Original Research Article

ECONOMIC IMPORTANCE OF HONEY BEES AND FARMERS' AWARENESS ABOUT BEEHIVE PRODUCTS IN SHIMLA HILLS OF HIMACHAL PRADESH, INDIA

ABSTRACT

Insect pollinators are responsible for pollination of most the fruit crops and they are performing it well. Pollinator mediated cross-pollination is needed for the better production of fruit crops. Many insects such as honey bees, bumble bees, wasps, hover flies, butterflies, moths and beetles are important pollinators but honey bees are the most significant and efficient pollinators of fruit crops. Honey bees are economically very important because they not only help in pollination but provide other valuable products like honey, beeswax, propolis, royal jelly, bee venom and pollen.

A survey was conducted to know the farmers' awareness about beehive products in Shimla hills of Himachal Pradesh, it was found that the farmers had knowledge about different insect pollinators visiting various fruit crops. They were practicing beekeeping not only for managed crop pollination but for producing honey also. This practice was benefitting the farmers directly as well as indirectly. Most of the farmers here were part-time beekeepers and rearing the bees for crop pollination. Only 67% of them were getting extra income by extracting honey from bee colonies. There was very little awareness among the farmers about other beehive products like beeswax, bee venom, royal jelly, propolis and pollens as well as regarding their use as industries, food, medicine, cosmetics and apitherapy. The climate and the conditions of Himachal Pradesh are not favourable for beekeeping. The lack of experts, financial support, labour, transport, honey market, knowledge of diseases and occurrence of winter snow fall at higher altitudes were demoralizing the farmers to make beekeeping as whole time profession. Apiculture requires organized honey marketing channels and awareness on limiting the use of pesticides in agriculture to protect the bees and the environment as well. The renovations in all aspects and application of improved beekeeping technologies not only benefits beekeepers but also farmers and the general public in pollinating their crops, gaining extra income, maintaining plant biodiversity and the ecology.

Key Words: - Honey Bees, Pollination, Honey, Farmers' Awareness, Beehive Products, Himachal Pradesh

INTRODUCTION

Insect pollinators are vital for the sustainability of crop ecosystems. The pollinator diversity is important for stabilizing crop pollination and its yield. It has been estimated that over 80% of angiosperm plants rely on insect pollinators. Many insects such as honey bees, wasps, flies, butterflies, moths and beetles are main pollinators of many fruit crops [1,2]. Among insects, honey bees are more effective pollinators than other insects because, unlike other insects, they are social and collect nectar & pollen not only to satisfy their own needs but to feed their young. They are

perfect pollinators because of their body hairs, flower constancy, floral fidelity and many species can be reared and managed for pollination [3]. Further, honey bees can be domesticated, marketed and transported from place to place [4].

The vibrant role which honey bees play in the pollination of large number of cultivated crops is often under estimated in developing countries. Main role played by honey bees in beekeeping is the pollination. Therefore, income from agriculture by the use of honey bees in crop pollination is many times higher than their value as honey and beeswax production [5]. Honey bee pollination is one of the most effective and cheapest methods of increasing their yield. It is not only the self-incompatible varieties which require cross-pollination, but self-compatible plants also produce more seeds of better quality if pollinated by honey bees and other insects [6]. The cross-pollination of different crops by honey bees increases the crop yield, improves fruit and seed quality and help to use hybrid vigour [7].

The biological evolution of honey bees is much older than human civilization, dating back to 50 million years ago or so. They are highly social insects which have fascinated the humanity since the prehistoric times. Commercial beekeeping (apiculture) is perhaps the only industry exploiting the domesticated species of honey bees for enhancing crop productivity, honey from nectar of floral and extra floral nectarines from plants, beeswax and several other products of medicinal value and help in conservation of global biodiversity through propagation of plant species as well as enabled speciation of new flora in nature [4][8]. There is an ever-increasing demand for food security in the face of challenges such as climate change, land-use changes, habitat transformation and the expanding human population. Proper pollination can improve the quantity and quality of fruits, nuts, oils and other crops produced [9]. According to market prices, pollination by animals improves the global crop output by an additional USD 235–577 billion annually, with the greatest economic benefits having been seen in the Mediterranean, Southern and Eastern Asia and Europe [10]. However, greater production also leads to an increased demand for pollination services [11].

Although, the soil and the climate of Himachal Himalaya is suitable for planting different types fruit crops and orchardists are also putting their intensive efforts, yet the yield and quality of fruits is reducing due to inadequate pollination [2]. Lack of awareness among farmers, extension workers and professionals at policy and planning level, is one of the main problems in promoting managed pollination. With a few exceptions of farmers in those areas where there is a pollination problem, people are not aware of the value of honey bees (including other pollinators) for agricultural production. This is both because beekeeping has always been promoted exclusively as an enterprise for honey production and because cash crops' farming is a new activity in many developing countries and there is no indigenous knowledge on the need for managed crop pollination for enhancing cash crop production. Raising awareness at all levels about the importance of managed crop pollination through beekeeping and other pollinators is the first step as part of development efforts [12,13]. Saville and Upadhaya [14] stressed the importance of traditional log hive, baiting hive method to capture swarms, swarm management, honey harvesting and processing, winter colony management and traditional methods of disease control for efficient administration of honey bee colonies for better pollination services.

MATERIALS AND METHODS

The data collected for this study is primary as well as secondary. Primary data was collected from farmers and they were questioned about different aspects like knowledge of bee pollination, beehive products and various problems faced by them in beekeeping at different localities in Shimla hills of Himachal Pradesh**.** The secondary data was collected from reference books,

research papers and different agencies like Directorate of Horticulture and Directorate of Industries Government of Himachal Pradesh, Khadi and Village Industries Commission (KVIC) and Central Bee Research and Training Institute (CBRTI), Pune. Elaborate interactions were made with the district and state level officials of Horticulture Department, Government of Himachal Pradesh.

RESULTS AND DISCUSSION

Apiculture is called eco-friendly source of direct (hive products) and indirect income (pollination). The purpose of beekeeping in Shimla hills of Himachal Pradesh is pollination of fruit crops. Honey bees visit the bloom to collect pollen and nectar and pollinate the flowers. They produce a range of substances for their own use and keep their colony well fed, watered and disease free which enables them to rear and look after their young. They also provide humans with some of the most important products on earth like honey, beeswax, pollen, propolis, venom and bee bread.

1. ECONOMIC IMPORTANCE OF HONEY BEES

1.1 HONEY

Flower nectar is a solution of sugars and other minor constituents that bees collect and concentrate into honey. It is a sweet, viscous fluid, produced by honey bees. It is collected as nectar from nectarines at base of flowers. It may also be collected from nectar secreted by plant parts other than flowers called extra floral nectarines, fruit juice, cane juice etc. Depending upon the source of sweet liquid and also the plant species in case of floral and extra floral nectar, the quality of honey varies. On this basis, the honey can be classified as floral honey or honeydew honey.

Honey is extracted and prepared for market by different methods. The honey from *Apis dorsata* combs is squeezed and it is ought to contain more pollen grains and even the juices of some brood and the honey is normally called squeezed honey. The honey from combs of *Apis cerana* and *Apis mellifera* is extracted with the help of honey extractors, so it is extracted honey. These honeys may remain in liquid form or may crystallize and, hence, can be presented to consumers as liquid honey or granulated honey. There are some other preparations for marketing honey which are not common in India. Small combs can be made to be raised and sealed honey in these combs is marketed as such as comb honey. Small pieces of combs are suspended in liquid honey packing and the preparation is marketed as chunk honey [15].

1.1.1 Composition of honey: Chemical composition of honey is very complex. Honey mainly contains sugars but acids, minerals, vitamins, enzymes and antibiotic substances are also present in small amounts. The solids in honeys vary with the floral source. Honey is also known as a supersaturated sugar solution. Natural honey is composed of 38.5% fructose, 31% glucose, 12.9% other sugars (i.e. 82.4% carbohydrates), 17.1% water, 0.5% protein, organic acids, multi-minerals, amino acids, vitamins, phenols and a myriad of other minor compounds [16].

Sucrose in honey varies between 0 and 5%. A reducing disaccharide maltose is also present 3-10%. Maltose may not be present initially, but the quantity increases with storage and this is due to conversion of other sugars by the action of enzymes and acids. Analytical methods have also shown the presence of many other common sugars such as isomaltose, trehalose, genitiobiose, maltulose, panose, turanose etc occurring in lesser quantity. These complex sugars account for 1-2% only. Mineral complex of honey is very wide consisting of potassium, calcium, sodium, magnesium, phosphorus, manganese, copper, silica, sulphur, silicon and iron. All these account for up to 1% of solids in honey. Different vitamins are present in honey are: thiamine (B1), riboflavin (B2), nicotinic acid, vitamin K, biotin, folic acid, pyridoxine, ascorbic acid, pantothenic acid and carotene. There is loss of vitamins during storage [15]. Honey constituents with health

benefits include phenolic acids, ascorbic acid, flavonoids, proteins, carotenoids and enzymes like glucose oxidase and catalase [16].

1.1.2 Uses of Honey

The different types of uses of honey [15] [17] are listed as follows:

Food supplement- Honey remained mainly as an essential food in religious ceremonies at the time of birth, marriage and death, as well as an item offered to the gods during worship. Social and cultural customs in all religious groups include use of honey. Use of honey as food continues, however, because of its natural flavor, taste and its preservative properties. Honey has been used directly in cooking and as an ingredient of other regular food items such as baked products. Hotel, health club and restaurants serve honey on the table, as bread spread, in salads or in their special food and drinks preparations.

Medicine or tonic- In many parts of the world, honey is used as a medicine or tonic and as a special treat for children. Modern medicine is increasingly using honey for a variety of treatments. It is used as laxative, blood purifier, fever, ulcers, burns, used in cold, cough and diabetes.

Cash crop- Fresh local honey is always more highly valued than imported honey. Many beekeepers sell their product directly to consumers. Honey is often used as an exchange commodity in villages, especially in remote areas or areas isolated by war or sanctions. Honey is a stable commodity with a long shelf life. If harvested carefully, it will remain wholesome for many years.

An export crop- As standards of living rise, honey consumption increases. Most industrialized countries import honey to meet demand. This requirement can provide developing countries with a useful source of foreign exchange from honey exports. The countries with the highest honey exports are Mexico, China and Argentina. Because beekeeping does not use land, production of honey for export need not conflict with growing crops for local consumption.

Industrial importance - Almost 10-12% of total production of honey is used in industry. This is largely due to the fact that honey is costly and therefore adds significantly to the cost of production. Forest honey is usually preferred in the industries because of its low costs. It is used for making honey tea, coffee, honey biscuits, honey wine and baking.

Ancillary products- Use of honey in mass production and fast-food industry has recently been increasing. Some products that use honey are processed food like cereals, ready- to-eat mixes, health food and baby foods and dairy products like yogurts, milk, sweetmeats, creams, fudges and ice creams.

Confectionery- During the past decade or so, use has been made of honey in confectionery like sweets, candies, toffees, eclairs and chocolates.

In bakery- Small quantities of honey are also being used in bakery products like special types of breads, biscuits, cakes and cookies. It is used as a sweetener and flavouring agent in the preparation of pancakes, pastries, pies and puddings. The hygroscopic nature of honey keeps bread soft, while improving its keeping qualities.

Honey as preservatives- This emerging industry has good potential to use honey both as a preservatives and as a flavouring medium. The fruit products industry that includes manufacture of jams, jellies, canned fruits, syrups, squashes, sauces and ketchups is just beginning to use honey in its products.

Pharmaceuticals- Much of the honey used in industry is for manufacture of medicines like cough drops, lozenges or syrup, tonics and other medicinal formulations. Interestingly, forest

honey contributed to only 22% of the honey used in Pharmaceuticals companies. Dental creams and antiseptic eye lotions are newly developed products of this industry using honey.

Cosmetics- Honey has a mild action on skin, but at the same time protects it from infection and nourishes it. Because of these properties it is in use in facials, shampoos and other cosmetics. Consumption in this sector was negligible. With the recent perceptible shift towards herbal preparation honey is increasingly used for manufacture of skin-care and hair-care products as a natural therapeutic and medicinal ingredient.

Antioxidant- Antioxidants are substances which protect the body from damage caused by free radicals. Free radicals are very reactive chemicals which react with and change other molecules next to them. Maurya *et al*. [18] investigated, the antioxidative properties of honey from different flora and reported that honey serve as a good source of natural antioxidant and hence, it is free radical scavengers that either reduce the formation of or neutralize free radicals. Honey is a healthy foodstuff for human health and nutrition.

Religious ceremonies– It high place in the world. Christian's use to make cakes on Christmas, Quran has special chapter for honey, Hindus use it as a holly thing.

Stamina booster- Athletics use it with the milk to increase their stamina.

Growth enhancer- It is used in plant growth and root cuttings.

Medium- In the laboratory, honey is used to grow bacterial culture.

Other industrial uses- Significant quantities of forest honey are used in incense sticks manufacture, perfumery, tobacco curing and cigarette manufacture.

1.2. BEESWAX

It is important byproduct of bee keeping industries. It is true wax secreted by four pairs of specialized glands on the ventral side of the abdomen (sternites 4-7) of about 2-week older worker bees. They secrete flakes of a soft, malleable material called beeswax that bees use to build the comb where honey is stored and larvae are reared. Bee's wax in elementary origin is whitish in colour and later becomes darker. In India, wax is obtained from rock bee (*Apis dorsata).* The wax has a relatively low melting point so it is easy to extract and purify with heat.

1.2.1 Composition of beeswax: Pure beeswax consists of at least 284 different compounds. All of them have not been completely identified but over 111 are volatile [19]. At least 48 compounds were found to contribute the aroma of beeswax. Quantitatively, the major compounds are saturated and unsaturated mono-esters, di-esters, hydroxyl-polyesters, saturated and unsaturated hydrocarbons and free acids. There are 21 major compounds constituting 56% of wax, each compound making up more than 1% of the pure unfractionated wax. The other 44% of various minor compounds probably contribute for beeswax's characteristic plasticity and low melting point [19]. The ratio of ester values to acids, is changed significantly by prolonged or excessive heating. At 100°C for 24hr the ratio of ester to acid is changed beyond the limits set for pure beeswax [15].

1.2.2 Uses of Beeswax

The different types of uses of beeswax [15] [17] are listed as follows:

Candles- Beeswax is mainly consumed by candle industry and bee industry for preparing comb foundation sheets. Bee wax candles are preferred in most Eastern Orthodox churches because they burn cleanly, with little or no wax dripping down the sides and little visible smoke.

Cosmetics- Wax is also an important constituent of cosmetics like cold creams, lipsticks and rouges because it adheres better to skin.

Pharmacy- Pharmaceutical and perfume industries are also major users of wax. It is also used in ointments, capsules, pill coatings and deodorants.

Furniture and inks- Wax is used for preparing shoe polish, furniture etc. because it acts as water proofing. Its minor use is made in adhesives, chewing gums and inks etc.

Cheese coating- It is also used as a coating for cheese, to protect the food as it ages. While some cheese makers have replaced it with plastic, many still use beeswax in order to avoid unpleasant odour that results from plastic.

1.3. BEE VENOM

Bee venom is a clear, odourless, watery liquid. It is produced by two glands associated with the sting apparatus of worker bees. Sting is evolved from ovipositors. Its production increases during the first two weeks of the adult worker's life and reaches a maximum when the worker bee becomes involved in hive defence and foraging.

1.3.1 Composition of bee venom: About 88% of venom is water. The glucose, fructose and phospholipid contents of bee venom and bee blood are same. At least 18 components, including various proteins, enzymes (Phospholipase, Hyaluronidase, Phosphomonoesterase, Lysophospholipase and B -glucosidase) and peptides (Melittin, Pamine, Mast Cell Degranulating (MCD) Peptide, Protease inhibitor, Secapin, Procamine, Adolapin, Tertiapin) and various small peptides and amines (Histamine, Dopamine and Noradrenalin) have been found in venom [20].

1.3.2 Uses Bee Venom

The different types of uses of bee venom [15] [17] are listed as follows:

Skin Diseases- Bees can be made to sting the patient who has skin disease and the venom collected can be used as medicines for subcutaneous infections. The treatment of diseases with bee venom is called as apitherapy.

Treatment of rheumatism- Bee venom has long been used in traditional medicine for the treatment of various kinds of rheumatism.

Other diseases- Its use in cure of the diseases, like chronic pain, epilepsy, rhinosinusitis, polyneuritis, neuralgia, migraine, multiple sclerosis, asthma and tropical ulcers.

Ointments- They can be prepared by thoroughly homogenizing bee venom with white Vaseline, petrolatum or melted animal fat and salicylic acid, in the ratio of 1:10:1, acid can be used to make the skin soft and increases penetration.

Blood Pressure- It has stimulating effect on heart muscles. It decreases cholesterol level and also lowers blood pressure.

1.4. PROPOLIS (BEE GLUE)

Propolis is a mixture of the beeswax and the resins collected by honey bee from plants. In the process of collection of resins, it is mixed with some saliva as well as with wax. The colour ranges from yellow to dark brown. Propolis is used by worker bees to line the inside of nest cavities, brood combs, to repair combs, seal small cracks in hive, reduce the size of hive entrances and to seal brood cells. At temperatures of 25 to 45ºC, it is a soft and very sticky substance. Typically, it will become liquid at 600 to 700 ºC, but for some samples the melting point may be as high as 1000 ºC [15].

1.4.1 Composition of propolis: The main constituents of propolis are resin (50%), wax (30%), essential oils (10%), pollen (5%) and other organic compounds (5%). Phenolic compounds, esters, terpenes, flavonoids, beta-steroids, aromatic aldehydes and alcohols are also the important organic compounds present in propolis [16]. Twelve different flavonoids, namely, pinocembrin, rutin,

acacetin, chrysin, luteolin, myricetin, kaempferol, apigenin, naringenin, catechin, galangin and quercetin; two phenolic acids, caffeic acid and cinnamic acid; and one stilbene derivative called resveratrol have been detected in propolis extracts by capillary zone electrophoresis [21]. Propolis also contains important vitamins, such as vitamins B1, B2, B6, C and E and useful minerals such as magnesium (Mg), calcium (Ca), sodium (Na), potassium (K), copper (Cu), zinc (Zn), iron (Fe) and manganese (Mn). Propolis also has a few enzymes, such as succinic dehydrogenase, adenosine triphosphatase, glucose-6-phosphatase and acid phosphatase [22].

1.4.2 Uses of Propolis

The different types of uses of propolis [15] [17] are listed as follows:

Ointments- As propolis is a natural effective antibiotic, it is useful in preparing ointments for healing cuts, wounds and abscesses in cattle. Mixed with Vaseline, it smoothens burns [23]**.** The Greeks, Romans and Egyptians already knew that propolis heals skin abscesses.

Sealant- It is used by bees for sticking frames, sealing cracks and crevices. It has been incorporated in special varnishes [23].

Cosmetics- It is used in cosmetics.

Health supplement- Propolis is sold as supplement in health shops too in the form of capsules, tablets and in liquids.

Its anti-bacterial, anti-fungal, anti-viral, anti-acne, anti-inflammatory and anti-oxidant characteristics provide many benefits of its applications in medicines, dermatological and cosmetic treatment. The antioxidant, antimicrobial and antifungal activities of propolis also offer scope for its applications as a preservative in food technology.

1.5. ROYAL JELLY (BEE MILK)

Royal jelly is a special liquid food, rich in proteins, hormones, vitamins, organic acids, lipids, carbohydrates and minerals, secreted by the hypopharyngeal gland of young worker (nurse) bees having the age of 6-12 days. Royal jelly is whitish in colour with yellow tinge with a pungent phenolic odour and a characteristic sour flavour. It is partially soluble in water. It is acidic (pH 3.6 to 4.2).

1.5.1 Composition of royal jelly: Royal jelly consists of water (50%–60%), proteins (18%), carbohydrates (15%), lipids (3%–6%), mineral salts (1.5%) and vitamins [24]. Royalactin is the most important protein present in royal jelly and it is composed of approximately 185 organic compounds. Fatty acid, proteins, acetylcholine, adenosine monophosphate (AMP) N1 oxide, adenosine, polyphenols and hormones such as testosterone, progesterone, prolactin and estradiol are other useful bioactive components present in royal jelly [16]. It also contains 10-hydroxy-2-decenoic acid (HAD), which has immunomodulatory properties. The major mineral salts of K, Ca, Na, Fe, Zn, Cu and Mn [15].

1.5.2 Uses of Royal Jelly

The different types of uses of royal jelly [15] [17] are listed as follows:

Energy Booster- The spectacular fertility and long life-span of the queen fed on royal jelly, has suggestively led people to believe that royal jelly may produce similar effects in humans too. People have experienced it as a general tonic and stimulant improving general well-being, resistance to fatigue, learning capacity and memory, appetite and general health improvement.

Immunity- Royal jelly improves immune response and general body functions.

Pharmaceutical- Royal jelly is used as ingredient in medicine-like products. It is usually mixed with medicines, tonics, beverages and cosmetic products soon after its production or sometime it is freeze dried.

Food supplement- A mixture of royal jelly in honey (1-3 % royal jelly) is probably the most common way in which royal jelly is used as a food ingredient. Royal jelly is a nutritious food for human beings also as it increases vigour and vitality.

Cosmetics: Probably the largest use of royal jelly is in cosmetics and dermatological preparations.

1.6. POLLEN

The worker bees (field bees) collect pollen from the plants. Pollen is used for feeding the hive larvae. The nurse bees of the hive will refine the pollen in to beebread or royal jelly for feeding to larva and young bees. Pollen is also used for human consumption since it's packed with 25 proteins and 18 amino acids. In India, Rock bees collect enormous quantities of pollen. The Central Bee Research and Training Institute, Pune made pollen supplements using rock bee pollen. After harvest from bee colonies, pollen loads are carefully air-dried or fresh-frozen for preservation and packed in airtight glass bottles. Pollen is also sold as tablets, in capsules mixed with honey.

1.6.1 Composition of honey: The major components are proteins, amino acid, lipids and sugars. The minor components are more diverse including flavonoids, carotenoids, minerals, vitamins, terpenes, nucleic acids and nucleosides, enzymes and growth regulators. All essential amino acids are found in pollen [15].

1.6.2 Uses of Pollen

The different types of uses of pollen [15] [17] are listed as follows:

Food supplement- The major use of pollen today is as a food or food supplement. Tribal people eat the combs pollen while harvesting honey.

Medicinal use- Pollen is used in medicine for treatment of diseases like chronic prostatitis, bleeding stomach ulcers, respiratory infections and in control of allergy reactions.

Energy booster- There is good number of non-scientific reports of benefits, cures or improvements in athletic performance, digestive assimilation, rejuvenation, general vitality, skin vitality, appetite, hemoglobin content and sexual powers by use of bee-collected pollen.

Cosmetics- Pollen has only recently been included in some cosmetic preparations with claims of rejuvenating and nourishing effects for the skin.

1.7. BEE BREAD

Bee bread is a source of protein produced by honey bees for the larvae and young ones. A mixture of pollen, lactic ferments and honey is prepared and sealed within the cells of the honeycomb that turns into bee bread roughly after three months of fermentation.

1.7.1 Composition of bee bread: Like most other bee products, this by-product, too, contains vitamins, enzymes, minerals, lactic acid and amino acids, among other things. Bee bread stored carefully at room temperature tends to retain its beneficial properties for a very long time [17]

1.7.2 Uses of Bee Bread

The different types of uses of bee bread [15] [17] are listed as follows:

Food supplement- A great source of energy, bee bread has detoxifying properties along with the ability to increase hemoglobin and boost energy.

Immune booster- It is an immune-boosting product recommended for children and people with mineral and selenium deficiencies.

Fat reducer- Bee bread also reduces appetite, helps with weight management and regulates cholesterol and triglycerides.

Medicine- This bee by-product is known for treating liver disorders, intestinal problems and constipation.

2. FARMERS' AWARENESS ABOUT BEEHIVE PRODUCTS

2.1. Beekeeping as a Pursuit

Most of the farmers (91.10%) practise beekeeping as a part time job and only 8.90% farmers are doing it as a full time job (Table 1).

Table 1: Beekeeping as a pursuit

Sr. No.	Beekeeping Type	Responses (%)
1.	Full time	08.90
2.	Part time	91.10

2.2. Motives for Rearing of Honey bees

Farmers were engaged in beekeeping since many years. Only 13.20% farmers practised the apiculture throughout the year, so they were professional beekeepers. Some of the farmers practised it in spring, summer and spring & summer both seasons. Farmers who reared the honey bees throughout the year gave more than one reasons for this (Table 2).

Table 2: Reasons for rearing honey bees throughout the year

Motives for Rearing	Responses (%)
Pollination purpose	65.30
Professional beekeeper	13.20
Honey production	13.20
For honey production and pollination (both)	06.80
Experimenting apiculture	01.50

2.3. Farmers' Awareness on Pollination

Analyses of data on farmers' awareness on pollination revealed that most of the farmers (80%) were aware that the introduction of honey bee hives in orchards at the time of flowering period helped in the fruit set and yield. But, they learned recently about the importance of bee colonies in pollination of fruit crops and this information was disseminated to them through some other person (70%) and by government agencies (30%). Most of the farmers (80%) knew that their crops were not naturally pollinated by wind or insects due to changing weather conditions (Table 3).

Table 3: Farmers' awareness about Honey bees in pollination

		Responses (%)
a.	**Knowledge about role of bees in pollination**	
	Yes	80
	No	11
	DNK	09
b.	**Source of knowledge about pollination**	
	Government officials	30
	Some other persons	70
c.	**Naturally pollinated by wind/insects**	
	Yes	80
	No	17
	DNK	03

d.	**Artificial pollination/loss**	
	Artificial pollination by colonies	75
	Loss in yields	25

2.4. Information on Beekeeping

Orchardists were rearing *Apis cerana* (40.50%) and *Apis mellifera* (55.50%) bees and only 04% had both types of bee species. However, 52.10% orchardists preferred native *Apis cerana* and 38% preferred exotic *Apis mellifera,* whereas 09.90% preferred to use both the species bees for pollination (Table 4).

Table 4: Type of bee species reared and preferred by farmers

	Responses (%)
Type of bees reared	
Apis mellifera L.	55.50
Apis cerana F.	40.50
Both	04.00
Preferred bee species	
Apis cerana F.	52.10
Apis mellifera L.	38.00
Both	09.90

2.5. Number, Strength and Placement of Bee Colonies

Data revealed that majority of the farmers (65.90%) were aware about the number of bee colonies required per hectare for pollination of temperate fruit. Most of them (85.70%) also knew that bee hives with better strength have better results. 65.70% farmers knew about the time of placement of colonies in their orchards. However, some orchardist (45.70%) shifted the colonies from one place to another during flowering period (Table 5).

Table 5: Farmers' awareness regarding number, strength and time of placement of bee colonies in the orchards

		Responses (%)
a.	**Number of bee colonies required per ha for pollination**	
	Yes	65.90
	No	25.40
	DNK	08.70
b.	**Bee hives with better strength have better results**	
	Yes	87.70
	No	08.50
	DNK	3.80
c.	**Time of placement of bee colonies in the orchard**	
	Yes	65.70
	No	26.10
	DNK	08.20
d.	**Shifting of colonies from one site to another**	

	Yes	45.10
	No	35.70
	DNK	10.20

2.6. Farmers' Awareness of Bee Flora

Only half the farmers (55%) had knowledge regarding the local bee flora. They had different types of bee plants on their own land, such as mustard, pear, apple, almond, kiwi, plum, peach, clover, rose and bottle brush. Only 47% orchardists agreed that there was sufficient availability of bee flora in local areas. According to most of the farmers (70%) the plants nearer to hives have better produce than distant ones. Most of the orchardists had plants nearby their houses. Farmers of different villages have different conceptions of honey flow period (Table 6).

Table 6: Farmers' knowledge regarding bee flora

		Responses (%)
a.	**Awareness about bee flora**	
	Yes	55
	No	35
	DNK	10
b.	**Sufficient availability of bee flora**	
	Yes	47
	No	19
	DNK	34
c.	**Plants nearer to hives have better yields than distant ones**	
	Yes	70
	No	19
	DNK	11

2.7. Information Regarding Types, Constituents and Value of Honey

Most of the farmers (66.80%) earned extra income from honey besides using honey bees for pollination. Most of the farmers (61%) preferred brown honey. About half of the orchardists (56.50%) had knowledge about the constituents of honey and 89.20% knew about the value of honey (Table 7).

Table 7: Information regarding Honey

		Responses (%)
a.	**Extra income from honey**	
	Yes	66.80
	No	29.60
	DNK	03.60
b.	**Preference for different types of honey**	
	White	36.60
	Brown	61.20
	Both	02.20
c.	**Knowledge about constituents of honey**	

	Yes	56.50
	No	42.30
	DNK	01.20
d.	**Knowledge about nutritional value of honey**	
	Yes	89.20
	No	09.70
	DNK	01.10
e.	**Honey from one or more sources**	
	One	33.90
	More source	66.10

2.8. Processing and Storage of Honey

Maximum farmers (81.20%) processed the honey by themselves. About 84% farmers stored the honey in glass containers (Table 8).

Table 8: Knowledge about Processing and storing of honey

		Responses (%)
a.	**Processing**	
	Manual	81.20
	Honey processing plant	14.30
	Not processed	04.50
b.	**Storing**	
	Glass containers	84.10
	Steel containers	09.40
	Drums	02.20
	Plastic Bags	04.30

2.9. Information on Other Bee Hive Products

Less than half of the farmers (44.90%) have knowledge about the bee hive products other than honey (Table 9). They had the knowledge beeswax and used it for various purposes.

Table 9: Knowledge of Other Bees Hive products

		Responses (%)
a.	**Knowledge of other bee hive products**	
	Yes	44.90
	No	51.70
	DNK	03.40
b.	**Use of beeswax**	
	Creams	05.60
	Sheets	16.30
	Polishes	04.30
	Candles	35.70
	Thread strength	07.80
	Sell	02.20
	Comb foundation	28.10

2.10. Marketing of Honey

Collection of honey was made available at different intervals. Most of the persons (61.40%) were satisfied with the collection interval. While most of the farmers (66.30%) were not satisfied with the transport arrangements in their regions. Most of them (79.90%) faced marketing problems of different kind. Most of the farmers (84.60%) sold their honey to private parties for more than one reasons (Table 10).

Table 10: Knowledge about Marketing of Honey

		Responses (%)
a.	**Satisfaction with honey collection interval**	
	Yes	61.40
	No	35.30
	DNK	03.30
b.	**Marketing problems**	
	Yes	79.90
	No	11.10
	DNK	09.00
c.	**Satisfaction with transport arrangements**	
	Yes	30.00
	No	66.30
	DNK	03.70
d.	**Types of problems**	
	Less price for honey	49.90
	Market was away	08.70
	Time consuming	11.30
	Long processor	02.30
	Winter snow falls	07.80
	Need of genuine support price	03.30
	Need of guidance	10.60
	No marketing facility	06.20
e.	**Sell the honey to private parties**	
	Yes	84.60
	No	14.40
	DNK	01.00
f.	**Preferences for private parties**	
	Easily available	54.30
	Advance payment	06.70
	High incentive	09.80
	Better rates	21.20
	Economic regions	03.90
	Money of transportation saved	04.10

Conclusion

Apiculture is an eco-friendly source of income, whether it is direct (hive products) or indirect (pollination). The purpose of beekeeping in Shimla hills of Himachal Pradesh is pollination of fruit crops. Honey bees visit the bloom to collect pollen and nectar and pollinate the flowers. They increase the yield of all fruit crops by cross pollination. They produce a range of economically important substances like honey, beeswax, pollen, propolis, venom and bee bread. Beekeeping and honey bee management in Himachal Pradesh is in infancy. Most of the farmers here practiced beekeeping as a part time job and were engaged in this venture for the past many years. The commercial beekeepers stressed on the role of honey bees as honey producers than pollinators of horticultural crops. Most of the farmers earned extra income from honey and other bee products besides using them for pollination purposes. They had knowledge regarding different aspects honey such as various constituents of honey, nutritional value, honey containers, honey processing, marketing problems etc. But only a few farmers were aware about other beehive products like beeswax, bee venom, propolis, royal jelly and pollen. They had very little knowledge of other beehive products like beeswax, bee venom, royal jelly, propolis, bee bread & pollens and their uses as medicine, cosmetics, pharmaceuticals, apitherapy and industry.

The beekeepers' awareness, financial assistance and improved beekeeping technologies are required in this region. It will not only benefit beekeepers but other farmers and general public also in pollinating their crops, gaining extra income and maintaining biodiversity.

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