevention and control*:** Honeybees are in the habit of fanning their wings to keep optimum temperature within the bee hive. This fanning by thousands of bees create strong currents within the bee box that does not allow free movement of ants. The bees also have the practice of pasting cracks and crevices in the hives with propolis, a resinous substance of plant origin. The ants can still congregate in places where the fanning effect does not reach. Protection of bee hives from ants is very necessary on the part of the bee keepers. Placing legs of the bee boxes dipped in earthen vessels containing water prevents ants from access to the colony. Few authors stated that applying spent engine oil and grease on the bottom and stands of the bee box acts as a repellent for ants (Thakur, 1991 and Gulati and Kaushik, 2004).

3.6.2. Birds

Cobb (1979) reported 47 species of insectivorous birds under the 24 families, out of 74 insectivorous families of birds in India, which feed primarily on honeybees and bee-wax. The degree of damage to commercial apiaries caused by predatory birds depends largely on the number of the predators and the intensity of the attack, the mere presence of a few predators in apiaries engaged in queen rearing can inflict serious losses. In Uttara Kannada, some places are seriously affected due to bird predation (for e.g. Harehulekal, Kakkalli and Vannalli of Sirsi taluk). The main bird predators here affecting apiaries are (Plate: 3.5) small green bee-eaters (*Merops orientalis*), drongos (*Dicurus spp*.), swifts (*Cypselus spp., Apus spp*.), shrikes (*Lanius spp*.), and woodpeckers (*Picus spp*.).

Prevention: Scaring away the birds is most effective in checking their visits' to beehives. High pitch sounds with different notes, beating the drums and empty tins etc. have been recommended (Gulati and Kaushik, 2004).

Small green bee-eater	Drongo
	

Plate 3.5: Some honeybee predating birds

Chapter 4: Beekeeping equipment

4.1. Bee-hive/Box

In Uttara Kannada, there are two types of boxes available viz. the standardized ISI marked boxes and locally prepared ones. The ISI boxes are of teak or other high quality timbers, while locally boxes are made of miscellaneous woods. A typical beehive contains various parts like hive stand, floor board, brood chamber, super chamber and outer cover (plate 4.1). The **hive stand** consists of a wooden pole or iron stand fixed to the ground. On the hive stand is a wooden plank or **floor board** that makes the floor of the hive which is separable from the hive stand. The **brood box** or **brood chamber** sits on this floor. The latter is a larger sized of box inside which eight full-depth wooden frames are arranged vertically and parallel to each other. On each of this frame is fixed a foundation sheet made of waxy material. The bees build the comb on both sides of the foundation sheet. The foundation sheet makes the preparation of bee comb a faster exercise and the combs are almost evenly spaced between the vertical wooden frames. A brood box normally contains one queen bee. The latter lays eggs, placing one each inside a cell of the comb. When the eggs hatch larvae are formed inside the cells and the larvae mature into the adult bees. When the brood chamber is well populated with bees the bee-keeper fixes a **super chamber** on the top of the brood chamber. Like the brood chamber the super chamber also has eight frames meant for comb making by worker bees. The super chamber is meant for storage of surplus honey and pollen in the cells by the worker bees and not for egg-laying by the queen. So that the queen bee should not enter into the super chamber to lay eggs a mesh work called **queen excluder** is placed between the brood and super chambers. However, if the queen is a prolific egg layer the bee keeper can use the option of fixing a second brood chamber to the first, before fixing the super chamber. In such cases there will be greater yield of honey because of more number of worker bees gathering nectar. The honey and pollen stored in the brood chamber is meant for only the developing larvae and not for extraction by the bee-keeper. The standard height of the super chamber is three-fourth of the brood chamber. More than one super chamber can be fixed to the brood box if there is more production of honey. If the bee-keeper extracts honey from the hive at short intervals there is no need for fixing a second or third super chamber to the first. Inside the super chamber boxes, beeswax may hang down from the frames. Although the standard super

chamber box is designed to hold eight frames, some beekeepers fix only seven frames inside it. So that water should not percolate into the bee box during the rains the super chamber is often roofed with wooden, aluminum or tin roofing. The roof that can be removed like a lid from the top of the super chamber may be flat or slanting. The slanting type is preferred by the local bee-keepers because of the heavy rainfall in Uttara Kannada. This lid has to be provided with few holes on sides for the purpose of ventilation. Towards one side of the brood chamber, just above the floor board, is an opening for the entry and exit of the bees. To prevent the queen bee from flying out of the box a metal plate with few holes that can permit only the entry and exit of the worker bees and drones is fixed to the entrance of the box opening. This slotted metal plate is called as **queen guard.**

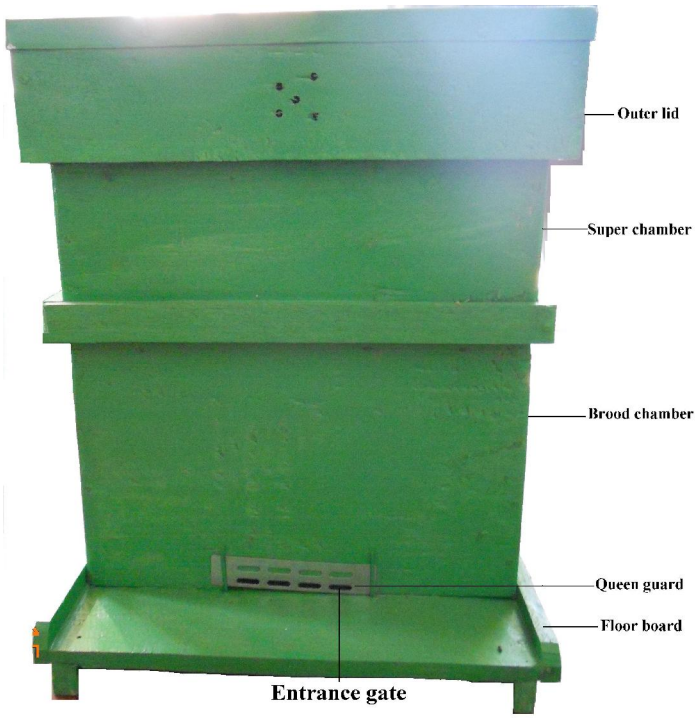


Plate 4.1: A typical bee hive or Bee box

4.2. Smoker

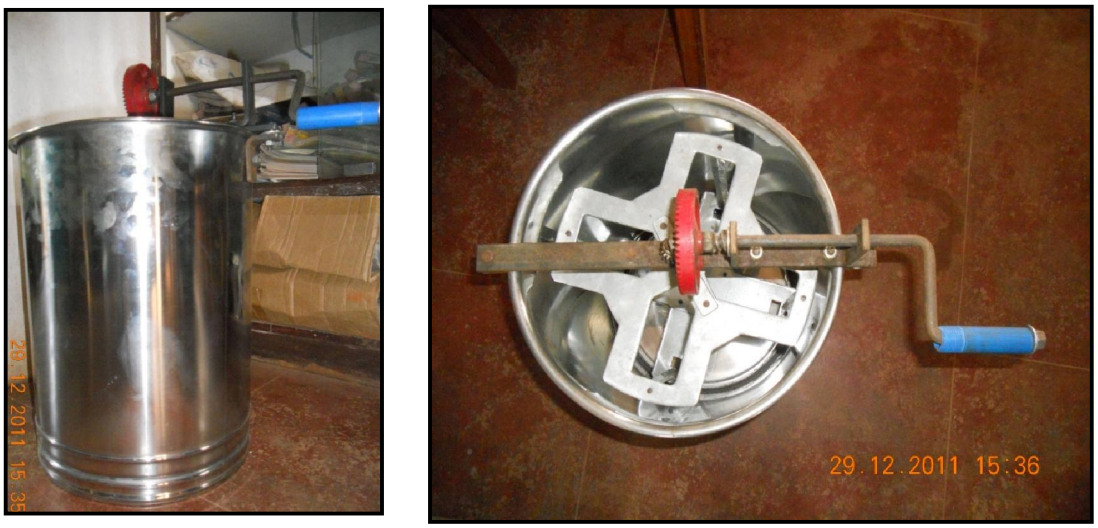
The smoker is a metal cylinder in which a fire is lit to produce smoke (Plate: 4.2). The smoker is attached with a bellow to blow air into the fire. The regulated smoke that comes out of the nozzle is directed into the hive to make the bees docile and less prone to sting.

Plate 4.2: Smoker

4.3. Honey extractor

It consists of a metal drum with a centrifugally rotating device, for the extraction of honey from the frames. Four frames filled with honey from the super-chamber can be placed in the extractor at one time to extract honey by rotating it with the help of a handle (Plate: 4.3). Use of the extractor will not cause any damage to the combs so that they can be placed back in the super chamber after honey extraction.

Plate 4.3: Honey extractor



Other accessories include **pollen traps** which are used for the collection of surplus pollen. **Drone traps** which are used for trapping drones and preventing them from re-entering the hive but allowing entry of the workers freely. A knife is used for uncapping cells. A wide mouthed bottle or dish is used for keeping bee food during dearth period. A hive scraper is used for cleaning the floor board, and leather gloves used for handling live frames. The bee keeper is recommended to wear overcoat to avoid bee stings.

Chapter 5: Beekeeper Co-operative Societies of Uttara Kannada

5.1. Introduction

Three-fourth of the India's population lives in rural India and 70 percent of them depend on agriculture and its allied activities. One of the very important factors to increase the agricultural productivity is beekeeping. Mahatma Gandhi, realize importance of healthy village economy tried to promote bee keeping. Training programmes for bee keeping were conducted in his ashram itself. After independence, Khadi and Village Industries Commission was constituted in 1956, This Commission played a crucial role in the strengthening of rural economy by promoting and developing beekeeping and other cottage industries. An extensive network of State Khadi and Village Industries Boards, Bee-keeping Cooperative Societies and registered Institutions were established in the country.

Beekeeping provides honey, a nourishing food and medicine, and various other valuable products like wax, pollen, bee venom, propolis and royal jelly. It has been estimated that bee-keeping in the world is being carried out in an estimated four crore colonies. The United States, USSR, and China together account for about 50% of the bee colonies and remaining are found in other countries. Few decades ago, China had 60, 00,000 bee colonies. Now that number has exceeded one crore colonies, overtaking India, and is targeting a phenomenal increase to five crore colonies in the next few decades. To achieve this target China has taken on afforestation mission on a large scale, including road-side plantings and other programmes to increase bee-flora and creating timber for production of bee boxes. All these bee colonies, besides honey production, are regularly used for planned bee-pollination of various cross-fertile crops, thereby improving the crop yields both, qualitatively and quantitatively (Phadke, 2008).

In Uttara Kannada the beekeeping activities have been promoted jointly by Khadi and Village Industries Commission (KVIC) and the National Horticulture Mission through beekeepers co-operative societies. The Honavar Beekeepers Co-operative Society, the first in Uttara Kannada district, was started in 1941. Four more such societies were established at Kumta, Ankola, Sirsi-

Yellapur and Siddapur (Karnataka state Gazetteer of Uttara Kannada, 1985; Prabhakar and Milind, 2011). Although the massive potential of honey production exists in the hilly taluks like Yellapur, Sirsi and Siddapur, the Sirsi-Yellapur society had gone almost defunct. The present study aims at an appraisal of the performance of the beekeepers co-operative societies in the district with regard to promotion of beekeeping, honey procurement, and constrains for the growth of such societies in Uttara Kannada district.

5.2. Materials and methods

Uttara Kannada district is situated in the north-west part of Karnataka State, between longitude 74^{o} 9' to 75^{o} 10'E and latitude 13^{o} 55' to 15^{o} 31'N. The district has a geographical area of 10,327 sq. km, and is bordered by the Belgaum district and Goa State to the north, Dharwad in the east, Shimoga and Udupi districts towards south-east and south respectively and the Arabian Sea to the west. The district has three distinctive zones such as coastal zone, hill zone and eastern transitional zone. These zones are currently divided into 11 taluks, of which Ankola, Bhatkal, Honavar, Karwar and Kumta make the coastal zone, Siddapur, Sirsi, Supa and Yellapur make the hill zone and the relatively flatter Haliyal and Mundgod make the transitional zone. Relief and climate have introduced these regional differences. The present study was carried out covering the performance of beekeepers co-operative societies in four taluks (Ankola, Kumta, Honavar and Siddapur) of Uttara Kannada (figure 5.1 for study area map).

We collected last 11 years data (2001-11) from these four beekeepers societies and additionally interviewed secretaries of the societies regarding growth in membership, trends in honey production, problems of beekeeping and training programmes being arranged by the societies. The data was entered and tabulated in the Microsoft excel sheets. Data analysis was done to find out the trends in honey procurements, society memberships and to find out the causes for malfunctioning of the societies if any.

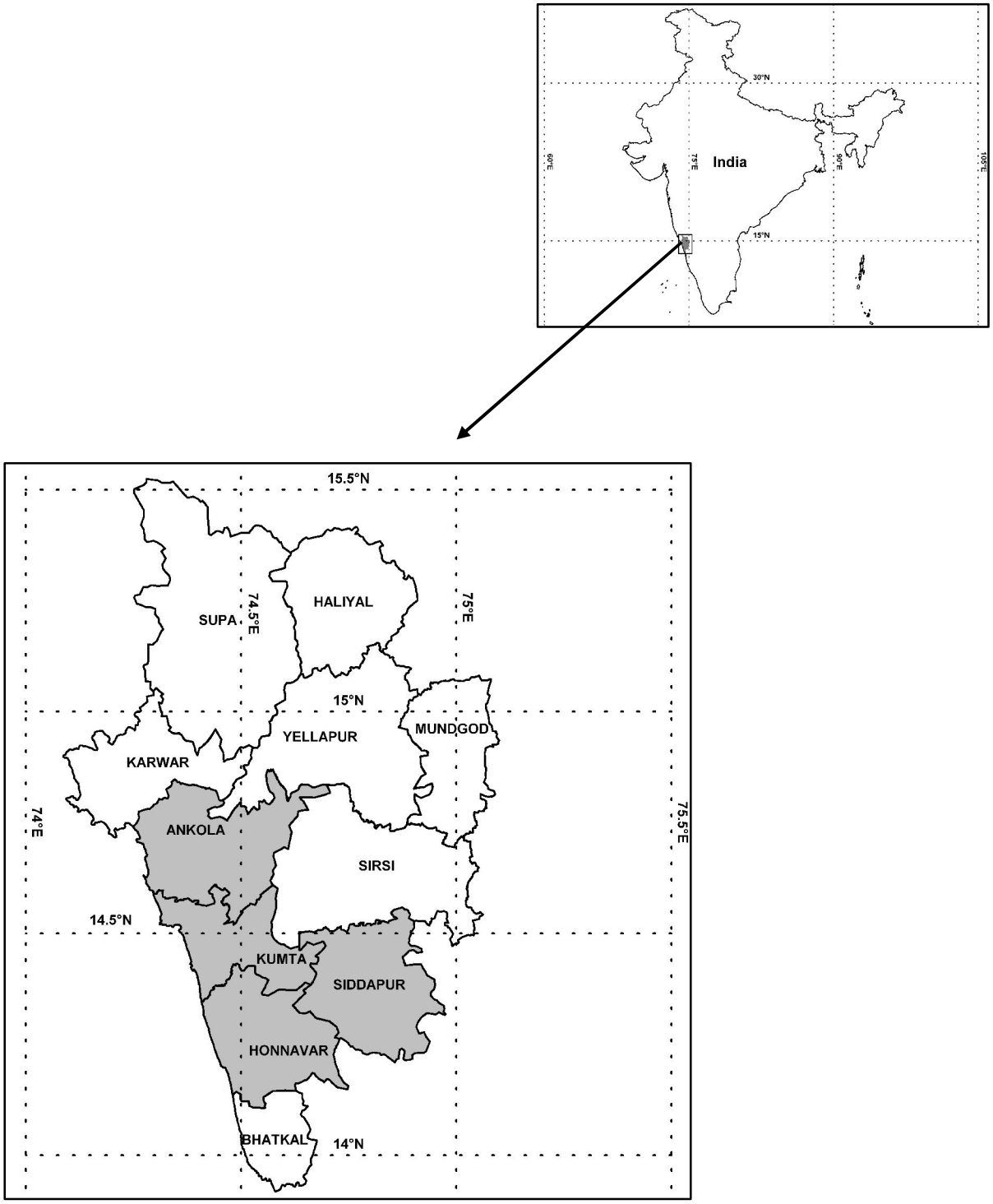


Figure 5.1: The map of Uttara Kannada with the study taluks shaded.

Plate 5.1: Data collection at beekeepers co-operative society at Ankola

Plate 5.2: Shridhar Hegde of beekeepers co-operative society at Honavar showing bee keeping equipments

5.3. Results and discussion:

Honavar society had the highest number of members (992) in 2011, and Ankola society had the lowest (204). A glance through the growth in membership over the past 11 years of all these societies reveal only stunted growth (Table: 5.1 and Figure: 5.2). The Honavar society showed even a decline in membership from 1148 in 2002 to 992 in 2011. The beekeeper societies, although constituted with good objectives of promoting beekeeping as on important enterprise in Uttara Kannada have entered a stagnant phase due to the following reasons:

1. The honey procurement prices of the societies are lower than the open market values, which prompts the producers to sell honey in the open markets. For e.g. whereas the producers get a price for Rs.250 to Rs.300/kg of mixed honey in the open market, the society procurement prices range from Rs.140/- to Rs.180/- only. For soapnut honey the market pays a handsome price of Rs.1000/- or more whereas the Honavar society's procurement price in 2011 was about Rs.500 – Rs.550/kg only and its selling price was about Rs.700/kg. from which the producer does not get any share.
2. The beekeepers society's records regarding procurement of honey do not reflect the real situation regarding actual number of producers in the jurisdiction of respective societies, apart from the members, the quantities produced, potential production etc. The societies' major sources of honey seem to be from the forest contractors who gather wild honey. Some societies even get litchi honey from states like Bihar and Uttara Pradesh at much cheaper rates, not exceeding Rs. 90/ kg, and blend with local honey, and market the mix (Honavar Bee-keeper's Society and Kadamba Marketing Souhardha Sahakar Ltd., Sirsi – personal communication).
3. The beekeeping equipments are not readily available from the societies to the members. The members many times are required to make repeated visits to get the equipments especially from Sirsi and Kumta taluk societies. Such equipments and accessories are more readily available from private sources (such as for e.g. from Dharmendra Hegde, Kangod, Balachandra Hedge, Salkani etc. - both in Sirsi) who are themselves good beekeepers. They as well sell bee colonies along with the boxes and other accessories. Kumta and Sirsi-Yellapur societies have almost gone into dormant states. Honavar, Ankola and Siddapur societies fare better.

Table 5.1: Membership of beekeepers in the beekeepers co-operative societies during 2001 to 2011.

Year	Ankola	Kumta	Honavar	Siddapur
2001	155	391	1100	334
2002	156	391	1148	337
2003	166	391	1145	342
2004	172	391	889	343
2005	178	391	926	345
2006	180	391	942	349
2007	180	391	950	349
2008	188	391	956	355
2009	195	391	965	355
2010	197	392	972	359
2011	204	393	992	378

Table 5.2: Quantity of soapnut honey procured by four beekeepers co-operative societies during 2001 – 2011.

Year	Qty. of soapnut honey procured			
	Ankola	Kumta	Honavar	Siddapur
2001	106	12	0	0
2002	120	0	0	0
2003	156	0	0	0
2004	350	2	0	0
2005	282	0	0	0
2006	120	20	0	0
2007	80	15	0	0
2008	86	3	0	0
2009	83	68	230	0
2010	52	4	250	0
2011	21	0	135	0

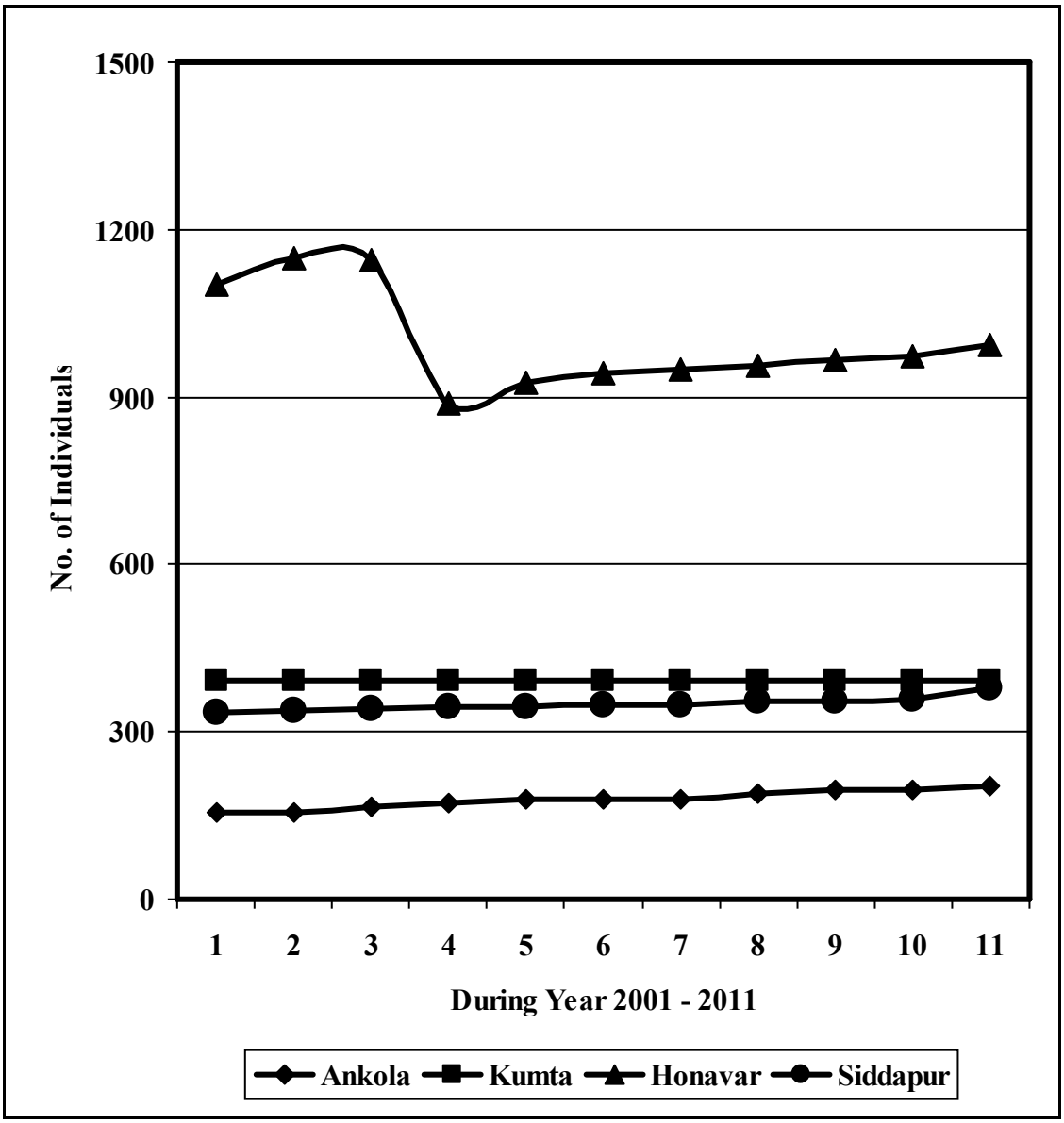


Figure 5.2: Membership in the beekeepers co-operative societies during 2001 to 2011.

Soapnut honey procured by societies

Honey from the soapnut tree (*Sapindus laurifolius*) is by far the most expensive honey. Soapnut trees flower during November-December period, before most other bee-forage trees flower. Therefore soapnut honey is often unmixed; attributed with medicinal values and fetches handsome rates to the producers. Soapnut trees are more characteristic of the coastal forests and homesteads than the interior places of the district. Therefore soapnut honey production is mostly

from the coastal areas of Uttara Kannada. All the soapnut honey being currently procured by the societies is mainly from the coastal taluks (Table.5.2). The quantities procured by the societies are not much and are showing declining trend (Eg. Ankola, Kumta and Honavar societies). In the Honavar society separate record keeping on soapnut honey procurement commenced only in 2009. Although soapnut is a tree that can be easily grown on a variety of soils, including in open areas and on roadsides, with little care, and considering that the fruit is economically valued, and the tree becomes a good cover for barren areas, very little efforts were made hitherto to plant these trees in large scale by the Forest Department or by private landowners.

Production and sale of non-soapnut or mixed honey

The procurement figures of non-soapnut honey, including mixed honey, by the four societies (**Table 5.3**) scrutinized for the period 2001-2011 shows that the role of societies in the overall honey trade is diminishing. The performances of all the societies, barring Siddapur, have reached the lowest ever during 2010-2011 periods. The Siddapur Society's records of procurement prior to 2005 were not available. The higher procurement in Honavar during 2004-08 periods is an exception. The rising demand for honey in the open market prompts the producers to sell their products directly to the consumers without the intervention of the societies. It may be concluded that these societies are mere shadows of their past and cannot justify their existence any further as procurers or traders of honey and their roles in promoting beekeeping need to be redefined; for e.g., role in creation of awareness and training programmes on bee keeping and supply of equipments to the bee keepers etc.

Table 5.3: Quantity of honey (other than soapnut) procured by beekeepers co-operative societies during 2001 – 11.

Year	Qty. of non-soapnut honey procured (kg)			
	Ankola	Kumta	Honavar	Siddapur
2001	2610	963	3152	NA
2002	1330	208	4635	NA
2003	1096	66	4610	NA
2004	2100	128	9388	NA
2005	3136	163	6969	3782
2006	2010	186	10019	423
2007	1121	250	11470	2422
2008	950	70	8291	1011
2009	1091	264	3653	5867
2010	1040	101	965	354
2011	1200	178	475	3068

NA = Data not available

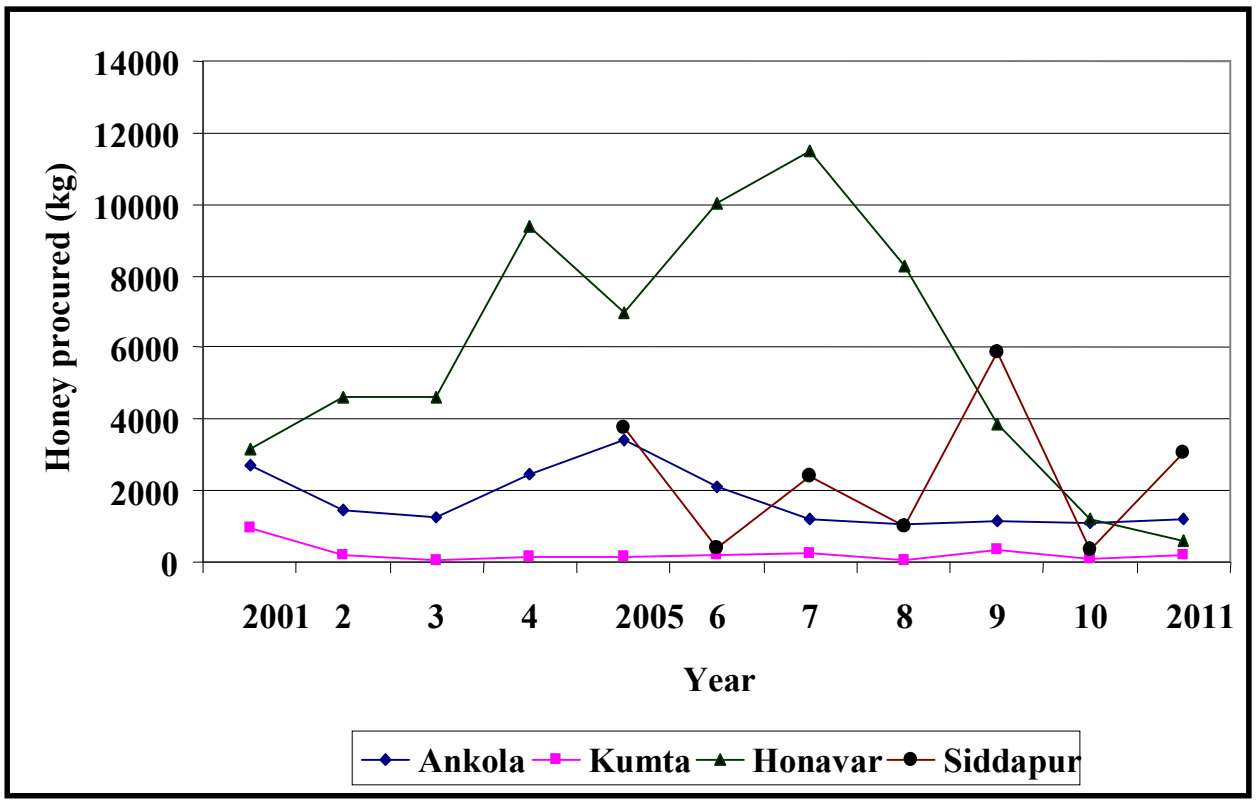


Figure 5.3: Trends in honey procurement by beekeepers co-operative societies for 2001-11.

Total quantity of honey procured by four societies

In figure 5.3 are shown the total quantity of honey (soapnut + non-soapnut) procured by the four societies concerned during the 2001-2011 period. The figures depict the uncertainties in the performance of the bee-keeper's societies examined. The societies had played key roles in the past highlighting the importance of bee keeping as an income generating rural enterprise and assisted the village communities to start these ventures by providing equipments, subsidies and technical consultancy. The societies also helped the producers in marketing honey. The growth of the open market with phenomenal prices offered to the producers has sidelined the importance of these societies.

5.4. Prescriptions for future

It is amply evident the bee-keeper societies of the district are not performing well in their prime task of procuring and selling honey. On the contrary more honey is sold in the market at good prices directly by the producers. In this changed scenario it is time to redefine the role of these societies in the field of be-keeping.

Honey is a precious plant product with ever increasing market demand. It is not only useful as a tasty food but also is rich in nutrients and is very useful for medicines and confectionary. The bee-keeper's societies played a historical role in Uttara Kannada district in popularizing bee-keeping as an important rural enterprise so as to generate family income and to reduce the intensity of honey collection from the wild which is more destructive to the bee colonies. The method of domestication of bees and extraction of honey scientifically using simple equipments were popularized through training programmes. Today the bee-keeping has grown beyond the domain of the societies. It is growing independently, more in a disorganized fashion. Although the potential of bee-keeping in Uttara Kannada, a well forested and horticulturally important district, is tremendous, the potential is hardly ever realized due to the lack of co-ordinated approach. In a free market economy, with ever increasing demand for honey from local markets and cities, the bee-keeper's societies, instead of going redundant, can play important role in systematically nurturing bee-keeping through awareness creation and training programmes,

foster the growth of bee forage plants and pave way for creation of employment for thousands of rural people.

Private bee-keepers in the district are not often a trained lot. Whereas some have got good mastery on the field and are good entrepreneurs and trainers, most others have performance below par, due to lack of proper training. In the early days of the societies there used to be expert trainers with them visiting villages to guide the bee keepers in scientific methods and even used to take care of the spread of bee diseases through control measures. The societies are today not able to grapple with open market system and are weakening in their performance. Instead of simply functioning as honey procurement centres at tardy prices they can concentrate on the conduct of training programmes and create awareness of beekeeping and importance of pollination crop productivity.

Chapter 6: Beekeeping Scenario

6.1. Introduction

Honey was an item traded from the south Indian west coast from time immemorial. Most of the honey collection was from wild sources or from semi-domesticated sources wherein often earthen pots with narrow mouths (especially water pots) where fixed to large trees for attracting bee colonies. In Uttara Kannada, the number of beekeepers was stated to be about 5300 in 1900-91. In 2002, after the passage of a century, the number of bee keepers got reduced to merely 1550, according to Bhat and Kolatkar (2011). There could have been different reasons for showing such low number. Firstly, the figures could have been obtained from the bee-keeper's co-operative societies in the district. It needs to be stated that all the bee keepers are not necessarily members of such societies. Therefore it is difficult to get a picture of the ground reality. Further, the closing years of the last millennium witnessed bee colonies perishing in large numbers all over the Western Ghats areas due to the spread of the Thai sac brood virus epidemic. Our studies at the village level, admittedly though far from complete, reveal that many bee keepers are not necessarily members of the societies, nor they sell their products like honey and beeswax to the societies. Therefore, it can be stated with certainty that, bee-keeping remains to be an unorganized sector despite its increasing attractiveness and rising demand for honey in domestic and international market. The district, with over 60% of its lands under forest cover, and about 15% under agriculture, has a huge potential to be a stronghold of honey production, at least in peninsular India. It is a field where scores more can find fruitful employment, not impacting the environment in any manner, except beneficially, through increased pollination, fruit and seed setting in both crop and wild plants. If combined with appropriate environment management the employment potential could be very high, next only to agriculture and fisheries. Through interviews of over 100 individual farmers from the coastal and interior malnadu taluks as well as using the information furnished by some of the notable bee keepers co-operative societies we have been able to provide a picture on bee keeping in Uttara Kannada.

6.2. Materials and methods

The study on bee keeping was carried out in six of the 11 taluks Uttara Kannada district namely: Ankola, Kumta, Honavar, Yellapur, Sirsi and Siddapur from November 2011 to March 2012. Details of Uttara Kannada district, geography, topography, climate etc. are given in the chapter 5. Primary data was collected from randomly selected villages and towns, through interviews with help of a questionnaire (Annexure-II). The locations of field study sites, pertaining mainly to visiting the bee-keepers, are given in figure 6.1. and 6.2. About 105 bee-keepers from 83 villages from six taluks (Annexure II) were interviewed, about the number of boxes they kept, honey production, processing, marketing, important bee-forage plants, types of honey and on problems and prospects of bee-keeping. Their bee colonies were also examined wherever possible.

Figure 6.1: Field study localities (indicated with stars) in Uttara Kannada district

6.3. Results and discussion:

Annual honey production/box

The 105 bee-keepers whom we interviewed owned 1453 bee boxes, at an average of 14 boxes each. The total honey production amounted to 10,424 kg, during the year 2011(Table 6.1), at a district average of 6.68 kg/per bee box. Taluk-wise per box honey production ranged from 5.73 kg in coastal Honavar taluk to 9.45 kg in Sirsi taluk of malnadu region. Of the other coastal taluks the average of Kumta was 5.94 kg and Ankola had 6.72 kg. Siddapur in the malnadu region had 5.96 kg/box and Yellapur had 6.29 kg/box. These details show that apart from Sirsi taluk the other taluks, whether interior or coastal, did not show any notable variation in annual honey production per box. The actual honey production ranged from 0.8 kg to 14.7 kg in a box / year. Exceptionally high production /box at 12-15 kg/yr for the coast was reported by a couple of bee-keepers, who together had 11 boxes. Such high production was noticed in Hodike-Shirur and Kadle-Koppa villages of Honavar. The lowest production for the coast was noticed in Belekeri village of Ankola and Mirjan of Kumta. Belekeri village has very poor vegetation for the coast as it being the seat of a minor port was ravished by iron ore transport beyond its carrying capacity. Mirjan, situated towards the bank of Aghanashini estuary, although is hilly for most of its terrain, the major vegetation is monoculture of the exotic *Acacia auriculiformis*, which is not a nectar producer. Krishana B. Gunaga of Alageri village in Ankola, close to Belekeri port village, has the practice of keeping his bee colonies in his native village until the close of flowering of the soapnut trees in December. Soapnut honey fetches a very high market price of about Rs.1000/kg. Thereafter, in mid February or so he transports his bee colonies to the rather densely forested Hillur and Yana villages towards the interior of the coastal region and installs them there until the end of April. This is a period of widespread flowering of forest plants which benefits him considerably to increase the honey output. Some other coastal bee-keepers also follow such good practice. Inner coastal villages have greater scope for bee-keeping because of better vegetation than along the coast and the nearness of the better forests in the interior to which they can shift their bee colonies when gregarious flowering begins. Details of the number of beekeepers surveyed and honey production/box/year in the coastal taluks and malnadu taluks are given in Figure 6.3 and 6.4 respectively

Situation in the malnadu villages is not much different from the coast, barring a couple of farmers, one from Kodkani village of Siddapur and the other from Kallalli village of Sirsi. Together these two farmers own 203 bee boxes and get high yields ranging from 12-15 kg/box/yr. Their villages have good vegetation and both of them have also good management practices. Wherever bee forage plants, especially nectar plants are less, scope for good honey production is bleak. The major problem of the bee-keepers in the interior hilly terrain is the scanty availability of bee forage materials during November to January. There is more need to enrich such areas with various early flowering herbs and other species until the forest trees come into bloom. These bee keepers require alternative locations, apart from their own private lands, during the lean season, to keep their bee boxes. Some of the malnadu farmers also get the benefit from the early flowering of the soapnut trees of the coast, by shifting their colonies and thereafter they return to their interior villages to get the benefit of summer blooms of forest plants.

Difficulties in evaluating the actual bee-keeping scenario

Most of the beekeepers interviewed were not in the habit of selling their products to the society, because of the lower prices such products fetch. It is difficult to estimate how many bee-keepers are there in Uttara Kannada through short term studies. Even in the 83 villages covered by us we could not meet all the bee keepers. Most of the terrain covered is hilly with often isolated houses or dispersed in small hamlets. Considering the fact that there are about 1200 revenue villages, in addition to over a dozen towns, the bee keeping, despite its waned state, is still an enterprise large enough to merit more detailed studies and assessment of potential for the future. The fact that nearly 7 kg of honey production per box, fetching an annual income of anything between Rs.2000-Rs.3000 per box maintained, reveals the enormous hidden potential of this enterprise to boost rural incomes through this eco-friendly activity which incidentally will also enhance agricultural income through pollination services from the bees. Further, our study does not cover honey collected from the wild by an uncounted number of persons from the villages close to the forests. Most of these activities are being carried out without any kind of special assistance to the farmers from the state. The study underscores the fact that if beekeeping is promoted and supported in all potential areas, Uttara Kannada can produce enough honey not only for domestic consumption but also for export.

A male-dominated enterprise

The family sizes of bee-keepers in the study area ranged from 2 to 16 persons at an average of 5.25. Wherever we surveyed it was found that bee-keeping was mostly a male dominated field. Greater female participation is necessary so as to increase the economic and nutritional security of especially the rural households. Motivation and training for women are necessary in this regard. Domestic use of honey in the households of the producers, despite its high nutritional quality, was poor. It varied from a minimum of 0.5 kg/yr to about 400 kg/yr in an exceptional case of a bulk producer from Sirsi, who has almost entirely replaced the household use of sugar and jaggery with honey and claims that to be the major reason for the good health of his family.

Bee-keeping for the landless

Although landed bee-keepers constitute a more privileged class, in Uttara Kannada there is good scope for the landless, especially in the villages, to adopt bee-keeping. Ganapati T. Naik of Bisgod village in Yellapur taluk, a landless person, owns about 60 boxes which he keeps in and around the village and earns a good income. He also sells bee colonies to others. The forest department should patronage the bee-keepers to use appropriate areas in the forests for keeping the bee-boxes, and as well as enrich the forests closer to villages with especially bee forage wild plants.

Table 6.1: Details of honey production during 2011 gathered from bee keepers in six taluks

Taluk	Persons interviewed	No. of Boxes	Qty (Kg)	Average (Kg)
Ankola	14	152	1021	6.72
Kumta	20	270	1604	5.94
Honavar	17	109	625	5.73
Yellapur	11	309	1945	6.29
Sirsi	14	451	4264	9.45
Siddapur	29	162	965	5.96
Total	**105**	**1453**	**10424**	**6.68**

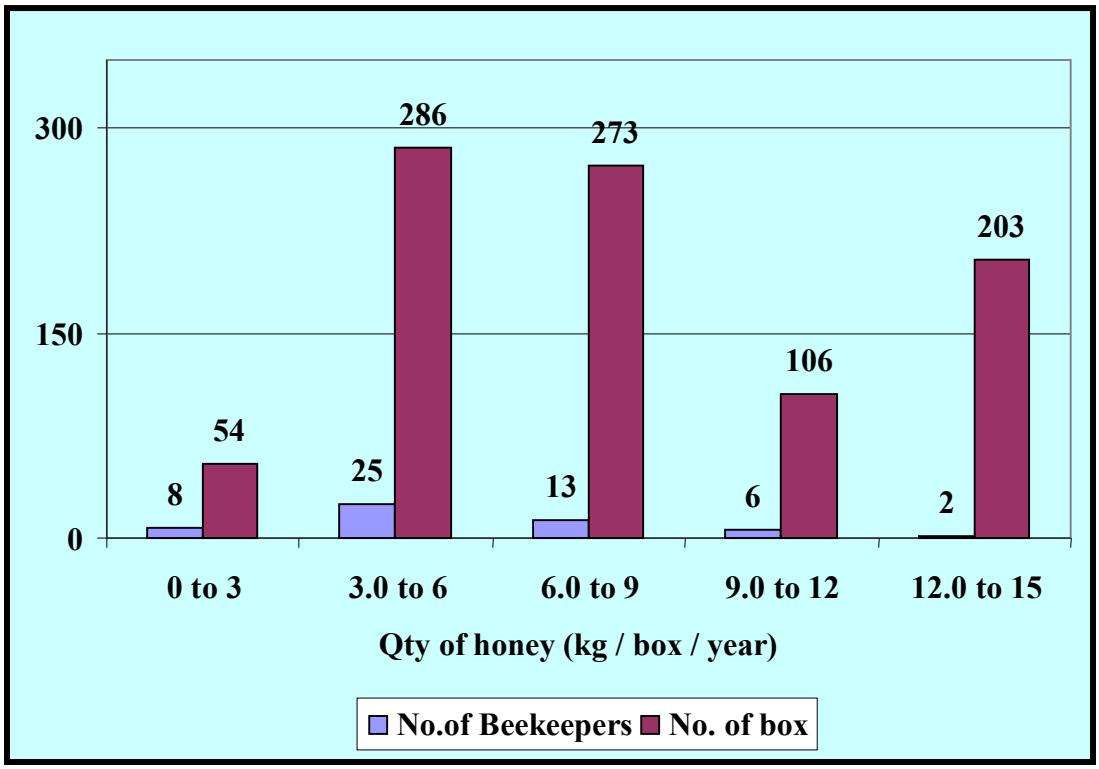


Figure 6.2: Beekeepers surveyed, number of bee boxes and average honey production/ box/year in the coastal taluks (Ankola, Kumta and Honavar) of Uttara Kannada

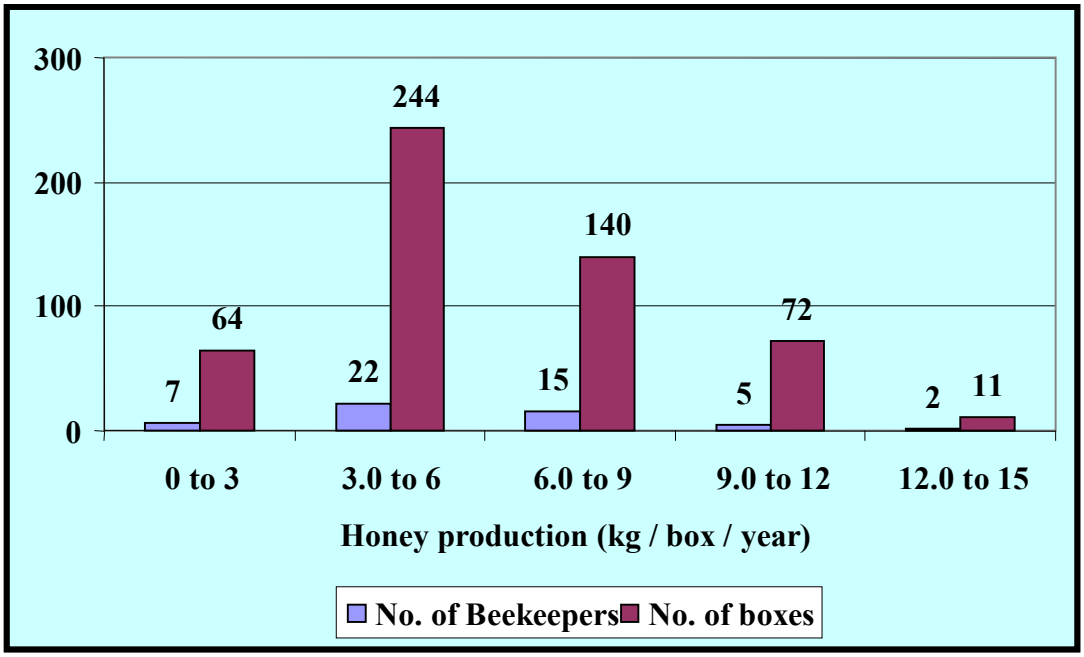


Figure 6.3: Beekeepers surveyed, number of bee boxes and average honey production/ box/year in the malnadu taluks (Yellapur, Sirsi and Siddapur) of Uttara Kannada

Plate 6.1: Kinds of honey produced by a bee-keeper in Sirsi taluk; 1. *Terminalia paniculata*; 2. *Carallia brachiata*; 3. *Syzygium cumini*; 4. *Strobilanthus* spp./*Carvia callosa*; 5. *Sapindus laurifolius*; 6. *Gliricidia sepium.*

Types of honey

The district produces a variety of honey types, mostly of organic origin. The honey type depends on the dominant kind of nectar sources of the season, which determines the colour, aroma, composition and taste. The composition of honey varies, depending mainly on the source of the nectar(s) from which it is originated and to a lesser extent on certain external factors, for eg. climatic conditions and bee keeping practices (White 1975). We could document seven types of honey from Sirsi taluk. Of these six types are unifloral honey mainly from the flowers of *Terminalia paniculata* (Honagalu honey), *Syzygium cumini* (Neerilu honey), *Carallia brachiata* (Andamurugilu honey), *Strobilanthus* spp. & *Carvia callosa* (Gurige honey), *Sapindus laurifolius* (soapnut or Atalakai honey) and *Gliricidia sepium* (Goppara) Plate: 6.1). Most commonly two kinds are recognized locally viz. mixed and soapnut honey. The demand for unifloral honey such as from soapnut is very high compared to mixed honey. It would be, therefore, beneficial to plant large number of soapnut trees in the district, especially in the coastal taluks. Even though the quality of honey was identified in three ways like physical, chemical and biological methods, most local people grade the honey by its taste, viscosity, smell and colour.

6.4. Recommendations

1. Training programmes

a) ***Honey production*: *theory and awareness:*** There is large number of aspirants for apiculture in Uttara Kannada. If proper awareness and training programmes are conducted bee keeping can be a major income-generating activity especially in rural areas. Many people have interest; yet they are scary of bee stings or about gaining profits due to lack of encouragement and proper knowledge. By appointing adequate number of trainers, directly by the Government, or commissioning experienced bee keepers from the district itself as trainers, on honorary basis, the bee keepers' societies can still play key role in promoting this enterprise and bring it at par with China, the world's highest producer of honey. The trainers need to conduct the programmes at two levels. Using power point presentation, especially at panchayat level they can impress upon the village

community on the importance of bee keeping. A selection can be made of prospective persons who can be given the second level of training with more practical components, including a series of visits to successful apicultural farms in the district and outside. Relevant literature on bee keeping theory and techniques should be provided to the trainees free of cost.

b) ***Using wild colonies from the jungles for domestication through traditional expertise:*** Many local villagers, especially belonging to the communities such as Halakkivokkals, Siddis, Kumri Marattis, Kunbis etc. have the knowledge of collecting wild bee colonies and transferring them to the bee-keeper's boxes. This is a much cheaper method, costing about Rs.300- Rs.500, per colony transfer. At the same time purchasing such a colony at market prices will cost anything between Rs.1200-Rs.1700, which many cannot afford. Caution is necessary regarding the timing of bee colony collection from the wild as the period from late March to early June is honey collection period from the forests. It is recommended strongly that for rearing purpose jungle colonies may be transferred to the brood chamber of the bee box during September and October. By February the box will be full of bees, all the seven to eight frames occupied by the bees through multiplication within the box itself. The bee box starts yielding honey from February to end of May. As this is the flowering season for most forest plants and horticultural crops, honey from the boxes can be collected at intervals of seven to 14 days.

c) ***Populating new boxes:*** A well maintained bee box can accommodate seven to eight frames of bees in the brood chamber. Each brood chamber is topped with a super chamber, from which alone honey has to be extracted as the brood chamber honey has to be kept in the reserve for the sake of the growth and functioning of the colony. Once the newly trained bee-keeper, becomes successful in rearing honey bees, he needs training in developing new colonies for introducing in more boxes in his own farm. He can even trade surplus colonies to others. To develop a new colony the bee-keeper may remove four frames with honey bees to a new bee box where already four empty frames are fixed. The new bee box to be populated has to be kept as far away from the original colony so as to prevent the migration of the queen from the old box to the new.

d) ***Regulating the number of queen bees:*** Normally one bee box should have only a single queen bee. If an additional queen tends to develop by chance in a larger cell the worker bees will not provide royal jelly critically necessary for maturity of the queen bee. By mistake if an additional cell with developing larva gets stored with royal jelly one more queen develops in the same box. If more than one queen develops in a bee box it is likely to fly away from the parent box to establish a new colony elsewhere. Her flight is often accompanied by a horde of thousands of worker bees, deserting the parent colony, leading to its collapse, as less number of workers is left here to gather pollen and honey. The bee-keeper should keep an eye on such disorders in the colony and remove the extra queen cell itself or destroy the larva developing in the queen cell.

e) Screening for healthy queen bees: The setting up of a healthy colony depends on the quality of the queen bee. If the queen bee is undersized or unhealthy or infected with parasitic mites it will affect the egg laying capacity, or the eggs hatch into undersized bees etc. The bee keepers are to be guided to select every year a new queen for the colony as it has greater egg laying capacity leading to more number of healthy worker bees resulting in greater honey production.

f) ***Ideal time for setting up new colonies:*** Separation of a queen bee for setting up a new colony has to done before September, in the conditions of Uttara Kannada. After September with the beginning of overall flowering season the bees become active collecting nectar and pollen for brood development and therefore the worker force has to be maintained in the box.

g) ***Shifting bee boxes for greater production:*** An atmosphere of goodwill has to be created among the bee keepers and the general public so as to facilitate the bee keepers shifting the boxes of bee colonies to places with good amount of bee forage plants. Considering also the fact that bees are tremendous forces in pollinating horticultural crops and forest trees, various other medicinal plants etc., the farmers and foresters should welcome bee keepers to set up the bee boxes in their farms and forests respectively. In a small way however, 'nomadic' bee-keeping is happening in the district. For instance most of the soapnut trees (*Sapindus laurifolius*), the sources of the highly priced soapnut honey, are concentrated in the coastal taluks. Soapnut trees are the earliest to flower, November-December being their blooming period. Some of the bee keepers from the interior

villages set up bee boxes in the coastal taluks on mutual understanding with the locals, so as to harvest soapnut honey, the first honey of the season. Likewise some of the coastal bee keepers also shift their bee boxes into interior hill ranges to derive benefit of the peak flowering season of a variety of wild plants.

Shifting colonies in search of flowers

K.B. Gunaga of Alageri, a sea coast village of Ankola taluk, and one of the best producers of honey from the taluk, as well as a member of the local society, finds it hard to get any honey, except from soapnut trees of the coast. The large-scale raising of *Acacia auriculiformis* plantations along the coast has adversely affected wild plant growth necessary for bees. Therefore the farmer shifts his almost 40 boxes into Hillur and Yana, well-forested villages, in the interior, from mid-February onwards to reap maximum benefit from mass flowering of a great diversity of plants. The shifting of the bee boxes has to be done only after sunset, when the bees have returned to their colonies. The entrance to the box has to be sealed with bee wax itself so as to prevent bees from flying away during transport.

Plate 6.2: K.B. Gunaga, beekeeper of Alageri, Ankola taluk, explaining foraging bees in beehive

h) Training in dis-infestation and disease control: Attack by mites, wax moth etc. and viral, bacterial and fungal diseases can have devastating effect on bee keeping (Chapter 4 for more details). The bee keepers are scared of such outbreaks of pests and diseases and

are often in the dark about how to deal with them. The bee keepers needs training in diagnosing the ailments of the bees and in adopting preventive and quarantine measures before greater expertise to deal with the problem is made available by the Government.

i) ***Protection from predators:*** Ants can be a menace on the bee colonies as honey in the hive is a great attraction for them. The use of water stored in containers around the legs of the box is the safest and most eco-friendly measure for keeping away the ants from access to bee colony. Awareness should be spread against the ill effects of chemical pesticides for that purpose. The attack by carpenter bees which capture and carry away honey bees to feed their young ones is almost an unsolvable problem that needs experts' attention.

j) ***Optional feeding during lean periods:*** The farmers need to be instructed about the importance of conservation of honey in the super chamber of the colony during the lean periods, especially the rainy season, when practically the bees do not get any food. There is the general practice among the bee keepers of providing sugar or jaggery solution as feed for the bees. Although the bees live feeding on such substances, these being mainly of sucrose, provide only calories and not the proteins vital for development of the larvae. Protein rich gram flour (from black gram, soybean, Bengal gram etc.) made into a paste with sugar and honey may be better option to provide vital nutrients to the adults and developing bees.

k) ***Awareness on pollination benefits:*** The great role of bees in pollination of especially horticultural crops need to be highlighted in the training programmes, through excursions to such farms with pronounced yield increase because of bees and through invited talks from such bee-keeper farmers. It is not merely extraction of honey for trade purpose that should motivate the farmers; the role of bees as pollinators to achieve higher yields and quality fruits and seeds is also very important. The bee keeping has to be ingrained as a culture among the farming community and even among the rural landless for the multiplicity of benefits that include income from honey, nutritional security and pollination of both cultivated and wild plants.

l) ***Awareness on organic farming:*** The widespread and indiscriminate use of pesticides in the agricultural sector can be detrimental to bee keeping. The evils of pesticide application can be far reaching on human health as well as of the various beings in the

ecosystem. The honey bees are very susceptible to the toxic effects of pesticide use as organophosphates can be deadly neurotoxins on them. The pesticide use is becoming a widespread practice in the coastal areas than in the interior of the district where organic farming is more popular. During our survey, we came across a case of organophosphate application on sweet potato crop in Bijjur village of Gokarna panchayat that caused death of honey bees in five boxes in the vicinity.

2. Forests in support of beekeeping

In Uttara Kannada district most human settlements, barring some major towns, are dispersed among forest lands. These forest lands might be having already good vegetation, or may be poorly vegetated; for instance, the coastal minor forest belt is substantially barren or supports only scrub and Acacia plantations. These are not good places for healthy bee colonies, and naturally, there are less people on the coast having interest in apiculture. In the interior villages the forests may be rich or may be a combination of diverse landscape elements which include monoculture plantations (teak, Acacia etc.), scrub jungle, savanna, betta (leaf manure forests which are often heavily lopped). Our surveys and interviews with the bee keepers reveal that good vegetation with several species of nectar plants are very essential for enhancing honey production. Therefore we recommend the following:

a) ***Enrichment of coastal minor forests with bee forage plants:*** The ground in the coastal minor forests is very eroded, rocky and compact, often lateritic, or strewn with granitic boulders and fragments. The laterite formations of Kumta to Bhatkal have been destitute of good vegetation even before the British arrival in Uttara Kannada. Human impact seems to be the major reason for the general state of vegetational devastation of the coast. Once the original vegetation is destabilized through cutting and burning, for repeated cultivation or cattle grazing, the torrential monsoon rains erode the exposed soils and thereafter the hot sun bake the surface creating hard lateritic surfaces. These coastal hills and plateaus at the most could support scrub or savanna and some kind of stunted semi-evergreen forests where the soil conditions are better. During the last two to three decades a good lot of these areas have been brought under monoculture of *Acacia auriculiformis*. Apiculture in the coastal villages is not all that attractive proposition in

the given situation, and the bee keepers are hard to find. Some of them carry their bee boxes into the interior forested villages once the early honey, mainly of soapnut plant origin is harvested. For instance K.B Gunaga from the coastal village of Alageri in Ankola moves into the interior villages of Hillur and Yana to fix his bee boxes, from mid-February of every year, after the soapnut honey season comes to an end as the coast does not have much to offer thereafter. Likewise some of the interior taluk bee-keepers take their bee boxes to the coastal areas to take benefit of the soapnut flowering.

b) ***The importance and profitability of soapnut tree:*** The soapnut tree (*Sapindus laurifolius*) is an excellent producer of high quality honey. It is one of the earliest to flower among the notable nectar plants, coming into bloom during November-December, soon after the rainy season. The honey, esteemed medicinally due to its slightly bitter taste and less sugar and other properties, was sold for about Rs.700/kg till a year ago and fetches these days a price exceeding Rs.1000/kg. Soapnut tree grows commonly along the coastal villages. It can be grown in a variety of soils including in lateritic areas and roadsides. Many bee-keepers demanded that soapnut tree be liberally planted by the forest department in all blank areas. On a modest estimate, if we succeed in raising 100,000 trees, at the average rate of three kg of honey per tree, each kg fetching Rs.1000/- at current market prices the potential income from one lakh soapnut trees could be Rs.30 crores. Apart from income from honey, the soapnut fruit is a non-timber forest produce used in production of soap and cosmetics. The tree will provide also a good cover for the open lands subjected to high degree of soil erosion.

c) ***Need for improving the betta forests:*** The bettas are forests allotted to arecanut gardeners for collection of dry leaves and lopped green leaves from trees as manure for their gardens. Betta allotment is highest in Sirsi, Siddapur and Yellapur taluks where horticulture is most important. Most of the bettas have today heavily lopped trees; they have open canopy and poor vegetation on the ground. Good bee-keepers shy away from keeping their bee boxes inside or closer to these bettas. Therefore, we suggest here that at least one third of the betta lands be enriched with bee forage plants, and the forest and horticulture departments should provide necessary guidance to the farmers and supply saplings of these bee forage plants.

3. Government assistance for bee-keepers

The Government may help bee-keepers with necessary equipments than with cash subsidies. The Government assistance may also include enrichment of bee flora in the village areas and the forests around, by planting such species along roadsides, public premises etc. Free guidance programmes should be taken up to help rural entrepreneurs to take up bee keeping, for purification and packaging honey and in disease prevention and control. Subsidies and loans are to be restricted to the functional boxes only so that Government aid is not misused.

4. Guidance for honey hunters

Honey hunting in the wild often happens to be destructive exercises. The bees are driven away with fire and smoke and the entire hive pulled down and squeezed to extract honey causing destruction of thousands of eggs, larvae and pupae. The honey hunting in the wild should be using sustainable methods. The Village Forest Committees and bonafide forest dwellers like Kunbis, Kumri Marattis, Karivokkaligas, Siddis etc. alone should extract honey on sustainable basis from only areas designated for the purpose by the Forest Department, leaving behind sufficient stock of untapped beehives so as not to decimate the genetic stock of wild bees very necessary for infusing resistance into the domestic bees, as the bee boxes are often colonized by capturing wild bees of the species *Apis cerana.* The Forest Department may periodically take stock of the situation and decide to close certain area of forests to honey collections, which are under threat from overharvests, until such areas recuperate well. The bonafide honey collectors may be provided with protective uniforms and awareness on scientific collection and processing techniques.

5. Bee colony heritage trees

The bees, especially *Apis dorsata,* prefer certain large trees such as *Tetrameles nudiflora* for establishing their colonies. Any such tree with more than ten colonies may be considered for declaration as a ‘heritage tree’ under the provisions of the Biodiversity Act-2002 of Government of India.

6. Prospects of beekeeping in mangroves

Mangroves play an essential role in maintaining a healthy coastal environment by providing protection for aquatic species, functioning as a habitat for a variety of terrestrial fauna, in improving coastal protection and acting as a source of nutrients that sustains many complex food chains. These swamp forest communities are often employed in promoting shrimp cultures (Olsen and Maugle, 1988; Stonich, 1992). A variety of renewable products including timber, food, charcoal, firewood, honey and medicine are traditionally obtained from mangroves by many local communities world-wide (Kovacs, 1999).

The mangroves are good producers of honey. Forest Survey of India (1999) estimated about 487,100 ha area under mangroves in the country. The Sundarbans, which has largest area under mangroves, has been a major production centre for honey. It accounted for 111 tons of honey production, which was 90% of the total honey from mangrove areas of India (Krishnamurthy, l990). *Phoenix– Excoecaria* combination of trees associated with mangrove swamps offer ideal habitats for honey comb formation in the wild in the Sundarbans, accounting for maximum number of combs per unit area. *Rhizophora* and *Avicennia* (*A. alba* and *A.officinalis*) also accounted for good number of combs. *Aegiceras corniculatum* and several mangrove associates are useful for honey production. Area under mangroves is steadily under rise in Uttara Kannada during the recent years due to consistent efforts made by the forest department. If more attention is paid to the planting of nectar producing species more people from the coast will be benefited by bee keeping.

7. Importance of organic honey production

The demand for organic honey is on the rise in developed countries. Honey production from intensive agricultural landscapes, because of usage of chemical pesticides and fertilizers cannot be termed as organic. Bulk of Uttara Kannada's honey production probably would fall in the organic category on account of the cattle and forest dependent farming practices. The district needs to capitalize on this and intensify production of organic honey for export, supply to pharmaceutical companies and for domestic consumption.

Chapter 7: Floral enrichment for honey production

Studies on the nature of the interactions between plants and animals are important to understand the structure and dynamics of ecosystems services, and have helped clarify issues of regeneration and conservation of resources. Mutual adaptation of flowers and insect pollinators especially honeybees and their interdependence are considered to be the result of their intimate co-evolution through geological ages. Many forms of flowers evolved due to selective pressure of pollinators. Flowers have to match with the needs of the pollinators and vice versa in the competition for limited resources. Whether it is for pollination or for food, selective pressure is directed towards increasing the excellence of the match between flower and pollinator (Bawa and Hadley 1990).

As flowers can be regarded as pollination units, their functional structure is closely related to their pollination mechanisms. In the animal pollinated flowers, usually the corolla is variously coloured, with different shapes and fragrances and produce nectar and pollen to attract the pollinators. The corolla also functions as a landing centre for pollinators, especially the insects. When the flower is ready for pollination the stigma of the female reproductive organ, the gynoecium gets sticky surface to which the pollen brought by the pollinator can stick and germinate to form the pollen tube that carries the male gametes into the ovary to the female gametes paving way for the seed setting. Honeybees are highly efficient pollinators. In combination with stingless bees they exploit nectar sources rapidly and surplus nectar is accumulated in their hives (Visscher & Seeley, 1982). The members of the family Apidae, including our honey bees, are long tongued with which they can suck nectar from nectaries situated deep in the flower.

Honey bees depend on plants for varied purposes such as for food in the form of pollen and nectar, and resin or propolis as an adhesive for attachment and repairs of hives. Pollen being the principal source of protein, fats, vitamins and minerals, it is essential for brood rearing and growth in colony strength. Nectar consists of carbohydrates, mainly sucrose, fructose and glucose, and is the raw material of honey (Duangphakdee et al., 2009). The composition and

properties of honey varies with floral sources utilized by the bees as well as regional and climatic conditions (Trstenjak et al., 1993; Salinas et al., 1994; Perez- Arquillue et al., 1994). Regardless of the initial concentration of sugar in the nectar, that varies from plant species to species, honeybees must concentrate nectar to at least 82% for larval food storage, by a process of evaporation first on their tongues and later in cells (Winston, 1987).

The bees depend on flowering plants of all life spans such as annuals, biennials and perennials and of habits like herbs, shrubs, trees and climbers. Notable examples of some of the annual plants that the bees forage for pollen and nectar are sunflower (*Helianthus annus*) and mustard (B*rassica juncea*). Studies showed yield increase to the tune of 67.7% and 28.08% respectively in mustard, for open pollinated crop and crop enclosed along with honey bees, respectively, compared to control crop enclosed without honey bees (caged without bees) (Harichand and Singh,1995). Nath and Viraktamath (2010) found that *A. dorsata* constituted 96.14% of the pollinators of sunflower followed by *A. florea* (3.35%) and *A. cerana* (0.51%) respectively. Several biennial crops also depend on bees for pollination. Honeybees were found to be predominant pollinators of cauliflower in Haryana. Among honeybees, *Apis dorsata, Apis mellifera, Apis cerana* and *Apis florea* constituted 28.3%, 26.32%, 24.20% and 21.23% respectively (Selvakumar et al., 2003). Perennials or plants that live for several years and producing flowers year after year (For e.g. Mango, Banana, Cashew, wild trees and others) are very important in bee-keeping. To maintain beehive populations throughout the year we need a mixture of crop plants including annuals (eg. sunflower, mustard), biennials (eg. radish, sesame) and perennials (eg. mango, soapnut, neem). Such mixed group of species of different habits and life spans, in combination with selected group of wild plants of the region will help in optimizing honey yields almost throughout the year.

Bee-flora is the most important factor in bee management as the bee population; its health and survival are related to the abundance of mainly the nectar plants on which the bees forage. Adequate nectar and pollen resources are critical in maintaining honey bee health (Haydak, 1970; Zamarlicki, 1984; Michener, 2007). A deficiency in quantity and quality of pollen and nectar can lead to population decrease of the colony; low colony populations in turn further reduces the number of bees available to collect pollen and nectar (Keller et al., 2005). Moreover,

recent work has shown the importance of pollen quality and diversity on the immune response of honey bees (Alaux et al., 2010). Decline of bees and their food plants are reported world wide (Biesmeijer et al. 2006 Steffan-Dewenter et al., 2005; Biesmeijer et al., 2006; Goulson et al., 2008; Freitas et al., 2009). Sustainable beekeeping in India can only be achieved through understanding and conservation of the most resourceful plants for the bees in terms of nectar, pollen and resin. Knowledge on bee-plants that are important to bees in different localities and seasons is still very scarce in India. Therefore we have attempted here documentation of important plant species to enrich the honey production. Our data was collected by primary field survey, interviews with bee farmers as well as from literature surveys applicable to the focal region (Sivaram, 2001; Banakar, 2009; Thomas et. al., 2009; Danaraddi et al., 2009 and Roy et. al., 2011). In Table 7.1 is given a list of nectar/pollen plants suitable for bee farming in Uttara Kannada district. We have also presented a more elaborate list of plants suitable for bee foraging in Karnataka State, based on Sivaram (2001) in the Annexure 2. The genera like *Syzygium, Terminalia, Strobilanthes*, *Holigarna*, *Sapindus, Vateria, Lagerstroemia, Phyllanthus, Areca*, *Cocos, Caryota, Crotalaria, Dalbergia, Pongamia, Pterocarpus, Xylia, Strychnos, Careya, and Vitex* are some of the very important genera as food sources for honeybees in Uttara Kannada.

Honeybee species have their own preferences for plants as habitats. This host specificity is determined by branching pattern, flowering phenology and provision of holes and crevices in tree trunks (Table 7.2). *Apis cerana* (cavity nesting bees) require cavities and hollows in big trees for nesting. *Apis cerana* are considered as photophobic bees and prefer shaded parts for colonization. In our study areas we could observe its nesting sites in trees like *Caryota urens, Careya arborea, Terminalia paniculata, Lagerstroemia microcarpa* and *Vitex altissima. Apis dorsata* is a more of a light loving bee and in our study area 21 tree species were associated with its colonies, in addition to the giant rock formations of Yana and some large buildings. *Tetrameles nudiflora*, a very gigantic soft wooded, deciduous tree is a preferred nesting site for this bee and several large sized hives are often seen on the same tree (Plate 7.1.). *Trigona iridepennis,* the stingless small bees, a minor source of honey (‘misri’ honey of medicinal value) was associated with seven tree species in our study area. In addition it also occurs in the holes and cracks of old buildings (Refer Chapter 6 for more details on promoting forage plants for honey bees).

Table 7.1: List of important pollen (P)/nectar (N) plant sources recommended for promotion of bee farming (Major sources in the bold), shrub (S), herb (H), climber (C), and tree (T).

S.No	Botanical names	Common names		Habit	P/N	Remarks/suitability
	Acanthaceae					
1	***Strobilanthes heyneanus***	Strobilanthus	Gurugae	S	P,N	All forests
2	***Strobilanthes callosus***	Strobilanthus	Gurugae	S	N	
3	**Strobilanthes ixiocephala**	Strobilanthus	Gurugae	S	N	Evergreen/semi-evergreen areas
	Anacardiaceae					
4	***Holigarna arnottiana***	Black varnish tree	Holegeru	T	P,N	Evergreen/semi-evergreen areas
5	***Holigarna beddomei***	Black varnish	Doddale holegeru	T	P,N	
6	***Holigarna ferruginea***		Holegeru	T	P,N	
7	*Mangifera Indica*	Mango	Mavu	T	N	All district
8	*Nothopegia racemosa*		Gandu holegeru	T	P,N	Evergreen/semi-evergreen areas
	Apocynaceae					
9	*Alstonia scholaris*	Devil's tree	Maddale	T	N	All district
	Arecaceae					
10	***Caryota urens***	Indian sago palm	Baine	T	P	Coast and malnadu
11	*Phoenix sylvestris*	Wild date palm	Echalu mara	T	P	Dry open areas
12	*Phoenix sp.*			T	P,N	
	Asteraceae					

13	Calendula sp	Marigold			P	Household gardens
14	*Cosmos sp.*				P,N	Household gardens
15	***Helianthus annus***	Sunflower	Suryakanthi	H	P,N	Cultivation, household gardens
16	Zinnia elegans	Zinnia				Household gardens
	Balsaminaceae					
17	*Impatiens sp.*	Balsam		H	P,N	Ornamentals, seasonal wild
	Bombaceae					
18	*Bombax ceiba*	Silk cotton tree	Booralu	T	P,N	Deciduous forests
	Boraginaceae					
19	*Cordia dichotoma*		Challe kayi	T	P	Deciduous forests
	Burseraceae					
20	***Canarium strictum***	Black dammer	Kayi dhoopa	T	P,N	Evergreen/semi-evergreen areas
	Caesalpinieae					
21	Cassia fistula	Indian laburnum	Kakke / Konde	T	N	Deciduous forests, roadsides, parks
	Clusiaceae					
22	*Calophyllum apetalum*	Coachwood	Bobbi	T	P	Evergreen forests along water bodies
23	*Garcinia gummigutta*	Malabar gamboge	Uppage	T	N	
24	*Garcinia indica*	Kokam	Murugalu	T	N	Evergreen/semi-evergreen areas
25	*Garcinia morella*	Gamboge	Arasina gurgi	T	N	
26	*Garcinia talbotii*			T	N	

27	*Garcinia Xaonthochymus*		Devegarige	T	N	
28	***Mammea suriga***	Surangi	Suragi mara	T	P,N	Coastal semi-evergreen areas
	Combretaceae					
29	***Terminalia bellirica***	Belliric myrobalan	Tare	T	N	Deciduous forests, roadsides, parks
30	***Terminalia chebula***	Myrobalan	Anale	T	N	Dry decidous forests
31	***Terminalia tomentosa***	Laurel	Matti, Kari-matti	T	P,N	Deciduous forests
32	***Terminalia paniculata***		Honagalu, Bili-matti	T	P,N	
	Convolvulaceae					
33	*Ipomoea sp.*				P,N	Protection of wild climbers
	Dilleniaceae					
34	***Dillenia pentagyna***	Karmal	Kadu kanigale	T	P,N	Deciduous forests, roadsides, parks
	Dipterocarpaceae					
35	*Hopea ponga*		Haiga	T	N	Evergreen/semi-evergreen areas
36	***Vateria indica***	Indian copal tree	Dhupada mara	T	P,N	
	Ebenaceae					
37	***Diospyros buxifolia***	Gaub tree	Kunchiganamara	T	N	
38	***Diospyros candolleana***		Kari-mara	T	N	Evergreen/semi-evergreen areas
39	***Diospyros malabarica***		Antina mara	T	N	
40	***Diospyros melanoxylaon***	Coromandel ebony	Tumari, Tendu	T	P	Dry decidous forests
41	***Diospyros montana***	Mountain ebony	Balagane	T	N	

42	***Diospyros oocarpa***		Kari-mara	T	N	Evergreen/semi-evergreen areas
	Euphorbiaceae					
43	Mallotus phillppensis		Kumkumada mara		P	Semi-evergreen/deciduous forests
44	***Phyllanthus emblica***	Gooseberry	Nelli	T	P,N	Deciduous forests, roadsides, savannas
45	*Santalum album*	Sandalwood tree	Chandana	T	N	Deciduous forests/gardens
	Fabaceae					
46	*Acacia catechu*	Cutch tree	Kachu, Khair	T	P	Dry decidous forests, open rocky areas
47	***Acacia sinuate***	Shikakai	Seege-balli	C	P,N	Deciduous forests
48	*Butea monosperma*	Flame of the forest	Muttaga	T	N	Decidous forests, roadsides, parks
49	***Dalbergia latifolia***	Rose wood	Beete / Sisam	T	N	Deciduous forests
50	***Pongamia pinnata***	Indian beech tree	Honge mara	T	N	Various habitats
51	***Pterocarpus marsupium***	Kino tree	Honne	T	P,N	Deciduous forests
52	*Samanea saman*	Rain tree		T	P	Avenue trees
53	*Tamarindus indica*	Tamarind	Hunise-mara	T	P,N	Roadsides, cultivation
54	***Xylia xylocarpa***	Burma Ironwood,	Jamba	T	P	Deciduous forests
	Flacourtiaceae					
55	***Flacourtia montana***	Mountain sweet thorn	Sampige hannu	T	P	Semi-evergreen/deciduous forests
	Lauraceae					
56	*Alseodaphne semicarpifolia*		Mashe	T	P	Semi-evergreen/deciduous forests

57	*Cinnamomum malabathrum*	Cinnamon	Dalchini	T	N	Evergreen/semi-evergreen areas
58	*Cinnamomum zeylanicum*	Wild cinnamon	Dalchinni	T	N	
	Loganiaceae					
59	***Strychnos nux-vomica***	Snake -wood	Kasarka	T	P,N	Deciduous forests
	Lythraceae					
60	Lagerstroemia indica			T	P	Deciduous forests
61	***Lagerstroemia microcarpa***	Ben teak	Bili nandi	T	P,N	
	Malvaceae					
62	*Hibiscus sp*				P,N	Ornamentals
	Melastomataceae					
63	***Careya arborea***	Ceylon Oak	Kavalu	T	P,N	Deciduous forests
	Mimoseae					
64	*Albizzia sp*		Bilkambi, Sirsul		P,N	Deciduous forests
	Moraceae					
65	*Artocarpus hetrophyllus*	Jack fruit	Halasina mara	T	P	Evergreen/semi-evergreen areas, cultivation
66	*Artocarpus hirsuta*	Wild jack fruit	Hebbalasu	T	P	Evergreen/semi-evergreen areas
67	*Artocarpus lakoocha*	Lakooch	Waate-huli	T	P	Cultivated; deciduous forests
	Moringaceae					
68	***Moringa oleifera***	Drum strick	Nuggi-mara	T	P	Cultivated
	Myrtaceae					

69	***Syzygium cumini***	Black berry	Neerle	T	P,N	Semi-evergreen/deciduous forests
70	***Syzygium caryophyllatum***	South Indian Plum	Kuntu Neerilai	T	P,N	
71	***Syzygium gardneri***		Henneralu	T	P,N	Evergreen forests along water bodies
72	***Syzygium hemisphericum***		Dodda Neerilai	T	P,N	Evergreen/semi-evergreen areas
	Oleaceae					
73	*Aporosa lindleyana*	Indian olive	Salle mara	T	P	Evergreen/semi-evergreen areas
	Polygonaceae					
74	*Antigonon leptopus*	Coral creeper	Antigonum	C	N	Ornamental creeper
	Rhamnaceae					
75	***Ziziphus rugosa***	Wild Jujuba	Bile mullu hannu	T	N	Evergreen/semi-evergreen areas
	Rhizophoraceae					
76	***Carallia brachiata***	Indian Oak	Andi/ Anda murugala	T	N	Evergreen/semi-evergreen areas
	Rubiaceae					
77	***Anthocephalus cadamaba***	Kadamba tree	Kadamba vruksha	T	N	parks
78	***Mitragyna parvifolia***	Kalam	Etagalu mara	T	P,N	Deciduous forests
79	***Randia dumetorum***	Bush randia	Khare mara	T	P	Deciduous forests, scrub
80	***Ixora brachiata***		Gurani	T	P,N	Semi-evergreen/deciduous forests
81	*Murraya Koenigii*	Curry leaf tree	Curry leaf plant	T	N	Gardens, deciduous forest undergrowth
	Sapindaceae					
82	*Allophylus cobbe*	Sidisale	Moorele balli	C	N	Scrub, semi-evergreen edges

83	***Sapindus laurifolia***	Soapnut tree	Antuvala / Attlakay	T	P,N	Coastal forests, roadsides, gardens
84	***Schleichera oleosa***	Ceylon Oak	Sagadi mara	T	N	Deciduous forests
	Sapotaceae					
85	*Chrysophyllum roxburghii*	The star apple	Hale mare	T	P,N	Evergreen forests
86	*Manilkara zapota*	Sapota	Chikku	T	P,N	Cultivation, household gardens
	Simarubaceae					
87	*Ailanthus triphysia*		Halamaddi dhoopa	T	P,N	Roadsides, semi-evergreen
88	*Zanthoxylum rhetsa*	Indian prickly ash	Jummana kayi	T	N	Coastal lateritic areas
	Tiliaceae					
89	*Grewia tiliaefolia*	Dhaman	Dadasalu mara	T	N	Deciduous forests
	Ulmaceae					
90	*Celtis cinnamomea*		Hitari, Hartal		P,N	Semi-evergreen/deciduous forests
	Verbenaceae					
91	*Gmelina arborea*		Shivani		P,N	Deciduous forests
92	***Vitex altissima***	Peacock Chaste Tree	Bharanige	T	P,N	Semi-evergreen/deciduous forests

Table 7.2: Nesting plants of honeybees (based on Thomas et. al., 2009; Danaraddi et al., 2009 and Roy et. al., 2011; Nair, 2003 and our own observation)**.**

S.No	Family	Scientific Name	*A.cerana*	*A.dorsata*	*Trigona sp.,*
1	Anacardiaceae	*Anacardium occidentale*	+	-	-
2	Anacardiaceae	*Mangifera indica*	+	+	-
3	Arecaceae	*Caryota urens*	+	+	-
4	Bombacaceae	*Bombax ceiba*	-	+	-
5	Burseraceae	*Canarium strictum*	+	-	-
6	Fabaceae	*Peltophorum ferrugenium*	-	-	+
7	Celastraceae	*Lophopetalum wightianum*	+	-	-
8	Combretaceae	*Terminalia bellerica*	-	-	+
9	Combretaceae	*Terminalia paniculata*	+	+	+
10	Datisticaceae	*Tetrameles nudiflora*	-	+	-
11	Dilleniaceae	*Dillenia pentagyna*	+	+	-
12	Ebenaceae	*Diospyros melanoxylon*	-	+	-
13	Elaeocarpaceae	*Elaeocarpus tuberculatus*	-	+	-
14	Euphorbiaceae	*Bridelia retusa*	-	+	+
15	Fabaceae	*Ficus microcarpa*	-	+	-
16	Fabaceae	*Acrocarpus fraxinifolius*	-	+	-
17	Fabaceae	*Ficus sp.*	-	+	-
18	Lauraceae	*Persea macrantha*	-	+	-
19	Lythraceae	*Lagerstroemia microcarpa*	+	+	-
20	Melastomataceae	*Careya arborea*	+	-	-
21	Fabaceae	*Albizia lebbeck*	-	+	-
22	Moraceae	*Artocarpus hirsutus*	-	+	-
24	Myrtaceae	*Syzygium sp.*	-	+	-
25	Sapindaceae	*Schleichera oleosa*	-	+	+
26	Sterculiaceae	*Pterygota alata*	-	+	-
27	Tiliaceae	*Grewia sp.*	-	+	-
28	Verbenaceae	*Vitex altissima*	+	-	+
29	Rubiaceae	*Neolamarckia cadamba*	-	+	-
30	Fabaceae	*Pterocarpus marsupium*	-	-	+

Plate 7.1: Nesting sites of honey bees

Tetrameles nudiflora	*Careya arborea*
	
Terminalia sp.,	***Apis cerana* hive on a termite mound**
	

Chapter 8: Honeybee Forage Plants and Planting Recommendations

Family: Acanthaceae
Adhatoda vasica (Vasaka)
A shrubby medicinal plant. Flowers good sources of nectar for honey bees.

Figure: ***Adhatoda zeylanica***

Family: Acanthaceae
Strobilanthes heyneanus*:** Shrubby plant closer to perennial streams in evergreen forests. This nectar producer is not common and habitat protection is important. Flowers once in four years. **Figure:** ***Strobilanthes heyneanus
Strobilanthes ixiocephalus: Shrubby plant with white flowers. Forest undergrowth in coastal and malnadu taluks.

Family: Acanthaceae
Stroblathes callosus *(Carvia callosa*) (vern: Karvi): A shrubby species of forest undergrowth. The species is gregarious and lives for about eight years; vegetative phase only lasts for about seven years and happens a mass flowering phase followed by the death of the entire population. The flowers are rich in pollen and nectar and are important forage plants for honey bees.

Family: Alangiaceae ***Alangium salvifolium*** (Ankolaemara): A thorny evergreen tree; often in moist secondary forests. Medium source of nectar and pollen.	
Family: Amaranthaceae ***Achyranthes aspera*** (Utrani; Apamarga): Medicinal herb; medium producer of nectar. Recommended promotion of its seasonal natural growth in beekeepers' gardens.	
Family: Acanthaceae ***Barleria cristata*** Shrubby ornamental grown for colorful flowers. Medium source of nectar; also good for pollen.	**Family: Anacardiaceae** ***Anacardium occidentale*** (**Cashew**): A major source of honey and minor source of pollen. It can be raised throughout the district as part of agro-forestry systems and household gardens. Hard laterite is to be avoided. ***Lannaea coromandelica*** (Gojjalu): Medium sized deciduous tree. Medium producer of nectar; also pollen plant.

Family: Anacardiaceae ***Holigarna*** spp.: Most bee-keepers from forested villages informed that two species of *Holigarna* (vern: Holegeru) namely *H. arnottiana* and *H. graham* are major nectar sources for bees. Both these species are wild trees associated with semi-evergreen and evergreen forests. The former ones are common along perennial water courses of villages. **Figure: *Holigarna arnottiana***	
Family: Anacardiaceae ***Mangrifera indica*** (Mango): The tree is anmedium producer of honey and minor source of pollen for bees. Wild varieties of mangoes like 'Appemidi' pickling varieties recommended for forests. ***Spondias pinnata*** (Amtekaimara): A medium size tree; good source of nectar for bees. Recommended for cultivation in household gardens of bee keepers	
Family: Apocynaceae ***Alstonia scholaris*** (Haalemara): Considered a notable plant for nectar production	

Family: Araliaceae
Schefflera venulosa: A woody climber with prolific seasonal flowering and high nectar production. The species need to be spared from indiscriminate climber cutting that has been practiced in traditional forestry.

Family: Arecaceae
Areca catechu (Arecanut, Adeke): An important pollen plant; also nectar source.
Cocos nucifera (Coconut; Tengu)***:*** An important pollen plant
Phoenix sylvestris (Wild date): An important pollen plant and nectar source. Good for dry open plains and fallows of maidan taluks.

Family: Asteraceae
Cosmos bipinnatus**:** An ornamental annual. A medium producer of nectar. Plant can be grown easily in household gardens.
Helianthus annus (Sunflower): An important bee forage plant, especially in its cultivation areas mainly for oil.
Recommended for Mundgod and Haliyal.
Figure: *Helianthus annus*

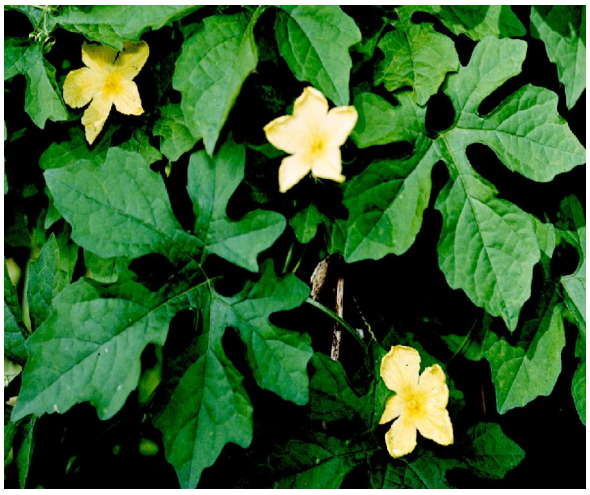
Family: Bignoniaceae ***Stereospermum*** spp (Patali): Large tree of semievergreen and moist deciduous forests. One of the earliest to appear in tree fall gaps of Western Ghats. Medium producer of nectar.	**Family: Balsaminae** ***Impatiens*** spp. (Balsam; Gourigida): Herb grown for ornamental flowers. Medium source of nectar is present. Recommended for household gardens
Family: Bombacaceae ***Bombax ceiba*** (Silk cotton; Simul): Major source of honey and pollen	**Family: Barringtoniaceae** ***Barringtonia racemosa*** (Samudraphal): Tree of slightly brackish water and fresh water swampy areas. Medium producer of nectar. Recommended for estuarine hinterlands.
Family: Bombacaceae ***Ceiba pentandra*** (White silk cotton): large, deciduous cultivated tree. Major source of nectar and pollen. Recommeded for cultivation in bee-keepers' premises and village common lands.	

Family: Boraginaceae
Cordia dichotoma: Deciduous tree; major source of nectar.
Family: Combretaceae
Anogeissus latifolius: Medium to small deciduous trees of drier areas. Major source of nectar. Dry deciduous forests of Haliyal, Mundgod and Yellapur.

Family: Burseraceae
Canarium strictum (Black dammar; Karidhupadamara): Evergreen tree; medium source of nectar.

Terminalia* spp.:** Major sources of honey. The trees grow naturally throughout the drier forests of the district. ***Terminalia bellirica (Tare) is ideal for roadsides and parks. Species recommended: ***T. bellerica, T. paniculata, T. tomentosa.***
T. arjuna (Holematthi; Arjuna) associated with river banks
Figure: *T. bellerica*

Family: Cucurbitaceae
Cucumis sativus (Cucumber; Savuthekai) is a cultivated vine; major source of nectar. Cultivation recommended in bee keeping areas, without use of pesticides..
Momordica charantia (Bittergourd; Haagalakai): Good source of nectar. Recommended for cultivation without use of pesticides
Figure: *Momordica charantia*



Family: Dipterocarpaceae
Vateria indica (Bili-dhupa): Large evergreen tree; moderate producer of nectar and pollen.

Family: Ebenaceae
Diospyros candolleana: Small tree of evergreen-semievergreen forests. Flowers rich source of honey
***Diospyros montana*:** Tree of dry deciduous forests. Flowers rich source of honey.
Diospyros spp.: These are usually evergreen forest trees; considered moderate sources of nectar.

Family: Elaeocarpaceae
Elaeocarpus spp.: Evergreen trees in evergreen forests (***E. tuberculatus***) and secondary forests in high rainfall areas of malnadu and coast (***E. serratus***). Moderate producers of nectar and pollen.

Family: Elaeagnaceae
Elaegnus latifolia: Shrubby climber in the forests. Flowers medium sources of nectar production. Identification and protection of the forests, having natural population necessary; especially in semi-evergreen and evergreen forest areas.

Family: Euphorbiaceae

Bridelia retusa: Medium sized deciduous trees; medium source of nectar.

Emblica officinalis (Gooseberry; Nellikai): Moderate source of nectar and pollen

Figure: *Emblica officinalis*

Family: Euphorbiaceae

***Excoecaria agallocha*:** Small statured mangrove trees. Major source of nectar. Recommended for estuarine banks.

Family: Fabaceae

Acacia catechu (Khair tree): Small tree of drier areas; good source of nectar.

Acacia nilotica (Jalimara; Babul): A medium tree in drier areas; major source of nectar. Good for black soils of maidan areas

Family: Fabaceae

Albizzia procera (Bilibage): Large tree; major source of nectar. Recommended for drier forests of Haliyal and Mundgod and for degraded betta lands

Albizzia lebbek (Siris; Bagemara): Large tree; major source of nectar. Recommended for drier forests of Haliyal and Mundgod and for degraded betta lands.

Family: Fabaceae

Bauhinia spp. (Mandara): Trees of deciduous forests; some species like *B. purpurea* are cultivated for flowers. Medium sources of honey. Recommended for all deciduous forests.

Family: Fabaceae

Butea monosperma (Palasa): Medium sized deciduous trees of medicinal and cultural importance. Medium source of nectar. Recommended for Haliyal and Mundgod and eastern parts of malnadu taluks.

Cajanus indicus (Red gram; togare): Shrubby annual; Major source of nectar and pollen. Cultivation recommended as a crop in bee keeping areas

Family: Fabaceae

Cassia fistula: Small tree with pendulous bunch of golden yellow flowers. Moderate source of nectar and pollen for bees.

Family: Fabaceae

Dalbergia spp. Various species of *Dalbergia* are good sources of nectar. Of these *D. latifolia* is found in deciduous forests and *D. sympathetica*, a gigantic liana in the coastal lateritic forests.

Dolichos lablab (Avare): Annual climber with prolific flowering. Major source of nectar and pollen. Cultivation of this important vegetable crop recommended throughout the bee-keeping areas.

Family: Fabaceae

Pterocarpus marsupium (Honnemara): Large, deciduous timber trees of medicinal and fodder value. Medium producer of nectar.

Family: Fabaceae ***Erythrina stricta:*** A small, prickly, deciduous, soft wooded tree. Good for seashores and coastal zones. A major producer of nectar.	
Family: Fabaceae ***Tamarindus indica*** (Tamarind): Cultivated large tree. Major source of nectar. Ideal for roadsides, and agro-ecosystems of maidan and eastern malnadu areas.	
Family: Fabaceae ***Pongamia pinnata*** (Hongemara)***:*** A large, evergreen tree; major source of nectar and pollen to some extent. The tree recommended for large scale planting as a biofuel plant. Beekeeping recommended in such areas.	

Family: Flacourtiaceae
Flacourtia Montana: Small sized evergreen fruit trees of the wild. Medium producer of both nectar and pollen.

Family: Lamiaceae
Ocimum sanctum (Tulsi): The cultivation of this sacred plant recommended throughout in the household gardens for various medicinal uses as well as important source of nectar.

Family: Lecithydaceae
Careya arborea (Kavalmara): Moderate sized deciduous trees, known for nectar production

Family: Lauraceae
Alseodaphne semicarpifolia (Mashe): A medium sized, aromatic, evergreen tree. A major producer of nectar and pollen.

Family: Loganiaceae ***Strychnos nux-vomica*** (Kasarka)***:*** Large deciduous trees of high medicinal value. Nectar production medium.	
Family: Lythraceae ***Lagerstroemia microcarpa*** (Nandi): Large, deciduous tree; major source of nectar. ***Woodfordia fruticosa:*** Shrubby plant; major source of nectar. Good for scrub forests throughout the district	**Family: Liliaceae** ***Allium cepa*** (Onion): An important source of nectar. Bee keeping recommended for onion cultivation areas of the district, especially in the coast of Kumta, in combination with other forage plants.
Family: Meliaceae ***Azadirachta indica*** (Neem; Bevu)***:*** A major source of nectar and pollen. Good for planting in agro-forestry systems. Ideal for planting in eastern parts of Sirsi, Siddapur and Yellapur taluk and throughout in Mundgod and Haliyal taluks.	**Family: Moringaceae** ***Moringa oleifera*** **(Drumstick tree)**: Flowers produce good amount of nectar and pollen. As flowering is present for several months it can be considered good bee forage plant, especially for nectar. Cultivation of the tree recommended throughout the district especially in home gardens.

Family: Musaceae ***Musa paradisiaca*** (Banana): Good producers of nectar. Bee keeping recommended for all banana growing areas.	**Family: Myrtaceae** ***Psidium guajava*** (Guava; Perila): A small fruit tree. Medium producer of nectar. Recommended for household gardens throughout the district.
Syzygium cumini (Jamun tree; Neerilu): Medium to large tree. One of the very good producers of nectar and pollen. It is amber to dark amber in colour with good taste. Honey is amber to dark amber in color, astringent taste and hard aroma make it unique. It's believed to have benefits for diabetics.	
Syzygium caryophyllatum: Small spreading evergreen trees. Medium producer of nectar. Found in coastal forests, especially in lateritic areas. Bee keeping need to be promoted in such forest areas.	

Family: Pedaliaceae
Sesamum indicum (Gingelly, Ellu): An annual herb grown for oil seed. A major source of nectar and pollen. Recommended as a crop for growing in Mundgod and Haliyal taluks and in eastern parts of malnadu areas.

Family: Rhamnaceae
***Zizyphus Mauritiana* (*Z. jujuba*)**: Considered an important bee forage plant.
Rhizophoraceae
Carallia brachiata (Andamurugila): Large evergreen trees, considered good producers of nectar.

Family: Polygonaceae
Antigonon leptopus
An ornamental vine with prolific flowering. A medium producer of nectar. Good for growing in household gardens of beekeepers.

Family: Rubiaceae
Adina cordifolia (Kalam; Heddi): Large tree; medium source of nectar.

Family: Rubiaceae
Anthocephalaus kadamba (Kadamba): Large, spreading tree; major producer of nectar. Suitable for avenues, gardens, parks and roadsides and premises of educational institutions and offices.

Family: Rutaceae
Aegle marmelos (Bael): A medium sized tree with moderate nectar nectar production
Citrus spp. (Lemon and related plants): These cultivated shrubby plants are good producers of nectar. Ideal for large scale cultivation in drier taluks.

Family: Rutaceae
Glycosmis pentaphylla: A shrubby aromatic plant is known to attract honey bees.
Murraya koenigi (Curry leaf): Shrub or small tree. A major source of nectar.

Family: Sapindaceae
Sapindus laurifolius (Soapnut tree; Atlekaimara): A very important nectar plant for bee forage. Soapnut honey is highly priced.
Schleischera oleosa: Medium sized trees of deciduous forests. Major producer of nectar and pollen.
Figure: *Sapindus laurifolius*

Family: Sapotaceae
Madhuca indica (Mahua tree): Large tree, good producer of nectar
Mimusops elengi (Ranjalu; Bakula)**:** Large tree; a good bee resource plant

Family: Verbenaceae
Avicennia spp: Mangrove trees growing gregariously in the estuaries and creeks. Good producer of special quality honey because of growing in salinity medium. Hardly any work is done to propagate this species in suitable habitats. Bee keeping needs to be promoted in mangrove areas.
Figure: ***Avicennia marina***

Family: Verbenaceae
Vitex negundo: A common shrub; major producer of nectar. Good for growing along seashores and hedges everywhere
Premna coriacea: A wild scrambling shrub of coastal forests and close to sea beaches. Major source of nectar. Awareness creation necessary for preserving such species.

Sn	Species	Coastal habitats	Inner coastal	Malnadu	Maidan areas	Roadsides	Other areas
1	***Adhatoda vasica***	Suitable throughout the district for hedges					
2	***Barleria cristata***	Suitable as hedges throughout the district					
3	***Strobilanthes callosus***		Forest undergrowth	Forest undergrowth; deciduous and semi-evergreen forests	Undergrowth, deciduous forests.		
4	***Strobilanthes heyneanus***		Forest undergrowth	Forest undergrowth; deciduous and semi-evergreen forests	Undergrowth, deciduous forests.		
5	***Strobilanthes ixiocephalus***		Forest undergrowth	Forest undergrowth; deciduous and semi-evergreen forests	Undergrowth, deciduous forests.		
6	***Alangium salvifolium***		Moist deciduous forests	Moist deciduous forests			
7	***Achyranthes aspera***	Weedy undergrowth in gardens and waste places					
8	***Anacardium occidentale***	Tree suitable for cultivation throughout the district; good for sandy coastal terrain					
9	***Holigarna*** spp						
10	***Lannaea coromandelica***	Lateritic areas; sea shores; estuarine banks	Deciduous to scrub	Moist deciduous and bettas	Dry deciduous forests		
11	***Mangrifera indica***	Lateritic areas	Forests, scrub	Semievergreen forests, bettas	Deciduous forests; fire prone areas to be avoided	Ideal	Village landscapes, as avenue trees
12	***Spondias pinnata***						
13	***Alstonia scholaris***	Lateritic areas	Forests, scrub	Semievergreen forests, bettas	Deciduous forests.	Ideal	Village landscapes, as avenue trees

14	***Schefflera venulosa***		Secondary evergreen forests	Semievergreen forests, bettas			
15	***Areca catechu***	Plantation crop					
16	***Cocos nucifera***	Plantation crop					
17	***Phoenix sylvestris***				Dry open areas		
18	***Cosmos bipinnatus***	Ornamental herb for household gardens					
19	***Helianthus annus***	As ornamental herb			As oilseed crop		
20	***Impatiens*** spp.	Ornamental herb and seasonal growth in wet places					
21	***Barringtonia racemosa***		Inner coastal creeks				
22	***Stereospermum*** spp		Forests	Semievergreen and moist deciduous forests, bettas	Deciduous forests;	Reco-mmeded	
23	***Bombax ceiba***		Scrub and secondary deciduous forests	Bettas and savannas	Throughout forests	Ideal for village roads	
24	***Ceiba pentandra***	Suitable or cultivation throughout the district					
25	***Cordia dichotoma***			Bettas and savannas towards east	Throughout forests	Ideal for roadsides in low rainfall areas	

26	***Canarium strictum***		Evergreen forests	Semievergreen, evergreen forests		for malnadu areas, in moderate shade	Village landscapes, as avenue trees
27	***Anogeissus latifolius***				Deciduous forests		
28	***Terminalia*** spp.		Secondary forests; *T. arjuna* for river banks				
29	***Cucumis sativus***	Cultivated vegetable					
30	***Momordica charantia***	Cultivated vegetable					
31	***Vateria indica***		Semievergreen forests- for introduction near villages	For introduction in degraded, but fireproof, forests		Good for coast and Malnadu	Avenue tree in parks and institutional premises
32	***Diospyros candolleana***		Semievergreen forests	Evergreen, semievergreen forests			
33	***Diospyros*** montana			Suitable for open dry betta forests	Forest tree; suitable for dry deciduous forests		
34	***Elaeocarpus*** spp		Evergreen/semi-evergreen forests				
35	***Elaegnus latifolia***						
36	***Bridelia retusa***		Deciduous forests	Deciduous forests, bettas	Deciduous forests	Recommended in beekeeping areas	

37	***Emblica officinalis***			Suitable for open dry betta forests; household gardens in moderate rainfall	Forest tree; suitable for dry deciduous forests	For drier zones	Household gardens, school compounds
38	***Excoecaria agallocha***	Mangrove areas					
39	***Acacia catechu***	Laterite hills	Laterite hills		Open dry forests		
40	***Acacia nilotica***				Open dry places		
41	***Albizzia lebbek***			Bettas	Deciduous forests		
42	***Albizzia procera***			Bettas	Deciduous forests		
43	***Bauhinia*** spp.				Deciduous forests		
44	***Butea monosperma***				Deciduous forests	Yes	Field bunds
45	***Cajanus indicus***			Cultivation recommeded			
46	***Cassia fistula***		Laterite hills, secondary forests; scrub	Suitable for open dry betta forests and semi-evergreen forests	Deciduous forests	Ideal	Household gardens, parks
47	***Dalbergia*** spp.				Deciduous forests		
48	***Dolichos lablab***	Recommended for cultivation as a vegetable crop					
49	***Erythrina stricta***	Sandy areas		Bettas	Village landscapes		
50	***Tamarindus indica***			Cultivation recommended		Maidan areas	
51	***Pongamia pinnata***	As mangrove associate; sea shores	In ravines and gullies, river and stream banks	Betta forests, stream banks	For plains and dry stream beds, ravines and gullies	Throughout the district	Farmlands, school compounds

52	***Pterocarpus marsupium***	Lateritic areas	Forests, scrub; lateritic areas	Deciduous forests, bettas	Deciduous forests	Ideal, throughout the district.	Village landscapes, as avenue trees
53	***Flacourtia Montana***		Semievergreen forests	Semievergreen forests	Moist deciduous forests	Recommended	
54	***Ocimum sanctum***	Garden plant; cultivation in more numbers recommended					
55	***Alseodaphne semicarpifolia***		Semievergreen forests	Evergreen, semievergreen forests; bettas		For coastal and malnadu	
56	***Careya arborea***	Laterite hills	Semi-evergreen and secondary forests	Bettalands, deciduous forests	Deciduous forests		
57	***Allium cepa***						
58	***Strychnos nux-vomica***	Laterite hills	Deciduous forests; laterite hills; scrub	Betta, and moist deciduous forests	All forests		
59	***Lagerstroemia microcarpa***		Deciduous and semi-evergreen forests	Betta, semi-evergreen and moist deciduous forests	All forests		
60	***Woodfordia fruticosa***		Edges of forests; in scrub				
61	***Azadirachta indica***		Well drained open areas	Drier eastern eastern parts, as part of agroforestry systems	Throughout, in non forest areas	Eastern malnadu and Haliyal-Mundgod	

62	***Moringa oleifera***	Cultivation as a vegetable plant recommended					
63	***Musa paradisiaca***	Widely cultivated					
64	***Psidium guajava***	Cultivated fruit tree					
65	***Syzygium cumini***	Laterite hills	Semi-evergreen and secondary forests	Bettalands, deciduous forests	Deciduous forests under fire protection	Ideal	Open places throughout the district
66	***Syzygium caryophyllatum***	In forests and scrub throughout					
67	***Sesamum indicum***	Oilseed plant; suitable for cultivation in drier parts of malnadu and maidan					
68	***Antigonon leptopus***	Cultivation as ornamental recommended					
69	***Zizyphus mauritiana* (*Z. jujuba*)**	Laterite hills	Secondary deciduous forests	Bettalands, deciduous forests	Dry deciduous forests	Wild	Open places throughout the district
70	***Carallia brachiata***	Laterite hills, in shade	Semi-evergreen forests	Bettalands, semievergreen forests		Ideal	Good as avenue tree
71	***Adina cordifolia***		Secondary forests	Moist deciduous forests; bettalnds	Forest tree; suitable for dry deciduous forests		
72	***Anthocephalaus kadamba***		For gardens and roadsides			Yes	
73	***Aegle marmelos***		Well drained open areas	Drier eastern eastern parts, as part of agroforestry systems	Throughout, in forest and non-forest areas on well drained soils	Eastern malnadu and Haliyal-Mundgod	Premises of temples, offices, institutions, houses.

74	***Citrus*** spp.		Cultivation recommended				
75	***Glycosmis pentaphylla***		Suitable for open grasslands and forest clearances				
76	***Murraya koenigi***						
77	***Sapindus laurifolius***		Secondary deciduous forests	Semievergreen forests, bettas	Deciduous forests.	Ideal	Village landscapes, as avenue trees
78	***Schleischera oleosa***		Secondary deciduous forests	Drier eastern eastern parts	Throughout, in forest areas and fringes of villages	Eastern malnadu and Haliyal-Mundgod	
79	***Madhuca indica***			Moist deciduous forests; bettalnds	Moist and dry deciduous forests	For drier areas	
80	***Mimusops elengi***		Fire protected vegetation; shaded lateritic areas	Semi-evergreen/evergreen forests; bettas		Good for malnadu and coast	Sacred groves
81	***Avicennia spp***:	Mangrove areas					
82	***Vitex negundo***:	As hedge plant					
83	***Premna coriacea***	Coastal, sandy areas					

Conclusions and Recommendations

Honeybees provide a variety of goods (honey, wax, pollen, royal jelly, propolis etc) and services (pollination) to human society and ecosystem. Across the world the bees support millions of livelihoods while also enriching the ecosystem. Beekeeping is an important enterprise to rural communities and related to agricultural and horticultural production. Even though, Uttara Kannada district has over 60% of its lands under forest cover, and about 15% under farming, the honey production is far below its expected potential. The case study conducted highlights that beekeeping could be elevated into much more profitable venture requiring small investment of capital and skilled labor for realizing high yield in comparison to other rural employment and poverty reduction programmes. We have taken into account the static performance of the bee-keeping societies, which had in their earlier days played vital role in spreading awareness on scientific bee-keeping and its profitability and assisted people in setting up bee-keeping units in their homes and helped in marketing the products. Presently there are several individual entrepreneurs in the district who have realized the importance of bee-keeping, in a consumerist society where there is steady and rising market demand for honey as a health food, as medicine, for use in confectionaries, in pharmaceutical industry and so on. We make here certain recommendations for promotion of bee-keeping:

I. Training programmes

a) To spread awareness on the importance of honeybees and bee-keeping
b) On using wild colonies from the jungles for domestication through traditional expertise.
c) On populating new boxes in potential beekeeping regions.
d) To regulate the number of queen bees per box and screening for healthy queen bees
e) For awareness on ideal time for setting up new colonies
f) On the importance of shifting bee boxes from one place to other, say for instance from the coast to the interior and *vice versa* so as to maximize production taking benefit of the different times of flowering.
g) Training in dis-infestation and disease control
h) Training in protection of bee-hives from predators

i) On the importance of providing supplementary food to bees during lean periods and on the composition of such supplementary food
j) Creating awareness on pollination benefits
k) To bring home the benefits of organic farming for healthy bee keeping, for health of humans and ecosystems and for enhancing market value of farm products.

II. The role of the Forest Department

The Forest Department, controlling over 60% of the land area of the district (>6000 sq.km) has to play major role if bee-keeping is to be nurtured as an important enterprise. The departmental involvement can be envisaged as:

a) Designing the vegetational composition of the forests in the immediate vicinity of villages so as to give premium to specially bee-forage plants
b) The department to take lead in raising bee forage plant species, particularly nectar trees (an indicated in the list included in this report) in its nurseries.
c) The coastal minor forest belt on lateritic terrain also to be enriched with bee forage plants
d) Soapnut trees (*Sapindus laurifolius*), indigenous to the region, needs to be raised in lakhs for planting in a variety of habitats, including household gardens, considering the high value of soapnut honey (Rs.700-1000/kg). The trees can come up even in degraded and rocky habitats and can also provide other benefits, such as shade, water and soil conservation, leaf litter for organic manure etc. in addition to the soapnut which has market value as NTFP.
e) Many species recommended for bee-keeping has also NTFP value - for eg: *Adhatoda vasica, Alangium salvifolium, Strychnos nux-vomica* (medicinal), *Mangifera indica, Spondias mangifera, Tamarindus indica* (food value), *Emblica officinalis* (food and medicine) *Canarium strictum, Vateria indica, Anogeissus latifolius, Acacia catechu* and *A. nilotica* (resins and gums), *Pongamia pinnata* (biofuel and pesticide) and so on.

f) Forest Department to permit bee keepers to keep their bee-boxes in the peripheral forests of villages and also allow them to shift their bee boxes to other similar forest areas without affecting National Parks, Sanctuaries and other such specially protected areas.
g) The department to take lead in improving betta forests for furtherance of bee-keeping.
h) Certain special types of large trees such as *Tetrameles nudiflora*, on which numerous large bee-hives of *Apis dorsata* may be found to be declared as 'Heritage Trees' under the provisions of the Biodiversity Act 2002, or under any other suitable category to ensure their continued protection.
i) On realizing the potential of mangroves in production of rare kinds of honey it is recommended that the department increase the population of nectar producing mangroves like *Avicennia* spp. *Excoecaria agallocha* etc.

III. Government assistance for bee-keepers

a) People aspiring to take up bee-keeping may be given training and equipments at subsidized rates. On proper utilization of infrastructure granted the entrepreneurs of especially poorer class may be given more assistance.
b) Government to help the entrepreneurs with testing and certification of the genuineness of honey produced so as to fetch good market price for them.
c) Guidance for forest honey collectors on sustainable and safe harvesting methods.
d) Importance of organic honey production.
e) Government assistance for honey quality improvement through making available moisture reduction technique.
f) To make available ready expertise to deal with bee diseases.

IV. General recommendations

a. Honey being a nutritious food the local populace in the honey producing belt should get benefit of honey production. It is recommended that at least once a week, some sweetmeats prepared using honey, may be included in the mid-day meal programmes of the schools.

b. Contract system for collection of wild honey may be dispensed with as the contractors have only short term interest and look for maximization of profit using non-sustainable methods. The VFCs and forest dwelling traditional communities be empowered to do honey collection. The honey should be marketed as 'forest honey' after due purification and dehydration by the Government agencies such as the local beekeepers society. Reasonable price should be paid to the honey collectors by the societies.

c. Honey packaging to be done scientifically and in attractive cartons/bottles so as to fetch good returns for the producers/collectors. Honey from forested villages should be marketed as 'forest honey' so as to fetch better prices

d. Bee-keepers be trained in hygienic collection of royal jelly, bee-pollen, propolis etc. which have much higher value and demand in foreign countries, for pharmaceuticals and as health products.

e. Efforts should be made to preserve nesting sites of honey bees in the wild, as the wild bees constitute important germplasm for the domesticated ones. Branches of certain large trees in the forests and domestic gardens, tree holes, termite mounds etc. are used by bees for build their hives (Plate7.1)

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Annexure – I

List of beekeepers interviewed in Uttara Kannada

No.	Date	Taluk	Village name	Farmer name	Boxes	Qty
1	24-Feb-12	Ankola	Belsare	Rama Ganapati Gouda	8	40
2	24-Feb-12	Ankola	Hegre	Goydu Timmappa Gouda	7	60
3	24-Feb-12	Ankola	Hegre	Tippayya G Gunaga	4	28
4	24-Feb-12	Ankola	Kodsani	Huliyappa T. Gowda	15	85
5	24-Feb-12	Ankola	Kodsani	Devappa B Gowda	25	95
6	25-Feb-12	Ankola	Alageri	K.B. Gunaga	27	300
7	25-Feb-12	Ankola	Keni	Ganapati G. Gaonkar	15	120
8	25-Feb-12	Ankola	Bhavikeri	Timmappa P Madivala	7	25
9	25-Feb-12	Ankola	Bobruwada	Ravindra K. Mahale	25	145
10	25-Feb-12	Ankola	Belekeri	Devappa S Naik	1	0
11	27-Feb-12	Ankola	Berolle	Vishnu B Bhat	8	80
12	27-Feb-12	Ankola	Alegeri	Venkatramana V.Hegde	5	8
13	06-Mar-12	Ankola	Sunksal	Alexfrancis Fernandis	3	25
14	06-Mar-12	Ankola	Sunksal	Manjunath Gopal Naik	2	10
15	21-Dec-11	Kumta	Bellangi	K.R.Bhat	30	300
16	21-Dec-11	Kumta	Yana	Bhairaveshwar	7	10
17	21-Dec-11	Kumta	Yalavalli	Ravindra G Bhat	25	100
18	22-Dec-11	Kumta	Yalavalli	Kehav Shivaram Hebbar	8	30
19	21-Dec-11	Kumta	Yalavalli	Krishna Ganapati Bhat	12	53
20	22-Dec-11	Kumta	Yalavalli	Anand Madivala	30	220
21	22-Dec-11	Kumta	Yalavalli	Sivaram Ganapati Hegde	12	10
22	21-Dec-11	Kumta	Hondradhakalu	Ramachandra. E.Desai	10	70
23	20-Dec-11	Kumta	Kanthavalli	Tulasu Goli Gouda	25	200
24	20-Dec-11	Kumta	Kanthavalli	Subramaniya R Hegde	25	115
25	20-Dec-11	Kumta	Kanthavalli	Seetharam Gajanan Bhat	2	10
26	20-Dec-11	Kumta	Hosad	Manjunath J. Gouda	50	275
27	20-Dec-11	Kumta	Konarae	Ganapati V. Hegde	5	50

28	29-Dec-11	Kumta	Muroor	Nagesh G Naik	4	16
29	3-Jan-12	Kumta	Alavalli	Subraya Eswara Hegde	3	20
30	3-Jan-12	Kumta	Alavalli	Devaru Narayana Bhat	2	13
31	4-Jan-12	Kumta	Nellikeri	Satish. G. Gouda	2	16
32	9-Jan-12	Kumta	Kumta	Krishna Beerappa Naik	5	21
33	24-Feb-12	Kumta	Bijjor	Ganu S Gowda	10	25
34	24-Feb-12	Kumta	Betkuli	Beerappa B Gunaga	8	50
35	3-Jan-12	Honavar	Kadatokka	Nagesh. A. Gouda	2	8
36	3-Jan-12	Honavar	Jettigadde	Narayana S. Gouda	11	33
37	9-Jan-12	Honavar	Hodike-shirur	Upendra Vasudeva Naik	4	20
38	9-Jan-12	Honavar	Hodike-shirur	Nagesh Iswar Hegde	15	36
39	9-Jan-12	Honavar	Hodike-Shirur	Kamalakar T. Naik	7	103
40	9-Jan-12	Honavar	Hodike-Shirur	Manjunath Devau Gouda	10	86
41	10-Jan-12	Honavar	Kudubail	Kandappa N Naik	10	70
42	10-Jan-12	Honavar	Kumbar-makki	Dattaterya	3	25
43	10-Jan-12	Honavar	Chippi-hackal	Nagappa S.Gowda	10	22
44	10-Jan-12	Honavar	Navilgon	Venkatappa R Naik	2	21
45	11-Jan-12	Honavar	Kadale Koppa	Krishna G. Hegde	4	55
46	11-Jan-12	Honavar	Kadale-Unchikeri	Mahableshwara G. Bhaghavath	4	16
47	11-Jan-12	Honavar	Hebbankere	V.M. Hegde	4	13.5
48	11-Jan-12	Honavar	Hebbankere	Putty Jettu Gowda	2	7.5
49	11-Jan-12	Honavar	Hebbankere	S.R.Bhat	6	20
50	11-Jan-12	Honavar	Vardekudalu	Manjunath G. Hedge	7	34
51	11-Jan-12	Honavar	Vandur	Hani. A. Gouda	8	55
52	8-Dec-11	Yellapur	Kavehuli	Ganapati N. Hegde	50	300
53	8-Dec-11	Yellapur	Shampumane	Narayana T. Gaonkar	4	20
54	5-Mar-12	Yellapur	Hitlalli	Harihare V. Hegde	100	450
55	6-Mar-12	Yellapur	Bellamane	Dattatray A. Gayankar	15	40
56	6-Mar-12	Yellapur	Shirvalli	Raghavendra R.Bhat	26	300

57	6-Mar-12	Yellapur	Arbail	Suresh M. Hegde	3	13
58	6-Mar-12	Yellapur	Jamguli,	Parameshwar N. Gaonkar	26	300
59	7-Mar-12	Yellapur	Bisgod	Ganapati T. Naik	60	400
60	7-Mar-12	Yellapur	Geral	B.G. Hegde	4	12
61	7-Mar-12	Yellapur	Angod	Shreepathi M Bhat	8	45
62	7-Mar-12	Yellapur	Hasangi	Hemanth Vinayaga Bhat	13	65
63	16-Dec-11	Sirsi	Kallalli	Madhukeshwar	200	2500
64	29-Feb-12	Sirsi	Edahalli	Raghavendra M Hegde	30	160
65	29-Feb-12	Sirsi	Atragi-Navilgar	Divakar N Hegde	2	12
66	29-Feb-12	Sirsi	Navilgar	Ananth V. Hegde	3	20
67	29-Feb-12	Sirsi	Salkani	Balachandra V.Hegde	40	425
68	29-Mar-12	Sirsi	Segaihalli	Bharghav R Hegde	3	4
69	02-Mar-12	Sirsi	Harehulekal	Vinay Chandrasekar Hegde	3	15
70	02-Mar-12	Sirsi	Harehulekal	Ravindra R. Hegde	1	6
71	02-Mar-12	Sirsi	Kakkalli	Prema V.Siddi	2	7
72	02-Mar-12	Sirsi	Kakkalli	Laxmi Gunja Siddi	2	4
73	02-Mar-12	Sirsi	Kuttykoppa	S.S. Hegde	2	5
74	02-Mar-12	Sirsi	Kuttykoppa	V.S. Hegde	3	6
75	02-Mar-12	Sirsi	Karooru	Ganapati Beer Gowda	10	100
76	15-Mar-12	Sirsi	Maschigadde	Dharmendra G. Hegde	150	1000
77	14-Mar-12	Siddapur	Yalukar	Umesh G. Joshi	10	45
78	14-Mar-12	Siddapur	Yalukar	Mahendra R. Joshi	4	18
79	14-Mar-12	Siddapur	Chittamavu	Vinayak Hegde	2	5
80	14-Mar-12	Siddapur	Kanchakuli	Venkatramana E. Joshi	1	4
81	14-Mar-12	Siddapur	Dhandugal	M.M. Hegde	4	26
82	15-Mar-12	Siddapur	Hegnur	Surendra R Hegde	6	32
83	15-Mar-12	Siddapur	Analebail	K.D. Bhat	2	10
84	15-Mar-12	Siddapur	Nelamavu	Ganapati B. Bhat	3	22
85	15-Mar-12	Siddapur	Nelamavu	Gajanan Vasudev Bhat	1	5

86	15-Mar-12	Siddapur	Maanimane	Krishnamoorthy G. Bhat	10	80
87	15-Mar-12	Siddapur	Artheybail	Mahableswar T. Hegde	25	150
88	15-Mar-12	Siddapur	Moorur	Narayana K Hegde	2	20
89	15-Mar-12	Siddapur	Analebail	Sridhar Bhat	4	12
90	15-Mar-12	Siddapur	Kallekone	Mahesh G. Hegde	5	26
91	15-Mar-12	Siddapur	Heblegadde	Ashok Hegde	4	20
92	15-Mar-12	Siddapur	Kamayan Jette	Gajanan G. Hegde	10	85
93	15-Mar-12	Siddapur	Heblegadde	Ashok K. Hegde	2	20
94	15-Mar-12	Siddapur	Hosemane	Moraraji G.Bhat	9	70
95	16-Mar-12	Siddapur	Bidrakan	Ganapati R. Bhat	4	15
96	16-Mar-12	Siddapur	Bidrakan	Shripathi G. Hegde	5	15
97	16-Mar-12	Siddapur	Bidrakan	Surendra R Hegde	3	5
98	16-Mar-12	Siddapur	Bidrakan	Nagaraj M. Hegde	20	50
99	16-Mar-12	Siddapur	Dodmane	Suresh G. Bhat	1	8
100	16-Mar-12	Siddapur	Kalkai	Sridhar G. Bhat	2	10
101	16-Mar-12	Siddapur	Harihalemane	Mahabaleswar N. Hegde	3	25
102	16-Mar-12	Siddapur	Madlamane	Gajanan N. Naik	20	105
103	17-Mar-12	Siddapur	Kodkani	Narayana D. Hedge	3	45
104	17-Mar-12	Siddapur	Kodkani	Shreepath Hegde	2	10
105	17-Mar-12	Siddapur	Sallimakki	Ganapathi B Madivala	2	-

Annexure 2

Flowering periods, nectar secreting concentration (%NSC) and other economic importance of bee flora recorded from Karnataka (Source: Sivaram, 2001).

Sl.No	Name	Family	Flower duration	% NSC	Economic importance
1	Abelmoschus esculentus	Malvaceae	Aug – Nov	46.2	Vegetable
2	Abutilon indicum	Malvaceae	Jan – Feb	29.65	Fibre
3	Acacia auriculiformis	Fabaceae	Mar-May	38.5	Timber and pulp
4	Acacia leucophloea	Fabaceae	Aug-Nov	39.56	Fibre
5	Acacia nilotica	Fabaceae	Jul-Oct	49.62	Medicine, timber
6	Acacia polycantha	Fabaceae	June-Sep	38.6	Fodder
7	Aegle marmelos	Rutaceae	Apr-May	-	Medicine
8	Ailanthus excelsa	Simaroubaceae	Jan-Mar	36.86	-
9	Albizia amara	Fabaceae	Feb-Apr	46.5	Timber
10	Albizia chinensis	Fabaceae	Mar-May	52.63	Timber
11	Albizia lebbeck	Fabaceae	Mar-May	44.52	Timber
12	Allium cepa	Liliaceae	Jan-Mar	-	Vegetable
13	Alstonia scholaris	Apocyanaceae	Oct-Nov	-	Medicine
14	Amaranthus gracilus	Amaranthaceae	Feb-Mar	-	Vegetable
15	Amaranthus spinosus	Amaranthaceae	Sep-Oct	-	Vegetable
16	Anacardium occidentale	Anacardiaceae	Feb-Apr	36.45	Fruit /nut
17	Annona reticulata	Annonaceae	Apr-May	47.25	Fruit

18	Antigonon leptopus	Polygonaceae	Apr-May	44.6	Ornamental
19	Arachis hypogaea	Fabaceae	Sep-Nov	-	Oil, food, fodder
20	Areca catechu	Arecaceae	Jun-Dec	52.9	Masticatory
21	Argemone mexicana	Papavaraceae	Sep-Dec	-	
22	Aster sp.	Asteraceae	Jan-Dec	30.25	Ornamental
23	Azadirachta indica	Meliaceae	Mar-Apr	56.85	Medicine, biopesticide
24	Barleria buxifolia	Acanthaceae	Oct-Jan	36.28	Ornamental
25	Barleria prattensis	Acanthaceae	Sep-Oct	33.25	Ornamental
26	Barleria cristata	Acanthaceae	Sep-Nov	42.5	Ornamental
27	Bauhinia purpurea	Fabaceae	Oct-May	-	Ornamental
28	Bauhinia racemosa	Fabaceae	Feb-July	-	Fibre
29	Bidens bidentata	Asteraceae	Jul-Feb	27.5	
30	Bombax ceiba	Bombacaceae	Feb-Mar	18.5	Fibre, softwood
31	Borreria sp.	Rubiaceae	Aug-Jan	53.5	
32	Brassica sp.	Brassicaceae	Oct-Nov	42.06	Condiment, oil
33	Cajanus cajan	Fabaceae	Dec-Mar	33.29	Pulse
34	Callistemon linearis	Myrataceae	Feb-Apr	38.5	Ornamental
35	Capparis sepiaria	Capparidaceae	Mar-May	-	Ornamental
36	Capparis zeylanica	Capparidaceae	Feb-Mar	-	Medicinal
37	Capsicum sp.	Solanaceae	Jul-Feb	-	Condiment, vegetable

38	Carissa carandas	Apocynaceae	Mar-Apr	46.5	Fruit
39	Cassia mimoisoides	Fabaceae	Jul-Oct	-	Medicinal
40	Cassia montana	Fabaceae	Feb-Jul	-	Ornamantal
41	Cassia italica	Fabaceae	May-Sep	-	Ornamental
42	Cassia occidentalis	Fabaceae	Mar-Jun	-	Ornamental
43	Casia tora	Fabaceae	Sep-Nov	-	Ornamental
44	Casuarina equisetifolia	Casuarinaceae	Feb-Jul	-	Timber
45	Celosia argentia	Amaranthaceae	Jan-Jun	-	Vegetable
46	Caesalpinia pulcherima	Fabaceae	Mar-May	-	Ornamental
47	Chenopodium amrosoides	Chenopodiaceae	Jan-Dec	52.65	Medicinal
48	Chenopodium murale	Chenopodiaceae	Mar-Jun	53.25	Medicinal
49	Chrysanthemun indicum	Asteraceae	Jan – Dec	43.8	Ornamental
50	Cinnamomum macrocarpum	Lauraceae	Jan-Jun	54.86	Medicine, spice
51	Citrullus lanatus	Cucurbitaceae	Sep-Oct	-	Fruit
52	Citrus reticulata	Rutaceae	Mar-Apr	41.75	Fruit
53	Citru aurantium	Rutaceae	Mar-May	39.5	Fruit
54	Citrus medica	Rutaceae	Mar-Jul	43.08	Fruit
55	Clerodendrum inerme	Verbenaceae	Mar-Apr	45.5	Hedge plant
56	Clerodendrum viscosum	Verbenaceae	Jan-Mar	53.25	Medicine
57	Coccinia india	Cucurbitaceae	Jan-Aug	-	Vegetable

58	Cocos nucifera	Arecaceae	Jan-Dec	-	Nut/Oil
59	Coffea arabica	Rubiaceae	Mar-Apr	30.5	Beverage
60	Commelina sp.	Commelinaceae	Aug-Dec	32.8	Weed
61	Corchorus aestuans	Tiliaceae	Nov-Dec	_	Fibre
62	Corchorus trilocularis	Tiliaceae	Aug-Dec	-	Fibre
63	Cordia dichotoma	Cordiaceae	Mar-Apr	44.62	Medicinal
64	Coriandrum sativum	Apiceae	Sep-Dec	60.29	Spice
65	Cosmos caudatus	Asteraceae	Nov-Dec	-	Ornametal
66	Crossandra sp.	Acanthaceae	Aug-Dec	40.5	Ornamental
67	Cucumis melo	Cucurbitaceae	Sep-Nov	-	Fruit
68	Cucumis sativus	Cucurbitaceae	Oct-Nov	-	Vegetable
69	Cucurbita maxima	Cucurbitaceae	Jan-Dec	-	Vegetable
70	Cucurbita pepo	Cucurbitaceae	Jan- Dec	36.5	Vegetable
71	Cynodon dactylon	Poaceae	Aug-Oct	-	Fodder
72	Dahlia variabilis	Asteraceae	Jan-Dec	35	Ornamental
73	Dalbergia sisoo	Fabaceae	Feb-Apr	54.96	Timber
74	Datura sp.	Solanaceae	Apr-Dec	-	Medicine
75	Delonix regia	Fabaceae	Mar-May	56.24	Ornamental
76	Dicoma tomentosa	Asteraceae	Jun-Jan	36.5	Medicinal
77	Diospyros melanoxylon	Ebenaceae	Mar-May	56.5	Timber, Tendu leaf
78	Diospyros montana	Ebenaceae	Jan-Dec	49.24	Timber

79	Dodonaea viscosa	Sapindaceae	Jan-Dec	49.55	Medicine
80	Ellettaria cardamomum	Zingeberaceae	Jul-Nov	37.48	Spices
81	Erythrina indica	Fabaceae	Feb-Apr	52.06	Ornamental
82	Eucalyptus spp	Myrtaceae	Nov-Apr	41.96	Timber, aromatic oil
83	Eupatorium odoratum	Asterceae	Jul-Aug	30.25	Weed
84	Gossypium sp.	Malvaceae	Dec-Apr	34.06	Fibre
85	Grewia hirsuta	Tiliaceae	Mar-Jul	44.38	Timber
86	Grewia orientalis	Tiliaceae	Apr-Sep	43.4	Timber
87	Grewia tiliaefolia	Tiliaceae	Apr-Aug	42.09	Timber
88	Guizotia abyssinica	Asteraceae	Sep-Nov	36	Oil
89	Helianthus annuus	Asteraceae	Nov-Dec	43.8	Oil
90	Hibiscus rosa-sinensis	Malvaceae	Jan-Dec	26.48	Ornamental
91	Hibiscus ovalifolius	Malvaceae	Jan-May	-	Ornamental
92	Hibiscus surattensis	Malvaceae	Aug-Nov	-	Fibre
93	Hygrophilia auriculata	Acanthaceae	Jul-Dec	29.64	Medicinal
94	Impatiens balsaminia	Balsaminaceae	Aug-Oct	21.5	Medicinal
95	Impatiens trichocarpa	Balsaminaceae	Aug-Dec	16.75	Medicinal
96	Ipomea alba	Convoluvaceae	Oct-Dec	37.25	Ornamental
97	Ipomea batatas	Covoluvaceae	Feb-Mar	36.27	Food
98	Ipomea eriocarpa	Covoluvaceae	Dec-Jan	27.46	Vegetable
99	Ixora coccinea	Rubiaceae	Feb-Mar	-	Ornamental

100	Jacaranda sp.	Bignoniaceae	Feb-Mar	44.63	Ornamental
101	Justicia betonica	Acanthaceae	Jan-Dec	48.25	Medicinal
102	Justicia glabra	Acanthaceae	Jan-Sep	43.8	Ornamental
103	Justicia simplex	Acanthaceae	Jan-Dec	36.57	
104	Kigelia pinnata	Bignoniaceae	Jul-Nov	33.46	Avenue tree
105	Lagscea mollis	Asteraceae	May-Nov	36.66	Medicinal
106	Lagenaria leucantha	Cucurbitaceae	Aug-Nov	46.65	Medicinal
107	Lagerstoemia reginae	Lythraceae	May-Jul	_	Timber, ornamental
108	Lagerstromia speciosa	Lythraceae	May-Jul	52.64	Timber
109	Lagerstroemia microcarpa	Lythraceae	Mar-Apr	39	Timber
110	Lawsonia inermis	Lythraceae	Mar-May	-	Medicinal
111	Leonotis nepetifolia	Lamiaceae	Sep-Nov	51.2	Medicinal
112	Lepedogathis cristata	Acanthaceae	Jan-Feb	26.43	Medicinal
113	Leucas aspera	Lamiaceae	Jan-Aug	38.92	Medicinal
114	Leucas lavendulaefolia	Lamiaceae	Sep-Mar	43.99	Medicinal
115	Linum mysorensis	Linaceae	Sep-Nov	29.67	Ornamental
116	Lycopercicum esculentum	Solanaceae	Jul-Sep	_	Vegetable
117	Madhuca indica	Sapotaceae	Mar-Apr	52.4	Oil
118	Medicago sativa	Fabaceae	Sep-Nov	48.5	Fodder
119	Melia azardirachta	Meliaceae	Feb- May	-	Medicinal

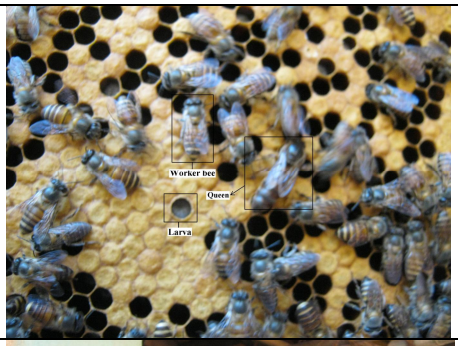
120	Melia dubia	Meliaceae	Mar-May	-	Medicinal
121	Millettia peguvensis	Fabaceae	Jan-Mar	46.25	Ornamental
122	Memecylon umbellatum	Melastomaceae	Jan-May	23.3	Medicinal
123	Mimosa pudica	Mimosaceae	Jan-Dec	30.5	Medicinal
124	Momordica charantia	Cucurbitaceae	Aug-Oct	-	Vegetable
125	Moringa oleifera	Moringaceae	Feb-Apr	56.4	Vegetable
126	Muntingia calabura	Tiliaceae	Dec-Feb	-	Avenue, fruit
127	Murraya koenigi	Rutaceae	Apr-Jun	51.66	Spice
128	Musa sp.	Musaceae	Jan-Dec	24.44	Fruit
129	Mussaenda frondosa	Rubiaceae	Sep-Dec	52.6	Medicinal
130	Neolitsea zeylanica	Lauraceae	Jan-May	41.5	
131	Nymphaea pubescens	Nymphaceae	Jan-Apr	23.75	Ornamental
132	Ocimum sp.	Lamiaceae	Jan-Dec	39.87	Medicinal
133	Opuntia monocantha	Cactaceae	Oct-Nov	46.75	
134	Oryza sativa	Poaceae	Aug-Sep	-	Food
135	Oxalis corniculata	Oxalidaceae	Mar-May	50.26	Medicinal
136	Passiflora foetida	Passifloraceae	Jan-Jul	44.56	Fruit
137	Peltaphorum pterocarpus	Fabaceae	Jan-Jun	44.5	Ornamental
138	Petrea volubilis	Verbenaceae	Feb-Apr	-	Ornamental
139	Phaseolus vulgaris	Fabaceae	Dec-Feb	34.86	Pulses
140	Phaseolus aureus	Fabaceae	Dec-Feb	28.3	Pulses

141	Phoenix sylvestris	Arecaceae	Dec-Feb	49.45	Timber
142	Polianthus tuberosa	Agavaceae	Oct-Dec	44.28	Flower
143	Polygonum sp.	Polygonaceae	Jun-Aug	33.86	Ornamental
144	Pongamia pinnata	Fabaceae	Feb-Apr	56.3	Oil
145	Portulaca oleracea	Portulaceae	Jan-Feb	-	Medicinal
146	Prosopsis cineraria	Fabaceae	Jun-Sep	52.45	Fuel
147	Psidium guajava	Myrtaceae	Mar-Jun	39.66	Fruit
148	Pterocarpus marsupium	Fabaceae	Feb-Apr	43.6	Timber
149	Ricinus communis	Euphorbiaceae	Feb-Apr	22.5	Oil, medicine
151	Rosa sp.	Rosaceae	Jun-Jul	26.55	Ornamental
152	Samanea saman	Fabaceae	Mar-Jun	38.5	Ornamental
153	Santalum album	Santalaceae	Jan-Jul	48.6	Wood/oil
154	Sapindus laurifoilus	Sapindaceae	Dec-Jan	40.5	Medicinal
155	Schefflera venulosa	Araliaceae	Apr-May	56.55	
156	Seasamum orientale	Pedaliaceae	May-Sep	-	Oil, food
157	Sechium edule	Cucurbitaceae	Jan-Dec	44.5	Vegetable
158	Sida acuta	Malvaceae	Jan-Dec		Weed
159	Sida cordata	Malvaceae	Oct-Dec	33.45	Weed
160	Sida cordifolia	Malvaceae	Jan-Dec	42	Weed
161	Solanum indicum	Solanaceae	Sep-Jan	24.58	Medicinal
162	Solanum melongena	Solanaceae	Sep-Jan	-	Vegetable

163	Solanum nigrum	Solanaceae	Jun-Dec	25.64	Medicinal
164	Solanum tuberosum	Solanaceae	Mar-Jun	19.36	Vegetable
165	Solidago sp.	Asteraceae	Nov-Dec	49.2	Ornamental
166	Spathodea compannulata	Bignoniaceae	Nov-Mar	-	Ornamental
167	Syzygium cumini	Myrtaceae	Mar-Apr	58.5	Timber/fruit
168	Syzygium jambos	Myrtaceae	Mar-Jun	49.65	Fruit
169	Tabebuia argentea	Bignoniaceae	Dec-Feb	42.4	Ornamental
170	Tabebuia rosea	Bignoniaceae	Aug-Sep	38.58	Ornamental
171	Tagetus sp.	Asteraceae	Jan-Dec	28.5	Ornamental
172	Tamarindus indicus	Fabaceae	Apr-Jun	56.74	Timber/spice
173	Tecoma stans	Bignoniaceae	Sep-Nov	16.24	Ornamental
174	Tectona grandis	Verbenaceae	Jun-Sep	56.25	Timber
175	Terminalia arjuna	Combetaceae	Mar-May	46.6	Timber
176	Terminalia chebula	Combetaceae	Mar-Apr	58.23	Timber, medicine
177	Terminalia tomentosa	Combetaceae	May-Jun	57.29	Timber
178	Thespesia populnea	Malvaceae	Jan-Feb	-	Timber
179	Todalia asiatica	Rutaceae	Feb-Sep	44.8	Medicinal
180	Toona ciliata	Meliaceae	Jan-Feb	-	Timber
181	Trichosanthes anguina	Cucurbitaceae	Jan-Mar	39.5	Vegetable
182	Tridax procumbens	Asteraceae	Jan-Dec	29.58	Weed
183	Vernonia albicans	Asteraceae	Aug-De	-	Weed

184	Vitex negundo	Verbenaceae	Sep-Nov	20.5	Medicinal
185	Zinnia elegars	Asteraceae	Jul-Jan	30.5	Ornamental
186	Ziziphus jujuba	Rhamnaceae	Jul-Oct	48	Fruit
187	Ziziphus oenopila	Rhamnaceae	Mar-Aug	44.64	Fruit
188	Ziziphus xylopyrus	Rhamnaceae	Mar-Sep	50.75	









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