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An overview of Beekeeping Economy and Its Constraints in Nepal

Sunil Aryal[1,3], Ratna Thapa[2] and Chuleui Jung[1]*

[1]Department of Bioresources Sciences, Andong National University, Republic of Korea
[2]Entomology Department, Tribhuvan University, Kathmandu, Nepal
[3]Entomology Division, Nepal Agricultural Research Council, Kathmandu, Nepal

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Abstract

Beekeeping has been in practice from an ancient time in Nepal. It is one of the high valued and income-generating activities for the people in Nepal. Diverse climatic conditions of Nepal harbor five species of honeybee out of which *Apis laboriosa, A. dorsata, A. cerena, A. florea* are native, whereas *Apis mellifera* was introduced and is being reared commercially. Three sub-species of *A. cerana*, viz. *A. cerana indica*, *A. cerana himalaya* and *A. cerana cerana* are distributed in different regions of Nepal. *A. cerena* is cultivated in traditional log hive as well as in modern bee hive. However, most of the annual honey production comes from wild honeybees. Number of hives recorded during 2012/13 was 169,000 with 1625 metric tons of honey production. Hive productivity is low due to problems associated with apiculture; low quality management of bees, colony migration and absconding, pesticide intoxication, product quality control, inadequate data on bee floral identification and inadequate bee research program, are major concerns for beekeeping in Nepal. Though attempts have been made to address few issues such as pest and disease management, behavioral study of wild honey bees, pollination and floral diversity, but most of the problems are unattended because research on beekeeping is scattered and not well organized. Ample opportunities are available to promote apiculture for pollination and hive product. This paper reviews on honeybee diversity, honey production, problems in apiculture, and areas for future study in Nepal.

Key words: Beekeeping, Floral diversity of Nepal, Pollination, Hive product, Honeybees

INTRODUCTION

Beekeeping, a cultural heritage in Nepalese community, practiced from an ancient time because honey hunting has been dated back to thousands of years (Joshi, 2008). The Government started to give training on beekeeping since 1968. In 1975, Vocational Entomology Section was established to look after beekeeping and sericulture. In 1980, a separate unit; Beekeeping Development Section (BDS) was created for development and extension of the apiculture. Entomology Division under Nepal Agricultural Research Council has mandated to conduct research on various aspect of applied entomology including industrial entomology. The beekeeping program is one of the integral parts of governmental policies as well as pursued by INGO/NGOs for upliftment of rural under privileged and marginal people of Nepal. Honeybee is regarded as important high value commodity of Nepal and one of the most important income-generating activities for majority people (Thapa *et al*., 2000). It helps to enhance agricultural productivity and conserves biological diversity and ecosystem through ensured pollination services (Thapa, 2006). There are tremendous potentiality of bee enterprise in Nepal due to the distribution of diversified bee flora (Pratap, 1997;

*Corresponding author. E-mail: cjung@andong.ac.kr

Bista, 2001; Thapa, 2006; Adhikari and Ranabhat, 2011) and suitable climatic condition for honeybee diversity (Thapa, 2012). One study estimated that Nepal could have as much as one million bee colonies producing more than 10,000 MT of honey annually (Pokhrel *et al*., 2014). Five species of the honeybees are present in Nepal viz. Apis florea F., *Apis cerana* F., *Apis mellifera* L., *Apis dorsata* F. and *Apis laboriosa* S. Among these, *A. cerana* and *A. mellifera* are the only domesticated honeybee species. Number of hives recorded during 2012/13 was 169000 with the honey yield of 1625 MT (ABPSD, 2013). Commercialization of beekeeping started with introduction of *A. mellifera*, its cultivation and colony migration practices. Honeybee diversity, honey production, problems in apiculture, and areas for future study are presented to explain the significance of apiculture in Nepal.

MATERIALS AND METHODS

The overview on apiculture and its constraints in Nepal has been reviewed consulting different available research papers published in journals, in national and international seminars, workshop proceedings, annual reports and students' dissertation works as well. This paper reviews mainly on the honeybee diversity, honey production, problems in apiculture, highlights on researches done so far in the field of apiculture and areas for future study in Nepal.

RESULTS AND DISCUSSION

Honey Bee Diversity

Apis laboriosa S., the Himalayan cliff bee is the largest honeybee of the world which bears only a single large colony at open space and is native to Nepal (Otis, 1996). It is generally found in high altitudes ranging from 1200 to 3600m, and forages at up to 4100 m (Joshi *et al*., 2004). Woyke *et al*. (2012) even observed the *A. laboriosa* nesting site at an 1178 meter above sea level (m.a.s.l.) ($27^0$52' 58"N, $85^0$54'51"E) in Chale near Chaku village, Sindhupalchok district. Likewise, Roubik, *et al*. (1985), mentioned the establishment of *A. laboriosa* nests between 1800m (Gosainkund Lekh, Dhunche) to 3700m (Janakpur, Rolwaling Valley, Beding). This is a unique species for conservation of Himalayan vegetation and ecotourism development in Nepal (Thapa, 2001). Its average honey yield per year per colony was reported as 25kg (Pokhrel *et al*., 2014), 20~50kg (Panthi, 2013) and 60kg (Gurung *et al*., 2012).

Apis dorsata F., a giant honey bee is native to Nepal with a single large comb at open place built on tree, buildings (Thapa, 2003) and water tanks (Thapa and Wongsiri, 2003). *A. dorsata* colonies seasonally return to the same old nesting sites (Thapa and Wongsiri, 2011). This bee inhabits the southern low land of the country between 190 to 1200m (Fig. 1) (Thapa, 2012). These bees migrate seasonally (Pokharel, 2010). The honey yield has been reported as 15 (Pokharel *et al*., 2012),5-50 (Panthi, 2013) and 30-50 kg honey/colony/year (Gurung *et al*., 2012).

Apis cerana F., the Asian hive bee and native species of Nepal is found at all over the country and is reared at different types of hives like Newton, wall and log hives etc. (Thapa, 2012). At least three sub-species/ecotypes of the *A. cerana* are reported: *A. cerana indica* in plain areas, *A. cerana himalaya* in valleys & hills and *A. cerana cerana* in high hills (Thapa *et al*., 2000). *A. cerana* can be found throughout Nepal up to 3500 m.a.s.l. (Gurung *et al*., 2012). Its honey yield has been reported as 8.1kg/colony/year (Pokharel *et al*., 2012), 8-15 (Panthi, 2013) and 20kg (Gurung *et al*., 2012). It has high tendency of swarming, absconding, and robbing which complicate the management of this bee (Thapa *et al*., 2000).

Apis florea F. is known as dwarf honeybee that be found up to 1200 masl especially in plain areas (Thapa *et al*., 2000; Gurung *et al*., 2012) (Fig. 1). It is a single comb species at open areas and nests in bushes (Thapa *et al*., 2000; Thapa, 2012). It yields very less honey (1kg/colony/year) with high medicinal value. It is efficient pollinator of crop and natural flora (Gurung *et al*., 2012).

Apis mellifera L. originate in Africa and spread to Europe and Asia. It is introduced in Nepal during 1990 (Thapa *et al*., 2000). This bee can be established up to around 1500 m.a.s.l. but it need migration to plain area during winter season (Fig. 1). It builds multiples parallel comb. With the introduction of this bee commercial bee-

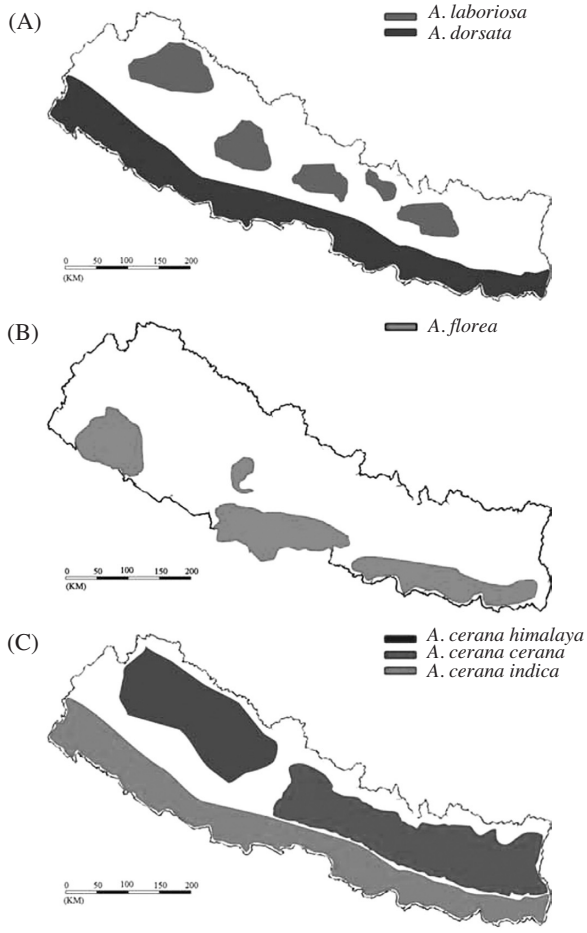

Fig. 1. Distribution of *A. laboriosa* (Upper scattered patches) and *A. dorsata* (Lower parts as indicated) (A), *A. florea* (B), and *A. cerana himalaya* (upleft part), *A. cerana cerana* (upright part), *A. cerana indica* (lower part) (C) in Nepal.

keeping was started in Nepal. Though swarming and absconding tendencies are quite low it is more susceptible to diseases and parasite thus needs good management. Except honey production, it is also good pollinators of fruit and field crops. Its honey yield varies 28.7kg (Pokhrel *et al*., 2012) and 40kg (Gurung *et al*., 2012) per colony per year is Nepal.

Honey production

Data on honey production were available from the year 1996. Initially the production data only focuses on the managed bee hives of domesticated honeybees but from the fiscal year 2001/2002 natural colonies number and honey production included in the record. After including

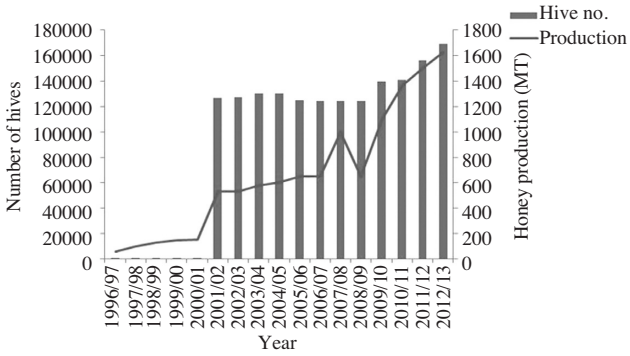

Fig. 2. Number of hives and honey production: In the year 1996-2012.

the natural colonies in the record, the honey production increased drastically from 150 MT with 1100 colonies (in the year 2000/01) to 529 MT with 126884 colonies (in the year 2001/02) (ABPSD, 2012/2013) (Fig. 2), which indicated that the most of the honey yield was recorded from wild colonies. However, with the increase in colonies of *A. mellifera*, it is estimated the contribution of the total honey production from *A. mellifera, A. cerena* and wild bees are 51%, 36%, 13% respectively (http://www.gandaki bee.com.np/production-scenario/). In this case the production of honey from exotic bee and the native bees are now almost equal. There is need to record the honey yield separately from different species of honeybees.

Constraints of apiculture

Pollination service is one of the major important factor in the yield increment of the crops (FAO, 2006) and of the total pollination activities 80% is performed by insects and bees contributes about 80% (Thapa, 2006). This fact on the knowledge on benefit about the pollination is not adequate among the farmers. Genetic quality of the native bee, *A. cerana* has been deteriorating (Thapa, 2002). Frequent migration and absconding (Pokhrel *et al*., 2006, Gurung *et al*., 2012) cause problem in managed beekeeping (Thapa *et al*., 2000). It has already been several years for commercial beekeeping but the work on advanced breeding for generating high yielding and research on agroclimatic adaptive and disease pest resistant brood is still lacking. Bee research program is not very well developed in terms of skill manpower as well as good infrastructure to perform

activities for most of the issues, therefore advanced apicultural research and educational activities for the commercialization is needed (Pokhrel, 2008).

Pesticides use on commercial agricultural crop also creates colony loss (Thapa and wongsiri 1999; Thapa, 2003). Inadequate data on bee floral identification and mapping of bee pasture with carrying capacity were also one of the major issues in apiculture. Quality aspects of the honey and its control mechanism are also poorly established and research on honey quality is also lacking.

While managing honeybee colonies farmers are facing many problems. The constraints in beekeeping was studied (Shivakoti and Bista, 2000; Pokhrel, 2006; Wilde *et al*., 2000). Thapa *et al*. (2000) mentioned two mite species *Varroa jacobsoni* and *Tropilaelaps clareae* were attacking honeybees. Neupane (2009) observed *T. clareae* in *A. cerana* and *A. dorsata* colonies where as *V. destructor* was observed in *A. cerena* and *A. mellifera* colonies and found that the level of infestation was highest in *A. mellifera* (78%) followed by *A. cerena* (70%) and *A.dorsata* (50%) on Chitwan, Nepal. Similarly Thai Sac Brood Virus Disease (TSBVD) in *A. cerana* (Shrestha and Shrestha, 2000a; Manandhar, 2000) and European Foulbrood disease in *A. mellifera* was two major diseases recorded (Shivakoti and Bista, 2000; Shrestha and Shrestha, 2000b; Manandhar, 2000). *Acarapis woodi* also have been reported from both managed bee colonies of *A. cerana* and *A. mellifera* (Manandhar, 2000; Thapa *et al*., 2000). Similarly Shrestha (2001) reported *T. clareae* and *Forcellinia galleriella* observed in deserted combs of *A. dorsata*.

The predators like *Vespa* (*V. velutina, V. tropica*, and *V. magnificia*) (Thapa *et al*., 2012) and birds are also among many constraints which feed on flying bees thus decrease the bee population (Shrestha and Shrestha, 2000a; Thapa and Wongsiri, 2003). Similarly research on management of hive during dearth period for forage and proper feeding mechanism are still lacking though the efforts are being made imparting training to the farmers with existing knowledge. Sophisticated laboratory to rear queen is lacking therefore replacement of the queen by farmer is not being practiced often. Pesticide residue and drugs used to manage diseases and pests in the hive deteriorating honey quality (FNCCI/AEC, 2006; Shrestha, 2007; Partap *et al*., 2012).

The problem in conserving the wild honeybee is another challenges in Nepalese perspective. Introduction of *A. mellifera* cause highest level of inter-species competition between the native honeybees (*A. cerana* and *A. dorsata*) for nectar and pollen collection in the Terai and Inner Terai i.e. plains and foothills because of similar foraging habit. (Pokhrel, 2010; Pokhrel *et al*., 2014). Some study (Thapa, 2001) indicated that there is rapid declining of *A. laboriosa* colonies due to disturbances in mountain ecology (landslides and land use change), destructive honey hunting practices, loss of forage and pests and predators (Joshi *et al*., 2004; Ahmad *et al*., 2003). Recent *A. laboriosa* hunting hot spot area are identified in Lamjung and Dolakha districts where lots of awareness activities has been carried out recently.

Some overview of research conducted

Management study: Bista *et al*. (2004), studied the performance study of European honeybee, *A. mellifera* on different management practices where he found that well managed colony with migration give good result on honey yield whereas non-managed and migrated but non-managed colonies destroyed within 6 weeks due to mites. Dawadi (2003) studied on the control of parasitic mite *T. clareae* in *A. mellifera* and concluded that Apistan application 1-2 times a year was good in managing it. Use of *Metarhizium anisoplae* on bee hive infested by *Galleria mellonella* L. showed that greater wax moth is highly susceptible and there is no harm for honeybees (Neupane, 2005).

Supplement diet for the honeybee study resulted that low dose sugar syrup combined with 30g pollen substitute diet was suitable for off-season honeybee colony management which also helps high rate of flight activities (Pokhrel, 2005). Entomology Division (1996) reported that artificial food should be supplied to bees during cold winter and rainy seasons depending upon the weather condition of Khumaltar, Lalitpur, Nepal. Development of healthy colonies with enough number of frame with sufficient population will help producing more honey (Bhusal *et al*., 2011) because it maintained the colony strength.

Table 1. Number of honeybee flora reported from various place of Nepal

SN	Location	Total number of plants species	References
1	Kathmandu	156	Kafle, 1984
2	Kathmandu	113	Partap and Verma, 1996
3	Jumla	103	Partap, 1997
4	Dolkha	119	Bista and Sivakoti, 2001
5	East Chitwan	85	Devkota, 2003

Pollination study: Partap *et al*. (2000a) reported that fruit set in peach and plum is significantly increased by 21.9 and 13.0% than control. The author also reported that the foraging behavior of *A. cerana* is major pollinator of *Citrus sinensis*. On strawberry, *A. cerena* forages for almost 11.27 hours just 56 minutes after sunshine and stops at 10 minute before sunset with a peak foraging occur at the time of 11:00 to 14:00 hours (Partap, 2000). Study on the comparative foraging behavior between *A. cerana* and *A. mellifera* on peach and plum revealed that the total duration of foraging activity of worker of *A. cerana* is significantly more than those of *A. mellifera* and also *A. cerana* started foraging early in the morning and ceases late in the evening than *A. mellifera* (Partap *et al*., 2000b). Flowers of cauliflower were most attractive to *A. cerana* where highest number of foragers were observed followed by broad-leaf mustard and was lowest on radish (Partap *et al*., 2000c). Pollination efficiency of *A. cerana* and *A. mellifera* on rapeseed and buckwheat at Rampur, Chitwan, Nepal showed that *A. cerana* was comparatively more efficient on pollination of rapeseed and buckwheat (G.C., 2003).

Honey bee Flora: Various plants belong to agricultural, horticultural, forage crops, ornamental plant, avenues trees, wild plants and forest trees are visited by honeybees which comprises more than thousand in numbers in different agro-ecozones of Hindukush Himalayas (Partap, 1997). Honey bee flora survey has been initiated from early nineties (Partap, 1997). Number of bee flora from different places of Nepal reported by different researchers is presented in Table 1.

Grayanotoxin of honey: In recent context the honey produced by the wild honeybees foraged on Ericaceae, *Rhododendron ponticum* and *R. luteum* (Altun *et al*., 2014) *Pieris, Agarista* and *Kalmia* contain diterpene grayanotoxins (Jansen *et al*., 2012) has been in great concern due to the presence of grayanotoxins. The honey is also known as mad honey. Few case reports suggested that consumption of the grayanotoxin contaminate honey cause symptoms of blurring of vision, diplopia, nausea, vomiting and even cardiac depression with low blood pressure and bradycardia (Oguzturk *et al*., 2012; Altun *et al*., 2014; Dubey *et al*., 2009). This grayanotoxin are also found in *Aconitum* spp. and *Entada scandens*. Recently, various Asian countries have tried to prevent the import of intoxicating honey from Nepal requiring a grayanotoxin certificate (Joshi, 2008). So there is urgent need of grayanotoxin content analysis especially on wild honey from *A. laboriosa*.

Areas of future research study

Research should focus on study on honeybee diversity and area wide selection of species/subspecies, colony selection for Asian hive bee for its breed improvement and queen management. Continuous selection of the best colonies may minimize the swarming, absconding and robbing tendencies of Asian hive bee. Breeding for generating high yielding, agro-climatic adaptive and disease pest resistant brood is one of the issue in apiculture. Low cost honey production technology with proper feeding management, mite and other pests management are prerequisite for good honey production (Bista *et al*., 2015). Besides honey, other hive products such as wax, propolis, royal jelly etc are also important by products. So that the technology for other hive products and their processing technique have also to be investigated. There are shortage of bee forage due to population pressure and high demand for farmlands. Therefore, pollination deficit area should be identified.

Study on bee floral diversity and development of floral calendar may help managing forage problem (Pokhrel, 2014). Based on the overview, some suggestions were made for boosting beekeeping economy in Nepal as follows:

- Genetic improvement and breed maintenance of domesticated species,
- Development of effective colony and queen management practices,
- Surveillance and management of honeybee pests,
- Honeybee floral identification, bee-pasture mapping and carrying capacity analysis,
- Conservation and utilization of wild native honeybees and
- Quality monitoring of honey and other hive products.

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