Honeybees in mountain agriculture

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Promotion and growth of the pollination enterprise can help improve livelihoods for several mountain farming families by generating employment and income as well as boosting the production and quality of crop. Managed pollination of apples as practiced in Himachal Pradesh, India is an excellent example of enhancing income and food security of not only apple farmers but also beekeepers. However, there is a need for scientific research, capacity building of farmers and putting appropriate rules in place to strengthen the system of managed pollination of apples in the state.

Agriculture is the main source of livelihoods for a majority of population living in the rural areas of the Hindu Kush-Himalayan (HKH) region. While two per cent of its rural population depends entirely on agriculture, a large majority i.e., 91 percent depend on it for making 30-50 per cent of their livelihoods. The agricultural land resources in mountain areas are limited and landholding size is small. About 90 percent of the farming households cultivate less than one hectare of land each. Moreover agricultural land resources in many areas are marginal in productivity. Therefore, many farming households in mountain areas are not able to produce enough food to ensure year round food security for their families.

Fortunately, in some valleys and in specific pockets, the agro climatic conditions are suitable for cultivation of a variety of fruit and vegetable crops. Taking advantage of these niches, cash crop cultivation is being promoted to enhance income and food security for the mountain people. Many farmers in such valleys have switched over to cash crops farming and planting a variety of fruits such as apples, almonds, cherry, loquat, peach, pear, plums, walnuts etc, as well as seasonal and off seasonal vegetable crops such as cabbage, cauliflower, chillies, lettuce, peas, radish and tomato etc. These cash crops have proved effective in bringing income and food security to mountain communities.

Mountain agriculture and the need for pollination

Many varieties of the cash crops currently cultivated in mountain areas are self sterile and require cross pollination for producing fruit or seeds. A diversity of pollinators including bees, flies, butterflies, moths, beetles help in cross pollination of these crops, thereby helping in maintaining (or improving) their yield and quality. Pollinators, thus, play a crucial role in improving food productivity.

In recent years pollinator abundance and diversity are declining worldwide, due to habitat loss, excessive use of pesticides, climate change and other factors
security and livelihoods of mountain households through provisioning of the pollination services. Pollinators also play an often unrecognized role in combating soil degradation by enhancing the replenishment cycle i.e. more pollination, more seed, more plants, retuning more biomass to the soil, more food for birds, insects and other animals. Globally the annual contribution of pollinators to the agricultural crops has been estimated at about 153 billion Euros.

For the Hindu Kush-Himalayan region it is estimated that the contribution of pollinators to the agricultural economy of the selected areas of the HKH region including Chittagong Hill Tracts of Bangladesh, Bhutan, Himalayan Hengduan mountain areas of China, northwestern Indian Himalayan states of Himachal Pradesh and Uttarakhand, and northern Pakistan is 2.69 billion US Dollars per year (Table 1). The figure could be double if Afghanistan, North-eastern Indian States, Myanmar and Nepal were also included in the study.

Declining pollinator diversity and abundance

Beekeeping is an important component of mountain farming systems and is source of income, nutrition, and medicine for mountain communities. It fits in well with the mountain specificities due to the high value, low volume, low perishability of honey and other bee products. Honeybees help in increasing the productivity of crops and maintenance of biodiversity through providing their pollination services. Traditionally, farmers manage the indigenous honeybee *Apis cerana* in log and wall hives close to the homestead. Commercial beekeeping started in 1970s with the introduction of the European honeybee, *Apis mellifera* to enhance honey production. Promotion of beekeeping with this bee by government, non-government and private sector organizations through using modern technologies and practices, and large scale capacity building and training efforts has led to a substantial increase in honey production in the region and income of honey producers (beekers) and primary processors, and others engaged in honey trade. Honeybees are important pollinators of crops and natural flora thereby help in enhancing productivity of agricultural and natural ecosystems.

It has been estimated that over three quarters of world’s crops and over 80 per cent of all flowering plants depend on animal pollinators. Bees are the most effective of over 100,000 species of animals that pollinate over 250,000 plants including various crops and natural flora. However, in recent years, pollinator abundance and diversity is declining worldwide, particularly in cash crops farming areas due to habitat loss, excessive use of pesticides, climate change and other factors leading to a serious reduction in yields and quality of crops, particularly those requiring cross pollination. This decline in pollinator abundance and diversity presents a serious threat to agricultural production and maintenance of biodiversity. Possibly, worst-affected crops are the cash crops such as fruits, vegetables, and oil seed crops on which farmers pin their hopes for better cash income returns. The best indicator of the decline in natural insect pollinators is decreasing crop yields and quality despite adequate agronomic inputs and intensive efforts. Thus, it is important to ensure a sustained supply of pollination services in order to maintain or improve crop productivity. One way of doing it is by promoting use of manageable insects such as honeybees for pollination of crops, as is being done in Himachal Pradesh, India.

Using honeybees for apple pollination

Honeybees are promoted and used for apple pollination in Himachal Pradesh in Northwest Indian Himalayan region since 1996. The use of beekeeping for pollination of cash crops has proved to be of great benefit not only to the farmers but also to the beekeepers. Beekeepers receive money for the pollination services of his honeybees and farmers’ income is increased through boosting crop productivity as a result of pollination services of bees.

It is important that the awareness and capacities of farmers is strengthened in bee management. Two to five per cent colony losses occur while migrating bees for pollination. According to some

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**Table 1: Economic value (million US$) of insect pollinators (EVIP) to different crops in the selected study areas of the Hindu Kush-Himalayan region**

(Source: Partap et al 2011)

<table>
<thead>
<tr>
<th>Study areas</th>
<th>Fruit crops</th>
<th>Oilseed crops</th>
<th>Pulses</th>
<th>Spices crops</th>
<th>Tree nut crops</th>
<th>Vegetable crops</th>
<th>All crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chittagong Hill Tracts, Bangladesh</td>
<td>33.09</td>
<td>0.97</td>
<td>0*</td>
<td>0.09</td>
<td>3.39</td>
<td>14.27</td>
<td>51.81</td>
</tr>
<tr>
<td>Bhutan</td>
<td>10.81</td>
<td>0.82</td>
<td>0.31</td>
<td>0.67</td>
<td>0.96</td>
<td>3.99</td>
<td>17.56</td>
</tr>
<tr>
<td>Chinese Himalayas</td>
<td>453.09</td>
<td>188.05</td>
<td>0*</td>
<td>4.03</td>
<td>0*</td>
<td>27.64</td>
<td>672.81</td>
</tr>
<tr>
<td>Kashmir</td>
<td>407.66</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9.73</td>
<td>8.22</td>
<td>425.61</td>
</tr>
<tr>
<td>Himachal Pradesh, India</td>
<td>353.02</td>
<td>1.28</td>
<td>1.58</td>
<td>0.02</td>
<td>0.05</td>
<td>7.84</td>
<td>363.79</td>
</tr>
<tr>
<td>Uttarakhand, India</td>
<td>159.43</td>
<td>3.85</td>
<td>0.79</td>
<td>0.57</td>
<td>0*</td>
<td>2.04</td>
<td>166.69</td>
</tr>
<tr>
<td>Nepal</td>
<td>54.38</td>
<td>23.82</td>
<td>1.78</td>
<td>0.25</td>
<td>0.26</td>
<td>0.19</td>
<td>80.76</td>
</tr>
<tr>
<td>Mountain areas of Pakistan</td>
<td>879.75</td>
<td>38.08</td>
<td>0*</td>
<td>-</td>
<td>36.44</td>
<td>0*</td>
<td>954.27</td>
</tr>
<tr>
<td>All study areas</td>
<td>2183.48</td>
<td>273.8</td>
<td>36.98</td>
<td>4.26</td>
<td>28.33</td>
<td>126.60</td>
<td>2685.3</td>
</tr>
</tbody>
</table>

* Crops/ varieties grown are entirely self-pollinated; **Producer price data were not available
beekeepers, the loss of colony strength during migration is as much as losing nearly 2 frames of bees. Sometimes, during apple flowering season weather becomes very cold or rainy and bees cannot come out for foraging. Orchardists, having no knowledge of beekeeping management do not feed bees. This results in further reduction in the strength of bee colonies. Such colonies do not prove very effective in pollinating the crops. Thus, it is important that farmers should have basic knowledge and are able to perform the basic bee management practices while using bees for pollinating their crops.

A well-organised system has been established for hiring and renting honeybee colonies for apple pollination in Himachal Pradesh. Apple farmers use both *Apis cerana* and *Apis mellifera* for pollination. Here, some farmers keep their own honeybee colonies while others rent them from the Department of Horticulture or from the private beekeepers. The fees for renting bee colonies - either *Apis cerana* or *A. mellifera* is INR 600 - 800/- (US$ 13-17) per colony for the flowering period of apple. *Apis cerana* colonies are booked in advance, beekeepers charge rent at the time of booking, while *Apis mellifera* beekeepers take money at the time of renting the colonies or after rendering pollination services.

Regular migratory Himachali *Apis mellifera* beekeepers have their fixed clientele for renting bee colonies. Migratory beekeepers from neighbouring states rent bees either through Fruit Growers Associations or through an intermediary local person. *Apis cerana* beekeepers prefer to rent their bees to those farmers who take care of bees better in order to avoid the loss of colonies. There are instances that beekeepers lose many (or all) their colonies to bear or pine marten attack especially when placed in orchards adjoining forest areas. This has a negative impact on the only source of their income and livelihoods. Thus, it is important that these beekeepers be compensated for their loss and for that there is a need to have appropriate rules. Rules are necessary to also curb some unhealthy practices that are prevailing in the region. Taking advantage of the fact that many farmers are afraid to open beehives and judge the strength of bee colonies, some beekeepers provide weak colonies to farmers to earn more money.

The large-scale use of honeybees for apple pollination has led to the development of a new vocation in this small state. A number of pollination entrepreneurs (beekeepers who rent honeybee colonies for crop pollination) have come up in the state to complement the official services. Beekeepers renting colonies to the orchardists are mainly from Himachal, but since the demand for bee colonies is much more than the number of colonies the Himachali beekeepers have, beekeepers from neighbouring states of Haryana and Uttar Pradesh are also encouraged to rent their colonies to meet the demand. Majority of beekeepers are supplying *Apis mellifera* colonies, except a few who are renting *Apis cerana* colonies to the apple orchardists. *Apis mellifera* beekeepers are practicing migratory beekeeping on commercial scale having 100 to 1500 bee colonies, while *Apis cerana* beekeepers are stationery beekeepers with 10-30 bee colonies. Success is also owing to the existence of strong research and extension institutions and farmers associations.

**Institutional efforts in promoting beekeeping for apple pollination**

Beekeeping for crop pollination is a new activity in the region. There are few institutions in the region with explicit mandates or expertise. Most institutions promote beekeeping as a cottage industry to increase family income through the sale of honey. Promoting the value of honeybees as reliable pollinators of apples and other fruit and vegetable seed crops requires special efforts to strengthen research and extension systems. It is, so far, only in Himachal Pradesh in the whole HKH region that such an organised system for managing apple crop through promoting honeybees (beekeeping) pollination exists. The success of this approach includes combined efforts of research and development institutions as well as farmers organizations, for example the Horticultural University, Department of Horticulture and Fruit Growers Associations, as described in the box.

**Impact of managed pollination in apples**

In a recent study conducted in 2011 regarding the impact of managed pollination on the crop yield and fruit quality of apples in Himachal Pradesh, farmers reported an increase of about 20-30% in apple production as a result of use of honeybees for pollination. Honeybee pollination also resulted in an improvement in the fruit quality, e.g. an increase in well formed fruits, better colour of the fruit and reduction in the percentage of oddshaped fruits. Farmers are able to market their produce effectively. This has opened up opportunity for both small scale *Apis cerana* and
Role of Institutions in promoting bee-keeping

Role of Fruit Growers’ Associations
- Provides platform for discussing fruit farming and marketing related problems
- Acts as a strong pressure group to seek government intervention
- Raised apple pollination problem with University and Department of Horticulture and sought rapid solutions
- Raised awareness about the scale of the problem in apple farming areas of the state
- Encouraged farmers to rear honeybees and become entrepreneurs for pollination, and
- Coordinated honeybee demand–supply aspects

Role of Horticulture University
- Has mandate for horticultural research and extension
- Strong scientific expertise is available on honeybees, beekeeping and pollination
- Has field stations in apple farming areas and monitors problems related to horticulture and focuses on problem-solving research
- Conducts on-farm research into and demonstration of the positive effects of beekeeping for apple pollination to popularize use of beekeeping for pollination
- Launched special awareness programmes in apple-farming areas
- Agriculture Science Centres (Krishi Vigyan Kendras), the extension centres of the university, give beekeeping training on-demand to farmers and interested new entrepreneurs.

Role of Department of Horticulture
- Establishment of a Beekeeping Development Office which maintains and rents honeybee colonies to farmers for apple pollination
- Assesses demand for honeybee colonies by apple farmers and facilitates supply arrangement with private beekeepers
- Provides attractive financial support and training for starting beekeeping enterprise
- Provided bee colonies initially at a subsidised price to promote their use for pollination

Role of the Regional Organization – ICIMOD
- ICIMOD works in partnerships with the concerned national institutions; developed partnerships with institutions and organizations engaged in beekeeping and horticultural research and development to jointly work on the issues related to apple productivity
- Conducted studies to identify problems affecting apple productivity including pollination issues
- Set up action research and demonstration to show the impact of bee pollination on apple yield
- Organized local awareness camps/ workshops
- Training for the farmers and beekeepers in managing honeybees for apple pollination

commercial Apis mellifera beekeepers, not only from Himachal but also from neighbouring states to earn extra income through raising and renting bee colonies as demand is increasing. Demand for bee colonies, and thus a potential for enhancing beekeepers income and employment is increasing which has led to the establishment of pollination enterprises in the state.

Need for upscaling
Promotion and growth of the pollination enterprise can help improve livelihoods for several mountain farming families not only in Himachal Pradesh but also in other areas of the HKH region. While the enterprise could be strengthened by directing efforts towards promoting scientific research in managing indigenous honeybee, building capacities of farmers, establishing rules and regulations, provision of easy loan etc., there is great scope for further expanding this enterprise as the large area of land is under cultivation of fruit crops.

References
Eardley, C; Roth, D; Clarke, C; Buchmann, S; Gemmill, B (2006) Pollinators and Pollination: A Resource Book for Policy and Practice, pp 77. Pretoria, South Africa: African Pollinator Initiative

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