



Status and Prospective of Beekeeping in Bhutan: A Review

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Abstract

Beekeeping is an ancient tradition in Bhutan. The country is divided into six agro-ecological zones and about 70.5% of the total land is covered with natural forest. Total six honey bee species are found. Three of them are kept in traditional and modern hives for honey production. Among the four regions, east central region produces the maximum honey followed by west central, western and eastern regions. The honey price per kg is Nu.5,000 (US \$ 63.5) to 7,000 (US \$ 88.9) for *Trigona* honey, Nu.550 (US \$ 6.9) to 1,410 (US \$ 17.9) for *A. cerana* honey and Nu.700 (US \$ 8.9) to 1,000 (US \$ 12.7) for *A. mellifera* honey respectively. Currently, the estimated number of three species of honey bee colonies in Bhutan is 18,000 including traditional and modern hives. As domestic honey production cannot meet the growing market demand of the honey, Bhutan imports the quantity equal to its annual production from India to meet the domestic market demand. Beekeeping sector development was mainly constrained by the lack of a laboratory facilities and absence of breeding station for bee selection and breeding. Further, pests and predators, agro-chemical use and the negative impact of climate change are hindering beekeeping sector development. To address these problems, government and non-government organizations including private sectors are collectively putting their efforts to improve the sector.

Keywords

Honey bee, Pollination, Hive products, Pollen, *A. cerana*, Bhutan

INTRODUCTION

Bhutan is a small and landlocked country covering the area of 38,394 km² out of which about 1,125 km² is arable (NSSC, 2010 in Chhogyel and Kumar, 2018). According to NSB (2018), the average land holding for the Bhutanese rural household is 2.22 acres which implies that there will be a shortage of land for cultivation and livestock rearing.

Beekeeping is environment friendly economic activity for the people that do not require additional space or huge investment. It can be easily integrated with the existing Bhutanese farming system. Honey bees are useful creatures for nature conservation and production of agricultural crops (Jodha, 1992; Patrap, 2011; Abrol, 2012; FAO, 2018). With new beekeeping technologies honey

bees can be managed scientifically for better production even the slack resources can be invested. Through the managed beekeeping techniques, pure and hygienic honey, royal jelly, pollen, bee wax, bee venom, propolis and healthy bee colonies can be produced. The management of honey bees with scientific knowledge and skills for the hive products and pollination service is known as apiculture (Punchihewa, 1994). Apart from the hive products and pollination service, managed beekeeping also generates the employment opportunities for poor and landless people (Verma, 1990; Ahmad *et al.*, 2007; Bradbear, 2009; Abrol, 2012).

All the four native honey bee species found in the Hindu-Kush Himalayan region are found in Bhutan viz. *A. cerana*, *A. florea*, *A. laboriosa* and *A. dorsata*. Including *A. mellifera* and *Trigona species*, there are

six honey bee species in Bhutan (Verma, 1990; Tamang, 2007; ICIMOD, 2012; Dawa, 2020). In the 6th Five Year Plan, *A. mellifera* and the Langstroth hive technology was introduced from India (Verma, 1990). In the 9th Five Year Plan, Department of Livestock with support from the International Centre for Integrated Mountain Development, Nepal had introduced the modern hive technology for *A. cerana* rearing in southern Bhutan. To lead the beekeeping sector, a National Beekeeping Program (NAP), an operational unit was created under the National Highland Research and Development Centre, Bumthang in 2014, which functions in collaboration with regional and districts development agencies.

Cottage industries diversification are one of the thrust areas of rural development in Bhutan where micro-enterprise including honey production are financially supported by the government (MoEA, 2019). Similarly, the Ministry of Agriculture and Forests also supports the beekeepers to take up commercial beekeeping by providing subsidy packages depending upon the scale of their operation (MoAF, 2019).

The existing population of honey bee colonies including *A. cerana* and *A. mellifera* in Bhutan is about 18,000 (DoL, 2018). One of the reports stated that a minimum of 50,000 managed colonies is needed in Bhutan for the efficient pollination of horticulture crops (Verma, 1990). The current hive population is not even the half of the estimated value, but the honey production for the last five years was on a constant rise (DoL, 2016–2020), which implies an increase in the number of beekeepers and honeybee colonies. Thus, it is important to study the status and perspective of beekeeping in Bhutan and come up with the relevant strategies for implementation so as to take the beekeeping sector to a greater height.

HISTORY OF BEEKEEPING IN BHUTAN

Beekeeping has been a part of Bhutanese culture from time immemorial especially in the south where Hindu communities predominate the rural settlements (Tamang, 2007). In the other parts of the country, beekeeping and honey consumption was considered as sin according to the Bhutanese Buddhist philosophy (Verma, 1990; Nidup 2021; Sherma 2021), because of which there was no beekeeping tradition for honey production in the past.



Fig. 1. Types of traditional hives used for *A. cerana* beekeeping in the south. Source: Photos from the field extension agent.

In 1980's *A. mellifera* colonies were imported from India and kept in Bumthang situated at an altitude range of 2,400 to 6,000 meters above sea level (Verma, 1990; Neopaney, 2019; Dawa, 2020; Sherma, 2021). Subsequently, the first beekeepers' group was formed at Gyelkhar, Bumthang in 1992. Efforts were made to propagate these colonies to the southern part of the country, but it failed, mainly because of the excessive pests and predators and presence of *A. cerana* in traditional hives.

Instead, the success of Newton hives for *A. cerana* management in Nepal and India encouraged the Bhutanese government to transfer this technology to Bhutan in 2006 (Tamang, 2007). The technology was successfully adopted by the traditional beekeepers in the southern Bhutan for honey production.

1. Honey production system

Traditional (log and wall hives) and modern movable frame hives were used to manage bees for honey production (Fig. 1 and Fig. 2). *A. cerana* beekeepers in the south keep traditional and modern hives around their houses and farm sheds to trap bees during the spring season. Some farmers also keep provision along the periphery walls of their houses which are known as wall hives. When they acquired the knowledge on modern moveable frame hive management, some of those colonies from the traditional hives are transferred to the moveable frame hive for better management and production. One study found that 37% of the



Fig. 2. Modern movable frame hives kept for *A. cerana* (A) and *A. mellifera* (B) rearing in Samtse and Bumthang Source: Photos from the farmers in Bumthang and Samtse.



Fig. 3. Raw honey extracted and packed with labeling (A) and raw honey extracted traditionally by squeezing the honey comb (B). Source: Photos from BPV, 2017 and ICIMOD, 2017.

bee colonies in the southern Bhutan are managed in modern hive and the figure is increasing as farmers are getting more access to modern beekeeping tools and equipment (Tamang, 2007; CIMOD, 2017).

The *A. mellifera* beekeepers in east central and western regions migrate their colonies within their districts during the nectar flow and feed table sugar syrup during dearth period, whereas in the south beekeepers neither migrate nor feed their colonies (BPV, 2017). *A. mellifera* beekeepers use modern tools and equipment along the production chain, but among *A. cerana* beekeeping communities such practice is improving and is not accessible to all (BPV, 2017; ICIMOD, 2017). Hive products such as pollen, royal jelly and bee venom are rarely harvested because of small scale operation focusing mainly for honey production. All the *A. mellifera* beekeepers use comb foundation sheet in moveable frame while *A. cerana* beekeepers hardly use them. With in-

creasing demand for Bhutanese honey in the domestic and international markets, Non-Government Organizations such as One Geog One Product project, Bio-Bhutan and SAVAH are also supporting rural beekeepers to enhance the local honey production in the country through material and financial inputs (BPV, 2017; ICIMOD, 2017; Dawa, 2020).

2. Types of hive products

The main hive product harvested from the traditional or modern hives is honey (Fig. 3). Few beekeepers in the east central and western regions ferment the honey wine and make candles from locally processed bee wax. (Fig. 4). Honey is highly valued and one of the most expensive farm products because of its importance in the socio-cultural and traditional lifestyle of Bhutan (ICIMOD, 2017; Dawa, 2020; Sherma, 2021). Honey



Fig. 4. Locally made candles (A) and honey wine (B) from *A. cerana* bee wax and honey. Source: Photos from farmers of Samtse.

Table 1. Annual average honey production, import and export figures with values 2016–2020.

Year	Honey production (kg)	Value (Nu)	Import (kg)	Value (Nu)	Export (kg)	Value (Nu)
2016	41,924	29,346,800	42,793	8,355,872	226	220,900
2017	48,274	33,791,800	39,040	8,074,423	254	259,712
2018	62,152	43,506,400	64,721	11,302,057	656	396,200
2019	65,896	46,127,200	42,295	9,722,329	341	240,671
2020	44,181	30,926,700	26,683	4,750,502	251	205,211
Total	262,427	183,698,900	215,531.66	42,205,183	1,728	1,322,694
Value (US\$)		2,551,373		586,183		18,370

Source: DoL, 2016–2020; NSB, 2016–2020

from three managed honey bee species; *A. mellifera*, *A. cerana* and *Trigona species* are sold in Bhutanese market besides the imported ones.

The honey production data of the past five years (2016–2020) reveals that there was continuous increase in honey production, but except in 2020 due to the major loss of bee colonies in Bumthang district in 2019 (DoL, 2016 to 2020). As the domestic production is not sufficient for the growing market demand, the quantity almost equal to the annual production is imported from India (BTS, 2016–2020) while small quantity was exported (Table 1). The honey production differs among the regions. For stance, the production trend for the last five years (2016–2020) shows that the highest amount of honey was produced from the east central region followed by west central, western and eastern region (Fig. 5) (DoL, 2016–2020). The regional honey production differences exist because of the variations in bee species, the number of managed colonies and the availability of bee forages.

Basically, the honey is harvested two times a year. The first and the major harvest is done between April and May in the *A. cerana* rearing areas in south while for *A. mellifera* beekeepers it happens between June and July. The second season is more applicable in the south where there is availability of honey bee forage throughout the year; cultivated and wild (ICIMOD, 2017; BPV, 2017; Dawa, 2020). However, few *A. mellifera* beekeepers do manage their hive for second honey harvest within September to October in Bumthang and Haa districts. A single *A. mellifera* colony can produce 50 kg of honey annually while a single *A. cerana* colony can produce 1.7 kg and 5.1 kg per year from traditional and modern hives respectively (BPV 2017; ICIMOD, 2017).

Although Bhutan has very rich floral diversity and conducive government policies for the sustainable utilization of natural resources, there are many unexplored opportunities about managed beekeeping and thus, the inadequate information on beekeeping development.

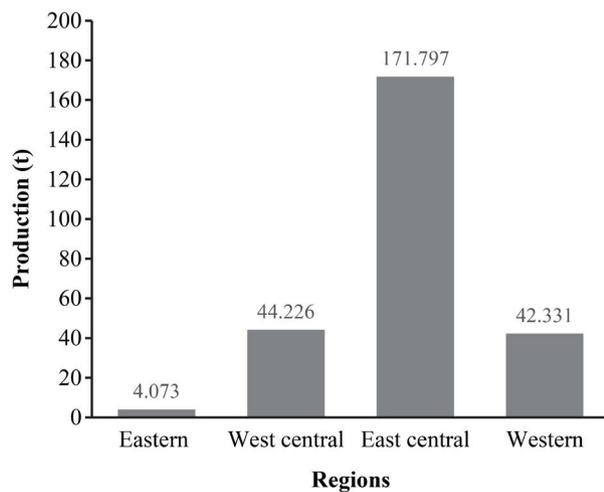


Fig. 5. Regional honey production over the last five years 2016–2020. Source: DoL, 2016 to 2020.

3. Hive products marketing system

Like elsewhere, there are different honey marketing channels in Bhutan. Some of the *A. cerana* and *Trigona species* (stingless bee) honey producers supply their product in bulk to One Geog One Product project, Bio-Bhutan and SAVAH Bhutan who do value addition to sell from their sales outlets in towns and cities (ICIMOD, 2017; BPV, 2017). Some beekeepers prefer to sale their products in village markets and others have their regular middlemen who come to collect the honey from their house. For the past five years OGOP has been the key project helping the farmers to market their farm products where honey is one of the most marketed products.

The prices of the honey depend mainly upon the bee species from which the honey is harvested. Generally, stingless bee honey is the most expensive costing Nu. 5000 (US \$ 63.5) to 7000 (US \$ 88.9)/kg in local and city markets followed by *A. cerana* honey costing Nu.550 (US \$ 6.9) to Nu.1410 (US \$ 17.9)/kg as it flows from producers to retailers in city markets. Regarding *A. mellifera* honey, Beekeeping Cooperatives of Bhutan is the largest wholesaler who pays Nu.550 (US \$ 6.9)/kg to the cooperative members and supply to retailers at Nu.700 (US \$ 8.9) /kg who sells at Nu.1000 (US \$ 12.9) /kg (BPV, 2017; ICIMOD, 2017).

Proper packaging and labeling of honey products are the first impression to draw customers' attention towards the products. Honey packaging has improved

since 2007 after the introduction of modern hive technology but in the south few beekeepers still reuse the alcohol plastic bottles to pack the locally produced honey (ICIMOD, 2017).

About 99% of honey produced by the country is consumed in the domestic market while small quantity is exported mainly to Taiwan, Singapore and Vietnam (BPV, 2017). Annually huge quantity of honey is imported from India to meet the production deficit in the country. Dabur company honey from India takes the maximum market share because it costs Nu.380 (US \$ 4.8)/kg which is cheaper than the Bhutanese honey (ICIMOD, 2017).

HONEY BEE RESOURCES IN BHUTAN

There are six agro-ecological zones with distinct climatic conditions and vegetation types in Bhutan. About 70.5% of country's total land area is covered with forest creating a favorable environment for the honey bee species (Bruggeman *et al.*, 2016). Further, it is mandatory to keep 60% forest coverage always according to the national constitutional law of Bhutan.

1. Honey bee diversity

Availability of different honey bee species helps to maintain the healthy and rich diversity of plants and animals through their pollination service besides providing the direct products from hive (Ahmad *et al.*, 2007; Partap, 2011; Abrol, 2012; Rogers, *et al.*, 2014). One study in Bhutan found that there are 12 species of bees and 22 species of wasps within the altitude range of 1,000 to 3,000 meters above sea level (Tenzin and Katel, 2019). Three groups of species; *A. cerana*, *A. mellifera* and *Trigona* species are managed in the traditional and modern hives while *A. laboriosa*, *A. dorsata* and *A. florea* exist in wild state. The existence of rich honey bee's diversity in the country shows the considerable biological materials for future beekeeping research and development in Bhutan.

2. Floral diversity for honey bee

Honey bees and plant species are interdependent to each other for their growth and development. Honey

bees help to maintain healthy plants and trees population which provide food and shelter for animals (Brad-bear, 2009). There are several floral types for beekeeping in Bhutan, but it is not documented (Sivaram, 2012). Some of the common bee flora found in Bhutan are; mustard (*Brassica nigra*), orange (*Citrus sinensis*), white clover (*Trifolium repens*), sunflower (*Helianthus annuus*), dandelions (*Taraxacum officinale*), Malabar silk-cotton tree (*Bombax ceiba*), Himalayan coral tree (*Erythrina arborescens*) and chinquapin (*Castaonopsis tribuloides*).

3. Infrastructure and human resource

Basic infrastructure including human resources are keys to accelerate and sustain beekeeping industry. Currently, the beekeeping unit under NHRDC, Bumthang facilitates research and development of beekeeping program in collaboration with regional and district stakeholders including NGOs. However, the Centre is expected to initiate the genetic up-gradation of the existing native honey bee stock to produce the superior quality bee colonies (DoL, 2020).

THE ROLES OF BEEKEEPING IN BHUTAN

The value of the honey bees is multilateral. They are not only the source of food but their importance is also felt in socio-cultural life, environment protection and livelihood improvement of poor and disadvantaged people in the country.

1. Socio-cultural importance

Guided by the Buddhist philosophy of co-existence in harmony with nature, honey bee has very special place in Bhutanese way of life. Generally, the feral honey bee nests built about the human settlements and structures are not disturbed for honey or wax by people. In fact, the sight of honey bee nest is regarded as sign of good luck and boon for the agricultural production of the community (ICIMOD, 2017). This belief system has created a favorable condition for honey bee to thrive freely in the nature with minimum human disturbance.

Towards the south, the Hindu communities have strong reverence for honey bees because of the impor-

tance of honey in their culture. In Hindu cultural practice, honey is one of the indispensable ingredients of elixir (Sherma, 2021), besides it is also regarded as super food and vital ingredient of rural folk medicine preparations for illness such as cough and cold, stomach ulcer, general weakness, minor wounds and asthma (Tamang, 2007a).

2. Economic importance

Honey bee produces low volume-high value products with long shelf life (Partap and Verma, 1998). The versatility of the modern moveable frame hive to manage honey bees for the varieties of hive products like honey, bee wax, royal jelly, pollen, propolis, bee venom has allowed beekeepers to produce the desired products and earn income. For Bhutanese beekeepers, beekeeping is a part-time job supported by other farm activities (ICIMOD, 2017). According to BPV (2017), a single *A. cerana* and *A. mellifera* hive can generate net profit of Nu.2,805 (US \$ 35.96) and Nu.6,450 (US \$ 82.69) per year respectively. According to DoL (2016–2020), the honey production income over the last five years shows that east central region makes maximum income of Nu.120.25 million (US \$ 1,541.667) followed by west central with Nu.30.95 million (US \$ 396,794), western with Nu.29.6 million (US \$ 379, 487.2) and eastern region with Nu.2.85 million (US \$ 36,538.46) respectively.

Besides income from honey production, introduction of modern technology has created the off-farm earning opportunities for the local artisans through the supply of moveable frame hive sets and other basic beekeeping tools, and equipment made by themselves (BPV, 2017). Essentially, managed beekeeping has provided the employment and income to the poor section of the societies in the country.

3. Environmental importance

The irreplaceable biological inputs from the honey bees for the sustainability of natural flora and fauna cannot be over emphasized. Besides, providing the direct hive products for human wants, honey bees are unfailing partner of agriculturist to enhance the quality and quantity of crops and naturalist to maintain the diversity of plants and animals in the nature (Brown and Paxton,

2009; Sharma and Abrol, 2014; Chantawannakul *et al.*, 2018). A symbiotic relation between honey bee and floral species have indirectly help to create the social fences of the beekeepers to protect the local forest resources in Bhutan as flower bearing plants and trees are an important source of the nectar for honey bees.

CONSTRAINTS OF BEEKEEPING IN BHUTAN

Beekeeping in Bhutan had been constrained by the lack of well-equipped operating system including human resources (MoAF, 2020). The important requirements for the success of managed beekeeping in developing countries are availability of ample nectar source, consistent technical backstop and skilled individuals to lead the beekeeping research and development programs (Schouten and Lloyd, 2019). Some of the persistent problems which have been deterring the flourishing of managed beekeeping in Bhutan are lack of basic infrastructure to solve the problem of absconding of honey bees, pest and predators, agrochemicals and impact of climate change.

1. Lack of vital infrastructure

Modern beekeeping technology is nascent in Bhutan and important requirements like scientific laboratory, subject matter specialist and commodity Centre are needed to provide better and more beekeeping service to the people (MoAF, 2020; NHRDC, 2020). Although the country is gifted with several honey bee species, desired level of development could not be achieved due to the absence of required scientific facilities with competent man power.

2. Absconding

Nest abandoning of the honey bee happens due to multiple factors including lack of food (nectar and pollen), pest and diseases, unsuitable weather conditions, improper handling techniques, and natural calamities (Hepburn, 2011). Among the three managed bee species in Bhutan, absconding habits is more problem in *A. cerana* especially when the colonies are transferred to the modern moveable frame hive from the traditional ones. This is the main drawback of *A. cerana* management

using modern hive in Bhutan (ICIMOD, 2017; Dawa, 2020). Similar problems were observed in Nepal and western Uganda (Thapa, 2003; Mujuni *et al.*, 2012).

3. Pests and predators

Introduction of *A. mellifera* colonies in order to maximize the hive production has led to the transmission of pest and parasites from *A. cerana* to *A. mellifera* and vice versa in Asia (Rosenkranz *et al.*, 2010 in Chantawannakul *et al.*, 2016). In Bhutan, black and red ants, cockroach, drongos (*Dicurus* spp.), hive beetles (*Aethina tumida*), greater wax moth (*Galleria mellonella*) and smaller wax moth (*Achroia grisella*), hornets and wasps (*Vespa* spp.) and bears are the common pest and predators (Tamang, 2007). Eight species and sub-species of the genus *Vespa* are recorded in Bhutan (Dorji *et al.*, 2017). In the beginning of 2020, about 60% *A. mellifera* colonies had died in Bumthang and the cause was suspected to nosema disease because of the presence of dried white and brown fecal spots around the hive entrance. But confirmatory test could not be made due to lack of laboratory facility for beekeeping program. Although varroa mites and brood diseases such as American foul brood, European foul brood, sacbrood virus are causes of honey bee mortality around the world, these diseases are not noticed in Bhutan which could be due to the lack of honeybee disease experts and honeybee laboratory to test honeybee diseases.

4. Use of agrochemicals

Use of unauthorized agricultural chemicals is not allowed by the agriculture sector in Bhutan. But beekeepers doubt that the use of chemicals is not completely absent. Agrochemicals are easily available in the local markets of India and Bhutan border towns from where the Bhutanese farmers can purchase for use. Persistent use of agricultural chemicals in the mountain farming was found to destroy the existence of natural pollinators including honeybees.

5. Climate change

All the places on the earth are affected by the impacts of climate change and Bhutan is no exception. Physical manifestations of climate change like unpredictable weather patterns and occurrence of more pest

and diseases in farms are already happening in Bhutan (Katwal *et al.*, 2015). In 2020, *A. mellifera* beekeepers in Bumthang lost about 60% their productive colonies due to the unforeseen weather condition for which the beekeepers failed to manage their hive. In the south, the farmers complain about the mass attack of their *A. cerana* hives by ants that were not seen before because of which many of their colonies had absconded the hive.

WAYS TO ADDRESS THE CHALLENGES

Different techniques were applied by the beekeepers to tackle the existing challenges of managed beekeeping in the country. For instance, to minimize the absconding the bee hives are kept at the suitable location safe from pest, predators and inclement weather conditions. Technical knowledge, skills and equipment were provided to the farmers through training programs for adequate management of bee colonies. Beekeeping research and development program is incorporated in country's Five-Year Plan documents and cottage and small industry development policy document to get the required support from the government.

CONCLUSION AND RECOMMENDATION

Rural beekeeping was an old tradition of Bhutan passed down from generations, however modern beekeeping technology is gaining its momentum to attain its full potential. The country has rich natural forest coverage (70.5%) and six agro-ecological zones with distinct climate and vegetation type. Traditional and modern hives are used to manage the three species of honey bees. In the current practice honey is the only commercial scale hive product and other hive products are not harvested. The quantity of honey produced differs by regions and type of bee species managed by the beekeepers. East central region tops the honey production followed by west central, western and eastern regions. Due to the less honeybee hive population and inadequate honey production, Bhutan imports the quantity equal to its annual production from India. However, the efforts are in swing to increase the honey production through creation of financial support pro-

grams and private sectors participation. Like elsewhere, beekeeping sector in Bhutan is constrained by the forces of climate change, pests and predators, lack of vital infrastructures, absconding habits of honeybees, illegal use of agro-chemicals and shortage of skilled manpower. Having these problems do not cease the beekeeping development in Bhutan. To take beekeeping sector to the greater height the following are the key recommendation that can be implemented in Bhutan;

The Ministry of Agriculture and Forests, through the support from the Royal Government of Bhutan should establish the well-equipped honey bee commodity Centre under department of livestock which should function in close collaboration with other green sectors.

The Department of Livestock, have to select *A. cerana* colonies from the existing stocks in the farmers' field and identify the suitable location to initiate stock improvement program. Similarly, the existing *A. mellifera* colonies needs to improve through selective breeding in order to provide the better performing colonies to beekeepers.

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