Chapter 1

Asian Bees and Beekeeping: Issues and Initiatives

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Beekeeping is an important component of agriculture and rural development programmes in many Asian countries. The role of beekeeping in providing nutritional, economic and ecological security to rural communities of Asia cannot be overlooked as it has always been linked with their cultural and natural heritage. At the household level, beekeeping is an additional income-generating activity. This, being a non-land-based activity, does not compete with other resource-demanding components of farming systems. In the crop fields, pollination activities of honeybees are important, as they contribute to the increased productivity.

Honeybee Diversity in Asia

The asian region is the richest in the world in honeybee species diversity. At least five different species of honeybee are found. Among these, *Apis dorsata, Apis florea, Apis laboriosa* and *Apis cerana* are native. *Apis mellifera* has been introduced for commercial beekeeping. *Apis florea, Apis dorsata* and *Apis laboriosa* are wild in nature and cannot be kept in the hives. *Apis cerana* and *Apis mellifera* are only honeybee species that can be kept in the hives for honey production and crop pollination.

The Asian Honeybee, *Apis cerana*

Genetic diversity

Based on the morphometric characteristics and mitochondrial DNA analysis, three subspecies of *Apis cerana* have been identified in the Himalayan region. These included *A. cerana cerana, A. cerana himalaya* and *A. cerana indica* (Verma, 1992; ICIMOD, 1994). Similarly, five subspecies of *A. cerana* including *A. cerana cerana, A. cerana skorikovi, A. cerana abaensis, A. cerana hainanensis* and *A. cerana indica* representing different eco-geographic zones have been identified in Chinese Himalayas (Zhen-Ming *et al.*, 1992). These subspecies also have further locally adapted populations 'the ecotypes' that differ from each other in several biological and economic characters. For example, there are three ecotypes of the subspecies *A. cerana himalaya* that correspond to geographic distribution in the Naga and Mizo hills, the Brahmaputra valley and Khasi hills, and the foothills of the northeast Himalayas (Singh *et al.*, 1990). In China subspecies *A. cerana cerana* has five ecotypes namely Guangdong-Guanxi type, Hunan-Hubei type, Yunnan type, North China type and Changbaishan type (Zhen-Ming *et al.*, 1992). In some parts of the Hindu Kush-Himalayas, *A.*

cerana cerana matches the European hive bee, *A. mellifera*, in honey production and has potentials for further genetic improvement.

The diversity at risk

Beekeeping with *Apis cerana* is a common practice among rural communities in Asia. Traditionally, the farmers have been keeping this species in log-, wall-, pitcher-, and box hives. This bee has a gentle temperament, is industrious, has qualities of cleanliness and can be handled easily. However, this is not popular among commercial beekeepers because of its low honey yield and undesirable behavioural traits such as excessive swarming and absconding and producing large number of laying workers. Therefore, the European honeybee, *Apis mellifera* has been imported to the region and has become popular among commercial beekeepers. It maintains prolific queens, has less swarming and absconding tendencies and produces more honey and beeswax.

As a result of promotion of beekeeping with *Apis mellifera*, populations of *Apis cerana* are declining rapidly threatening its extinction in the Himalayan region. The process of extinction has already started and the species is endangered in the hilly areas of Afghanistan, Bhutan, Bangladesh, China, Myanmar, Nepal, Pakistan and to some extent from India (Crane; 1992,Verma 1993; ICIMOD 1994). In western Indian Himalayas where there is a centuries-old tradition of beekeeping with *A. cerana* government institutions are busy replacing their *A. cerana* stocks with *A. mellifera*. In the Kashmir region of the northwest Himalayas where *A. cerana* matches *A. mellifera* in body size and honey production only a few per cent of *A. cerana* colonies are left. Thus the long-established craft of beekeeping with *A. cerana* is being destroyed in the entire Hindu Kush-Himalayan region. Similarly, in Japan, beekeeping with *A. cerana* has been completely replaced by *A. mellifera*, and only a few beekeepers and research institutions are raising *A. cerana* colonies (Sakai, 1992). In China, among over 8.5 million colonies of honeybees only 30 per cent are *A. cerana* (Zhen-Ming *et al.*, 1992). In South Korea, only 16 per cent of beekeeping is with *A. cerana*; the remaining has been replaced by *A. mellifera* (Choi, 1984).

Studies carried out by ICIMOD have shown that in HKH region at present there are only few areas where *Apis cerana* can be found. These include the mountain areas of Nepal and India and Yunnan Province of China (ICIMOD 1994; Bangyu and Tan 1996). In Pakistan, where *Apis mellifera* was promoted much more vigorously, the last strains of *Apis cerana* survive with a few villagers in the Kalash valley of Chitral. It is being realised that if this process of replacement of *Apis cerana* with *Apis mellifera* continues for another decade, it may lead to complete extinction of the Himalayan bee.

In the Himalayan region, Nepal was the biggest gene pool of *Apis cerana* until 1990. There was a ban on the importation of *Apis mellifera*, and beekeeping with this native bee flourished well throughout the country. This ban was lifted in 1990 and *Apis mellifera* was imported in large scale. Within this decade it replaced the native *Apis cerana* in the plains and up to mid-hills. *Apis cerana* now remains with mountain farmers of remote areas like Jumla, Humla and Jajarkote. *Apis mellifera* has not arrived in these areas due to inaccessibility, and also that the farmers find it difficult to apply winter management practices such as keeping the colonies warm, feeding sugar, and migrating to low hill areas. The decline in the populations of *Apis cerana* from Himalayan region will have bad consequences for biodiversity and agricultural productivity.

Factors contributing to declining diversity

In seeking ways to conserve genetic diversity of *A. cerana*, it is necessary to have a clear understanding of the major threats that this species is facing in its native habitat. Main factors contributing to decline in *Apis cerana* populations include environmental perturbations such as loss of habitat quantity and quality, introduction of more productive European honeybee, *Apis mellifera;* pathogens and diseases especially Thai

sac brood virus (TSBV) and European foulbrood (EFB) infections; human predation like traditional honey hunting, and pesticide hazards; behaviour like frequent swarming, absconding and robbing; and production of a large number of laying workers.

The need to conserve *Apis cerana*

One may argue that when there is a more productive bee like *Apis mellifera*, why should we save a less productive bee? The following discussion might provide the answer to this. First, *Apis mellifera* is more suitable for commercial beekeeping. However, beekeeping in many areas of the HKH region is a small household activity providing some income and nutrition to the poor mountain people for which *Apis cerana* is much more suitable. Second, *Apis mellifera* may produce more honey than *Apis cerana* during honey flow season, but needs much more sugar feeding during dearth period which the poor farmers do not afford. Moreover, the race of *Apis mellifera* imported to Asia is highly cold susceptible. It is generally migrated from mountains to warmer areas during winter. As a result, pollination of early blooming mountain crops is adversely affected. If not migrated to warmer areas it requires a lot of winter management. But the high mountain races of *Apis cerana* are cold resistant and suitable for stationary beekeeping. These match *Apis mellifera* in behaviour, honey production and maintenance of prolific queens. Another very important argument in favour of *Apis cerana* is that this bee is less prone to attack of wasps and is resistant to the common mites like *Varroa jacobsonii*, and *Tropilaelaps clarae*. Bee diseases like *Nosema* which are serious threat to beekeeping with *Apis mellifera* do not affect *Apis cerana*. Moreover, *Apis cerana* in the mountain areas of the region has comparative advantage over *Apis mellifera* in crop pollination. It is an excellent pollinator of mountain crops which bloom during early spring season such as almond, apple, pear, plum and different vegetable seed crops.

Value of Conserving Honeybee Diversity

The natural products that honeybees produce are honey, royal jelly, pollen, propolis, beeswax and bee venom. These materials have been widely used as nutritional food and for medicinal and pharmacological purposes since ancient times. These products have both consumptive and productive value because they can be consumed by family or these can be commercially harvested for exchange in formal markets throughout the world. However, besides these direct resources, honeybees provide non-consumptive benefits of conserving botanical resources that may far outweight direct values when they are computed. These social insects deal with primary functions of the ecosystem that involve reproduction including pollination, gene flow and cross-fertilisation, and maintenance of biodiversity, environmental forces and species that influence the acquisition of useful genetic traits in economic species and maintenance of evolutionary processes. These non-consumptive benefits can be harnessed to the maximum extent through the use of native bee species such as *A. cerana* rather than with the exotic *A. mellifera*.

Strategies for conserving *A. cerana*

Stock improvement

Many subspecies of *A. cerana* are at present not economically viable. However, preliminary research carried out on honey production potential of different populations of *Apis cerana* have found that there are three sub-species of *A. cerana* in the Indian and Nepal Himalayas. These include *A. cerana cerana, A. cerana himalaya and A. cerana indica* (Verma 1990a; 1992; ICIMOD 1994). Similarly, China has five sub-species, i.e., *A. cerana cerana, A. cerana skorikovi, A. cerana abaensis, A. cerana hainanensis* and *A. cerana indica* (Zhen-Ming *et al.*, 1992). Among these sub-species, the bees of *A. cerana cerana* found in the high altitudes areas of Jumla (Nepal), Himachal Pradesh and Kashmir (India), and northern China are larger in size, more productive and comparable to *A. mellifera* in terms of honey production and other behavioural characteristics (Zhen-Ming *et al.*, 1992; ICIMOD 1994; Partap and Verma 1997).

Research efforts are now needed to multiply the colonies of this highly productive subspecies, i.e., *A. cerana cerana* through selection, breeding, and mass queen rearing. Selection and breeding programmes of this superior genotype are required to produce a bee suitable for intensive management. To achieve stock improvement, colonies of *A. cerana cerana* should be accumulated at a central location and research to identify superior genotypes conducted. Another important prerequisite for stock improvement is to evolve an efficient queen-rearing technique for *A. cerana* and also establish isolated mating stations for pure-line breeding. The latter is essential because artificial insemination in *A. cerana* has unexpectedly turned out to be a difficult task because of the low volume of semen ejaculated by drones (Verma, 1990b).

Research on apiary management

During the course of evolution, *A. cerana* has developed certain behavioural characteristics such as frequent absconding and swarming that are essential for survival of colonies but undesirable from a beekeeping point-of-view. Lack of sufficient bee flora, excessive handling, exposure of colonies to summer sunshine and incidence of sacbrood virus diseases have been identified as major causes of absconding. Management practices such as sugar-feeding, provision of shade and providing a queen gate at the hive entrance significantly reduce absconding. One of the most effective ways of reducing frequent swarming is to follow a selection programme against this undesirable trait. The removal of newly constructed queen cells during the active swarming season also helps check swarming considerably. Currently, recurrence of sacbrood virus epidemics after an earlier cycle during 1982–86 has threatened beekeeping with *A. cerana* throughout its range. Some colonies are still resistant to this disease and in the absence of any effective chemical control, vigorous selection needs to be followed (Verma, 1992).

Research on disease management

Thai sac brood virus disease is at present one of the most serious constraints in beekeeping with *A. cerana*. The identification of the causal organism of the disease has been reconfirmed. Control measures such as the administration of antibiotics, antiviral chemotherapy developed by the Chinese Institute of Apicultural Science, provision of brood frames for diseased colonies, introduction of new queens, mechanical removal of affected brood, strengthening of affected colonies by uniting them have been tried by several workers. The conclusions drawn are;

- The disease starts appearing in colonies in spring when honey-flow season begins.
- Usually weak colonies are more susceptible than stronger colonies.
- About two to three generations of brood in affected colonies suffer the worst attack but later all affected colonies start recovering
- The best way to check the disease is to keep colonies strong by uniting the adult bees of weak ones and discarding affected brood.
- In severely affected colonies, sterilisation of hive and combs with formalin also reduces the incidence of disease.

Research on crop pollination

Apis cerana shows distinct advantages for pollination of agricultural crops. These include longer foraging hours, earlier initiation of foraging activity, short flight range, low cost of colony management during dearth periods, no foraging competition with other native bee species and non-*Apis* pollinators, and co-evolution with native crops, etc. (ICIMOD, 1994). Keeping this in view, promotion of beekeeping with *A. cerana* appears to be essential for enhancing the productivity of farming systems. Unfortunately, in the developing countries of south and southeast Asia, the role of bees and beekeeping for enhancing the productivity of agricultural crops has often been underestimated. The development of agriculture in the twenty-first century will therefore

necessitate reorientation of present crop production technologies. Along with making use of physical inputs like fertilisers and irrigation managing cross-pollination through honeybees will also become essential for maintaining productivity. Thus, there is a need to create awareness amongst policy makers, planners and aid agencies about promoting bees and beekeeping as an important component of present-day strategies for sustainable agriculture in Asia (Verma, 1990a).

Zonation of beekeeping areas

In those countries of south and southeast Asia where *A. mellifera* has already been introduced, the beekeeping industry is facing a dilemma. In order to resolve this, zonation of beekeeping areas for *A. cerana* and *A. mellifera* appears to be a logical solution. Based on the past several years' experience, it is now well documented that for subtropical regions *A. mellifera* especially the *ligustica* race is well suited. In temperate regions, beekeeping with *A. cerana* is better suited. It is so because subspecies/ecotypes of this native bee are more prolific and its genotypes are superior to its counterparts in subtropical regions. Such zonation of *A. cerana* and *A. mellifera* into eco-geographic zones has been especially successful in China. India is following the same strategy. This would go a long way in solving the problem of interspecies competition, and both species could be complimentary.

Asian Apicultural Association 'AAA'

The Asian Apicultural Association (AAA), established by scientists from the Asian region, provides a common platform to exchange knowledge and information. AAA is an organization that networks with scientists and development workers interested in Asian bees and beekeeping. Although, so far, the AAA is not a big organization, it encourages research on the biology and management of honeybee species found in Asia. The main objective of AAA is to promote the exchange of scientific and general information relating to honeybee sciences and apiculture in Asia and to encourage international co-operation in the study of problems of common interest.

—Excerpts from Welcome Address delivered by AAA President, Prof. M. Matsuka during Fourth AAA Conference, Kathmandu, 25th March 1998

Status of Beekeeping in Asia

In recent years, great strides in modernising beekeeping with native and exotic honeybee species are being made in the eco-geographic zones of the Asian region. China, at present, is the major producer and exporter of honey and other hive products in the world. Similarly, India has taken the lead in south and Southeast Asia in utilising honeybees for pollination purposes to boost yield and improve quality. In other countries of the region, efforts are being made to develop beekeeping along modern scientific lines. However, constraints such as lack of basic infrastructure, skilled manpower, training, extension, and facilities for basic and applied research mean that the situation is far from satisfactory despite ideal climatic conditions and availability of diverse floral resources throughout the year. Described below is the current information on the status of beekeeping in some of the Asian countries provided by Asian Apicultural Association (AAA) Chapter delegates in their Countries.

Bangladesh (N. Islam, Bangladesh Institute of Apiculture, Mohammadpur, Dhaka)

Three species of honeybee including *Apis cerana, A. dorsata, A. florea* and one species of stingless bee, *Trigona iridipennis* are indigenous to Bangladesh. Among these, *A. cerana indica* is easy to handle, and can produce 2-3 kg of honey every 10-15 days during spring honey-flow season. This productivity has tremendous potential for apiculture development for Bangladesh. Bangladesh Institute of Apiculture (BIA) has been established to promote beekeeping for integrated rural development. The main objective of the Institute is to introduce beekeeping to the rural poor in order for them to

Beekeeping Promotion in Nepal

Beekeeping is a traditional household activity of our Nepalese farmers throughout the mountain areas. Both beekeeping and honey have fascinated our people throughout the ages, and at the same time given income and supplied nutrition to the rural poor, marginal farmers and the landless. Beekeeping is a part of the socio-cultural heritage of the Nepalese people. Beekeeping plays an important role in helping the rural poor not only through beehive products for their additional income generation but also increasing the production of their crops, fruits and vegetables through cross-pollination which is also vital from our food security point-of-view. Nepal is rich in bee flora and has many indigenous bee species, both wild and domesticated. While these are in need of conservation and promotion, traditional beekeeping also needs to be improved and modernized. His Majesty's Government of Nepal also attaches great importance to beekeeping and has placed it in a priority sector. The Agriculture Prospective Plan, adopted by His Majesty's Government, stresses developing this sector further over the years. There are two national beekeeping institutions with several working units all over the country. There are many more private institutions and apiaries throughout the country. These are all engaged in various fields of beekeeping such as training, production and marketing.

—Excerpts from Address by Chief Guest, Dr. Prakash Chandra Lohani, Minister of Agriculture, HMG, Nepal, Fourth AAA Conference, Kathmandu, 25th March 1998

earn an additional income, and to promote bee pollination of agricultural and horticultural crops. Organizing Bangladesh Beekeepers' Association (BKA) is the ultimate goal of BIA.

India (V.K. Mattu, Department of Biosciences, HP University, Shimla, Himachal Pradesh)

Approximately 236,000 beekeepers keep 678,000 colonies of *Apis cerana* and *A. mellifera* in India. Exotic *A. mellifera* was introduced in the mid-1960s in the northern India but it spread to southern India only recently. Migratory beekeeping is also practised in some parts. Estimated production of honey from *A. cerana* is 6500 t, *A. mellifera* is 2700 t and from *A. dorsata* the estimates are of 18,000 t. Total value of this honey is estimated about six million US dollars. Average yield of honey in India is 8–10 kg/colony for *A. cerana*, 10–15 kg/colony for *A. mellifera*, 10–25 kg/colony for *A. dorsata* and 0.5–2 kg/colony for *A. florea*. There is a vast difference in the price of raw and processed honey. Raw honey costs about US$ 0.6–1.2 per kg and processed US$ 1.4–3.6 per kg. No substantial production of pollen and other products is reported. India enjoys tremendous ecological diversity. A variety of honey plants exists in different agro-climatic zones but most promising are *Brassica, Robinia, Syzygium, Nephelium, Plectranthus, Helianthus, Eucalyptus, Dalbergia, Butea, Carvia, Citrus, Grewia, Hevea, Toona, Trifolium, Terminalia* spp., etc. Acarine, nosema and Thai Sac Brood Virus are the most important diseases. Thai Sac Brood Virus, which killed almost 80 per cent of *A. cerana* colonies in the 1980s, is still prevalent in some parts of the country. Wax moths, mites, wasps and birds also pose problems. Other constraints are frequent swarming, absconding, robbing; mating and foraging competition between native and exotic bee species; pesticide poisoning; and invasion of pests and pathogens. Beekeeping research is being conducted by universities and institutes in Himachal Pradesh, Pune, Haryana, Bangalore, Kerala, Tamil Nadu, Uttar Pradesh, Punjab, and Jammu and Kashmir. The state departments of agriculture and horticulture look after extension work and provide training to farmers and entrepreneurs. However, the most important training centre is Central Bee Research and Training Institute (CBRTI), Pune. Many projects are underway in universities and institutes. Major one is the 'All-India Co-ordinated Project on Honeybee Research and Training' at Hisar. Locally organized development projects have been funded by CARE-India, SIDA, Oxfam, YMCA, Action Aid and others. Many books on Indian beekeeping and related subjects are published. Among Indian journals, the most important is the English quarterly *'Indian Bee Journal'* published by the All-India Beekeepers' Association, Pune.

Japan (T. Yoshida, Honeybee Science Research Centre, Tamagawa University, Machida-Shi, Tokyo)

There are 6261 beekeepers keeping 199,846 *Apis mellifera* colonies (registered in January 1996). About 102,465 colonies are being used for pollination in glasshouses (mainly for strawberries) and 31,187 outside. *Apis cerana* is kept by hobby beekeepers without registration. National production of honey is 3,138 t. Approximately 41,592 t of honey is imported, and 108 t exported. Production of beeswax is 48.8 t. Royal jelly production is 5.8 t; 398 t are imported. Pollen production is 4 t. Recently propolis has become popular health food and is imported from Brazil and China. Prices of bee products vary as follows: domestic honey 1500–2500 yen per kg depending on nectar source; imported honey 500–1250 yen per kg; and royal jelly approx. 10,000 yen per 100 g. The most popular honey source is Chinese milk vetch (*Astragalus sinicus*) but its cultivation has decreased to 168 km^2; orange is 840 km^2 and apple is 337 km^2. Wild *Robinia pseudoacacia* is also popular. *Varroa* mites and giant hornets are the main pests. American Foul Brood (and European Foul Brood) is a legally designated disease. About 0.5 % of colonies are incinerated every year. Recently, *Bombus terrestris* (approx. 40,000 colonies) has been introduced from abroad for pollination of tomatoes in glasshouses. Honeybee Science Research Center (HSRC) at Tamagawa University, Tokyo acts as an office for Asian Apicultural Association, and as IBRA branch library for eastern Asia. There is also the Japan Beekeeping Association (JBKA). Several Japanese books on beekeeping and related subjects, and *Honeybee Science* (quarterly journal) are published by HSRC, Tamagawa University.

South Korea (K.S. Woo, Department of Agriculture Biology, College of Agriculture and Life Sciences, Seoul National University, Suwon)

According to 1996–1997 reports, there are approximately 39,678 beekeepers keeping 719,224 bee colonies. These include 399,764 colonies of *Apis mellifera* and 319,460 of *Apis cerana*. Korea produces approximately 8,299 t of honey, 255 t pollen, 31 t royal jelly, 46 t beeswax and 19 t propolis. The prices of bee products in Korea are as follows: honey approximately US$ 5.7 per kg, pollen US$ 16.2 per kg, royal jelly US$ 26.7 per kg, beeswax US$ 2.0 per kg, and propolis US$ 33.3 per kg. *Comus officinalis, Brassica napus, Buxus microphylla, Malus pumila, Castanea crenata, Robina pseudoacacia, Styrax japonicus, Allium fistulosum, Tilia amurensis, Laeocarpus sylvestris, Sesamum indicum,* and *Rhus chinensis* constitute important bee flora of the country. In addition to producing honey and other bee products, honeybees, *Apis mellifera* and *A. cerana* play important role as pollinators for strawberry and Chinese melon in glasshouses. Bumble bees are also being used for tomatoes. Apicultural organisations include Apicultural Society of Korea, which publishes a biannual Korean Journal of Apiculture since 1985 and organizes annual conferences. Korean Beekeeping Association (KBA) organised Apiexpo 1997 in Inchon. KBA publishes monthly Newsletter and organizes meetings. Another organisation is Institute of Korean Beekeeping Sciences (IKBS) in Seoul National University, which organizes extension education courses for beekeepers. It published *Advanced Beekeeping Management* (in Korean) in 1997. IKBS also organises regional education programme in different provinces. Endemic bee diseases in Korea include American Foul Brood, chalk brood, and nosema, and mites *Varroa jacobsoni, V. underwoodi* and *Tropilaelaps clareae.*

Thailand (S. Boongrid, Department of Agricultural Technology, Ramkhamhaeng University, Bangkok)

Thailand has many species of tropical bees (both *Apis* and non-*Apis*) including the honeybee, *Apis mellifera*. The population of indigenous bees has decreased due to deforestation and use of pesticides. Two hundred and ten beekeepers keep approx. 120,000 colonies of *A. mellifera* for

Asian Apicultural Association
Recommendations for Regional Action on Extension Activities

- Assist in the development of beekeepers' associations
- Be a facilitator for networking amongst beekeeping farmers, entrepreneurs and NGOs
- Publish a directory of all organizations involved in beekeeping development
- Publish and spread information as to the advantages of *A. cerana* bees.
- Define policy inputs to promote beekeeping with indigenous honeybees

—Recommendations made during a special workshop held during Fourth AAA Conference on Beekeeping Extension in Mountain Areas in Kathmandu, 24th March 1998

Promoting Beekeeping in Mountain Areas for Improving Livelihoods

Beekeeping is considered an important component of integrated rural development; one that can contribute to poverty alleviation and environmental conservation. Linking agriculture, including beekeeping, with enterprise development is a major challenge for two of ICIMOD's thematic Divisions: Mountain Farming Systems, and Mountain Enterprises and Infrastructure. Beekeeping for pollination is of great importance to mountain farming systems; it may not be of direct interest to individual farmers but is essential for overall rural development. As such, genetic conservation of different bee species and varieties for enterprise development and income generation in mountain development is important. Honey and other hive products are of high value, low volume and low perishability. These are major considerations when promoting crops and products in mountain areas that often suffer from inaccessibility to goods, services and markets.

—Excerpts from Welcome Address delivered by Director General of ICIMOD, Mr. E. Pelinck on the Inauguration of Beekeeping Workshops in Kathmandu on 23rd March 1998

honey, royal jelly and pollen production; wax is a by-product. 2000–3000 t of longan honey are produced each year: 60 per cent is exported to Taiwan and the rest is sold in the domestic market. About 1000 t of lychee, sesame, kapok, sunflower, bitter weed and wild flower honey is also produced annually and sold in local markets. 50 t of royal jelly is produced annually from 100 apiaries, about 12,167 kg was exported to Japan in 1994 and 8865 kg in 1995. The rest is sold in domestic markets and to other countries in the form of fresh royal jelly, encapsuled royal jelly, or freeze-dried royal jelly. About 80 t of bee pollen are harvested each year, and exported to Taiwan and Japan or used for domestic consumption. Some is kept for feeding to bees. 80 t of beeswax is collected annually and used for making wax foundation and candles, and for industrial purposes. *Tropilaelaps clareae* and *Varroa jacobsoni* are the main pests. Wasps, *Vespa* spp., attack *A. mellifera* during June–October. There has been an outbreak of chalk brood disease. There are no control measures against the major honeybee pests. Beekeeping activities are mainly carried out by universities including Ramkhamhaeng University and Chulalongkorn University, and Ministry of Agriculture. Ramkhamhaeng University activities include a proposal for a project entitled 'Conservation of insect pollinators for sustainable agriculture along with the use of the European honeybee for pollination of tropical fruit crops in orchards'. The aims are to reduce pesticide application rates, to augment local insect pollinators, and to further understand the pollination process for each crop. Chulalongkorn University activities include projects for academic research. Department of Agriculture and Department of Agricultural Extension of Ministry of Agriculture are helping to solve problems of beekeeping, and doing research on bees. Besides, many other organizations also have activities on bees and beekeeping. There is no Thai beekeeping journal. Beekeeping researchers usually send their papers to agricultural magazines and/or journals. There are many Thai books on beekeeping.

Conserving *Apis cerana* in the Hindu Kush-Himalayan Region: An ICIMOD Effort

Beekeeping should not be considered in the context of individual country only. In fact, issues relating to the problems and potentials become rather clear when thinking about beekeeping in a regional context. At present, the biggest issue is the conservation of native *Apis cerana* and the debate about introduction and promotion of *Apis mellifera* for beekeeping in the HKH region. *Apis mellifera* is being introduced to the region and promoted vigorously for commercial beekeeping. As a result of this introduction populations of native *Apis cerana* are declining and the species is becoming extinct in its native habitat. Therefore, there is need to make efforts to check the importation of *Apis mellifera* at least in those areas of the HKH region where potential subspecies of *Apis cerana* exist and can be promoted for beekeeping. ICIMOD has been for the past eight years implementing a programme to conserve native *Apis cerana* in the HKH region. Besides promoting beekeeping with this bee in mountain areas, it is trying to convince government and non-government organizations to support beekeeping with *Apis cerana*. One strategy that ICIMOD is adopting for the conservation of *Apis cerana* is based on its potential and efficiency as pollinator of early blooming mountain crops, which essentially require cross pollination.

Changing mind-set about beekeeping

The traditional way of thinking is that beekeeping is done for honey production. The idea of using bees for crop pollination is relatively recent and has received less attention in the Hindu Kush-Himalayan region. Importation of *Apis mellifera* has been done under similar initiative. However, the recent trend of diversification of mountain agriculture from traditional cereal crops to high value cash crops, fruits and vegetables, require insects for cross pollination, since most commercial varieties of these crops are essentially cross-pollinated.

Conservation and Development of *Apis cerana* in the Himalayan Region: An ICIMOD Programme

Within ICIMOD's overall mandate of poverty alleviation and environmental conservation in the Hindu Kush-Himalayan region, documentation and sharing of information are our prime activities. The Hindu Kush-Himalayan region is well known for its ecological, biological and cultural diversity, which are also reflected in the number of bee species and varieties as well as the different management practices adopted by rural households for harvesting honey and other beehive products. While the traditional management practices were very appropriate for the subsistence economies that prevailed in this region until quite recently, the transition towards a monetary economy poses new challenges for beekeeping with respect to both opportunities and problems. The opportunity to derive income from marketing honey and beehive products responds very well to the rightful aspirations of rural households to improve their livelihoods. The challenge before you is how to contribute your knowledge to increasing productivity, in particular by combating diseases, and improving the quality of honey and other beehive products as well as their marketing, without losing sight of the sometimes lesser known and more intangible values of beekeeping such as pollination and conservation of genetic diversity. It was these challenges and concerns that motivated ICIMOD five years ago to begin a programme addressing issues related to the most mountain-specific of all bee species in the world, *Apis cerana*, the Asian honeybee.

—Excerpts from the Welcome Address delivered by Director General, ICIMOD, Mr. E. Pelinck, Fourth AAA Conference, Kathmandu, 25th March 1998

Within the Hindu Kush-Himalayan region there are already reports of declining fruit crop yield and crop failures due to lack of adequate pollinators in intensive cash crop farming areas (Partap and Partap 1997). Moreover, many crops e.g. almond, apple, cherry, pear and plum, and various seed vegetables bloom during early spring season when natural insect pollinators are not available for the pollination of these crops due to various reasons (Partap and Partap 1997). Therefore, need for insect pollinators, especially honeybees has increased in the recent years.

Asian Apicultural Association: Resolution

AAA puts on record the valuable financial and logistical support provided by the Federal Chancellery of Austria and ICIMOD in organizing the Fourth Conference in Kathmandu, Nepal. Considering that beekeeping is an important, income-generating, eco-friendly activity and that honeybees play an important role in boosting the productivity of mountain crops and conserving biodiversity through pollination, beekeeping R & D programmes fit well in ICIMOD's mandate and assigned functions. AAA, therefore, resolves to encourage ICIMOD to continue its research, training and extension programme at the regional level.

Conclusions and recommendations

- Throughout Asia, great strides are being made in modernising beekeeping with indigenous and exotic honeybee species in different eco-geographic zones. However, constraints such as lack of basic infrastructure, skilled human resources, research, and training and extension facilities mean that the beekeeping industry in Asia still requires considerable support. Therefore, AAA resolves that for further development of beekeeping in Asia, co-ordinated and systematic efforts be made to establish Asian Bee Research and Training Centre in the region. Such a Centre should have a continuing internationally funded programme in beekeeping training and research.
- Sustainable development of agriculture in the twenty-first century will need to integrate pollination activities of honeybees as they contribute to the sustainability and increased productivity of different farming systems. However, in developing countries of Asia, the role of bees in crop pollination is underestimated. *Apis cerana* shows distinct advantages over *A. mellifera* for pollination of agricultural crops. AAA, therefore, resolves that policy makers, planners and aid agencies be sensitised to promote beekeeping with *A. cerana* as an important component of strategies for sustainable agriculture and rural development.
- *Apis cerana* is a vital component of our natural ecosystem. However, natural populations are suffering precipitous decline and the species is threatened with extinction. Keeping this in view, conservation is essential for the maintenance of biodiversity. AAA resolves that international organizations encourage projects to conserve this genetic resource by promoting *A. cerana* beekeeping. AAA further resolves that the activities and programmes of the new '*Apis cerana* Conservation and Promotion Working Group' be strengthened.
- In some parts of the Hindu Kush-Himalayan region, productive subspecies and geographic ecotypes of *A. cerana* with commercial potential similar to *A. mellifera* have been identified. AAA resolves that further research work on *A. cerana* genetic diversity, selection and testing based on economic and biological characters be continued under similar environmental conditions on a regional basis.
- Beekeeping extension is a process by which skills and knowledge are exchanged. There is a need for greater understanding of how best to carry out this process. Therefore, AAA resolves an extension network be formed and time and facilities to deal with this growing and important area provided.
- *Tropilaelaps clareae, Varroa jacobsoni* and Thai Sac Brood Virus Disease pose serious threats to bees in Asia. Therefore, AAA resolves that basic and applied research under the ecological conditions of each member country be carried out and a special workshop be held on bee pathology during the next AAA Conference in Thailand.
- The Beekeeping Project in ICIMOD has made significant progress on various aspects of beekeeping with *Apis cerana.* This includes the comparative advantage of *A. cerana* as a pollinator, bee botany and melissopalynology, genetic diversity research, appropriate technologies such as the straw hive, Jumla top-bar hive and farmer-participatory extension in beekeeping. AAA, therefore, resolves that these significant findings be tested and disseminated widely.
- AAA recommends to member countries that policies on fair marketing of bee products are formulated and implemented to the benefit of farmers and users.

—Resolution Passed during Fourth International Conference, Kathmandu, 25–28th March 1998

Farmers are, however, trying to manage the pollination of their cash crops through different ways. For example, in Himachal Pradesh, in the Northwest Indian Himalayas, honeybees are being used for apple pollination. There are very few private pollination entrepreneurs who rent

Asian Apicultural Association
Recommendations on Bee Diseases Research

- Major constraints on all forms of beekeeping in subtropical and tropical Asia are diseases or endemic mites, pests and predators. These reduce the economic potential of beekeeping and its role in pollination.
- Notable problem of *Varroa jacobsoni* is one reason but equally serious is the problem of another mite, *Tropilaelaps clareae*
- It is not easy to control mite pests in *A. mellifera* bees since chemical methods are limited in effect. It requires a mixture of management, biotechnical and chemical control. Control programmes should be integrated instead of focused on parasite management only.
- It should be noted that mites cannot be eradicated as they are endemic in Asia and will re-infest treated colonies.
- Applied research needs to be expanded to the following fields: biotechnical and 'soft-chemical' control; *A. cerana* resistance to disease; and selection for 'resistant' *A. mellifera* bees.
- Thai Sac Brood Virus Disease (TSBVD) is an epidemic disease of *Apis cerana* not only in the Hindu Kush-Himalayan region, but also in other parts of Asia. As a consequence, the number of *A. cerana* beekeepers and colonies have been gradually declining making *A. cerana* vulnerable to extinction in Asia. Measures to reverse the trend are necessary.
- Relieve stress to colonies by feeding pollen and honey is an effective way to control Thai Sac Brood Virus disease.
- Other recommended measures include; removing all combs infested by TSBVD, requeening from healthy colonies, caging queens, ventilating hives, removing old and unoccupied combs, keeping colonies strong and healthy, and sterilisation of hives, equipment and combs.
- Bee flora and management are key factors for prevention of TSBVD in *A. cerana* colonies.
- Genetic studies on TSBVD have to be carried out because TSBVD appears for 2–3 generations.
- Migration of bees colonies from poor habitats to rich habitats to exploit new floral resources.
- Devise a simple and easy method to identify TSBVD in the field.
- Research on selective breeding of TSBVD-resistant *A. cerana*.

—Recommendations made during a special Workshop held during Fourth AAA International Conference on Bee Diseases and Pests Control in Kathmandu, 24th March 1998

bees for pollination. In Maoxian county in Aba Prefecture of Sichuan province in China honeybees are available for pollination but the apple farmers are doing mechanical pollination (hand pollination). This explains the need to promote ways that place more emphasis on the use of honeybees in the pollination of mountain crops.

Promoting *Apis cerana* for pollination

Studies on comparative effectiveness of *Apis cerana* and *Apis mellifera* in pollinating different crops have shown that *Apis cerana* is a better pollinator of crops flowering during spring season than *Apis mellifera* (Verma and Partap 1993; Partap and Verma 1994; Partap and Partap 1997). *Apis mellifera* is also a good crop pollinator, but the race of *Apis mellifera*, which has been imported to this region is highly susceptible to cold and need to be migrated to low hill areas during winter season. Therefore, it is not possible to use this bee for pollination of early blooming mountain crops. In northern areas of Pakistan, where fruit cultivation is common and *Apis mellifera* has been introduced on a large scale, pollination of temperate fruit crops is badly affected resulting in crop failures. The high mountain sub-species of *Apis cerana* is cold resistant and an excellent pollinator of early blooming mountain cash crops. Thus, there are great prospects for promoting this bee for crop pollination in hilly and mountain areas. Its conservation in the mountain areas is, therefore, essential to maintain the productivity and enhance the quality of high value crops.

Surveys conducted in the apple growing areas of India and China indicated that farmers need bee colonies for the pollination of their apples and other fruit crops but most beekeepers are not interested to rent bee colonies. This is because the farmers use lot of insecticides on their crops. These insecticides also kill honeybees and the beekeepers lose their bees. Therefore, to ensure safe pollination of cash crops, farmers can be given training on how to save bees from insecticides. Farmers can also be encouraged and

trained to keep and manage their own bee colonies for pollination. So far, Himachal Pradesh is the only state where such efforts have been taken. In this small fruit growing State of Northwest Indian Himalayas, apple farmers are being encouraged by providing them bee colonies on a highly subsidised price and training them in beekeeping management. Similar efforts are required in other countries of the region.

Asian Bee Research and Training Centre

For future development of beekeeping with *A. cerana* in south and southeast Asia, a co-ordinated and systematic effort for establishing a Research-cum-Training Centre for Asian bees and beekeeping is essential.

In conclusion, conservation and management of native bees and the maintenance of a thriving beekeeping industry are essential for sustainable agriculture and rural development. Swaminathan (1986) in his foreword in the FAO Service Bulletin on Apiculture stated 'In spite of all global resolutions on food security, several hundred million children, women and men are going to bed hungry everyday, particularly in the countries of the South. Since prospects for global food security still appear grim at present, it will be necessary for developing countries to build their own national food security systems. In this task, apiculture can play a useful role. At very little expenditure, honeybees will not only provide food and income, but will also enhance the productivity of horticultural and other field crops through pollination'.

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