Chapter 1

Concerns about Productivity in Mountain Farming

There are signs that across the Hindu Kush-Himalayas the overall productivity of many mountain crops – the amount of crop produced per unit of planted area – is going down. Possibly the worst affected crops are the cash crops like fruit, particularly apples, and off-season vegetables that are the hope of the region in terms of providing farmers with cash income and underpinning development efforts. This reduction in productivity is taking place despite extensive efforts at extension and information to support improvements in a range of management practices, and strong support for the introduction of successful commercial varieties. This book is concerned with raising awareness about and stimulating interest in one of the major factors involved, failure of pollination, and suggesting strategies for dealing with the problem.

'Managed' Pollination and Why We Need It

There are several factors that affect the productivity of mountain crops. They include soil fertility; poor quality of planting material; agronomic inputs including irrigation, fertiliser, and/or manuring; and use of pesticides – but pollination plays possibly the single most significant role. Pollination is an essential prerequisite for fertilisation and fruit and seed set. If there is no pollination, no fruits or seeds will be formed, and there will be nothing to harvest.

Pollination: the transfer of pollen from the male part of a flower, the anther, to the female part, the stigma, either of the same flower, another flower on the same plant, or another flower on another plant of the same species. If flowers are not pollinated, they cannot produce seed.

Self-fertile or self-compatible crops are fertilised by pollen from anthers of the same plant or another plant of the same variety. They are mostly self-pollinated, with pollen carried by wind or plant movement

Self-sterile or self-incompatible crops require compatible pollen from a different variety of the same crop.

Crops can be divided into two categories: self-fertile (self-compatible) and self-sterile (self-incompatible). Self-fertile crops include such plants as wheat, rice, and maize. They are largely self-pollinated and farmers rarely have any pollination problems with them. In contrast, many commercial varieties of fruit and vegetables are partially or fully self-incompatible. Successful pollination requires the presence of another appropriate compatible plant (i.e. a pollinizer), conditions that ensure synchronised or overlapping flowering in the two plants (the stigmas of the commercial variety

Good pollination – a cluster of well-developed apples

flowers must be receptive at the same time as the anthers ripen in the pollinizer flowers), and a pollinising agent like a bee. To obtain good yields, farmers must ensure that these conditions are met – this is crop pollination management.

Although mountain farmers try their best to enhance crop productivity by improving agronomic inputs, for example use of better quality planting material, better irrigation, and improved fertiliser and pesticide application, they rarely consider managing pollination – and neither do the government organisations advising them. This is probably the major reason why many crop yields are declining despite improvements in all agronomic inputs.

In 1997, ICIMOD (the International Centre for Integrated Mountain Development) published a discussion paper on 'Managed Crop Pollination: The Missing Dimension of Mountain Agricultural Productivity' (Partap and Partap 1997). In this paper we looked at the question of why farmers and agricultural institutions do not pay attention to the role of pollination in ensuring agricultural productivity. What do farmers and institutions know about it? Are mountain farmers and agricultural research and extension institutions aware of it? Do they understand the severity of the problem? Our research indicated that few farmers or institutions in the Hindu Kush-Himalayan (HKH) region were aware of the severity of the problem, and most did not have the mandate or expertise to address it. The paper highlighted the lack of information on the value of managing pollination.

Clearly more concrete information was needed to document the severity of and variation in pollination problems across the HKH region and to identify clearly the factors responsible for inadequate pollination. We chose apples as a representative, widely grown, and economically important, self-incompatible crop and carried out an extensive survey of apple-growing areas in India, China, Pakistan, Bhutan, and Nepal. The results are likely to be indicative for the many other crops like temperate and sub-tropical fruits, vegetables, and seed vegetables that require a management strategy to ensure pollination. Apple farmers, agricultural scientists, extension workers, and local leaders were interviewed to collect information on pollination-related productivity issues in a series of case studies. This book summarises the outcome of these studies.

The Importance of Apples for Farmers with Marginal Land

Agriculture is the basis of the livelihood of over 80% of the rural population in the countries of the HKH region. However, more than 90% of the farmers in the hill and mountain areas are marginal or small land-holding families, cultivating less than one hectare of land each (Banskota 1992; Partap 1995; Koirala and Thapa 1997; Partap 1999). Most agricultural land in the mountain

areas is not only marginal in terms of potential productivity, its quality also appears to be deteriorating as indicated by declining soil fertility and crop productivity. Many mountain families face food shortages of varying degrees, and these are contributing to the chain reaction process of poverty–resource degradation–scarcity–poverty (Jodha and Shrestha 1993). It is necessary to explore all possible ways of increasing the sustainable productivity and carrying capacity of the farming systems in the mountains (Partap 1998, 1999). Development efforts tend to focus on exploring farming approaches to increase the productivity and carrying capacity of farms (Partap and Partap 1997; Partap 1999).

Cabbages planted between apple trees

One option for enhancing the farm income of mountain farmers is to exploit the comparative advantage or 'niche' for the cultivation of cash crops such as fruits, off-season vegetables, and vegetable seed. Mountain farmers can never have a comparative advantage in producing grain. Crops such as apples, almonds, pears, peaches, plums, cherries, and off-season vegetables bring farmers several times the income they could expect from staple food crops, and farmers' interest in them is increasing (Partap 1995, 1999; Partap and Partap 1997). These high-value crops can be grown in the mountains at a time when they cannot be produced in the lowlands and can command a relatively high price in the market. The diversification of mountain agriculture from the farming of traditional grain crops to the farming of cash crops on small plots of land has provided relief to some marginal and small farmers (Partap 1999). Farmers can earn money to buy food and other necessities for themselves and ensure a better education for their children. In Himachal Pradesh, for example, a farmer can earn up to US $4500 per hectare annually with a net return of US $2000-2200 from fruit farming (Sikka and Saraswat 1992). In other words, a marginal farm household with between 0.5 and 1 ha of land could earn up to US $1600 per annum, and a small farm household (1-2 ha) up to US $4000. These incomes are much higher than those that could be obtained through any of the other farming activities possible on such land.

Apples have emerged as the leading cash crop in several areas of the HKH region, assuming great importance in helping many farmers move out of the poverty trap. They are found in areas as far apart as the Indian Himalayas, northern Pakistan, the mountain areas of China, and northern Bhutan. They can account for 60-80% of the total household income of those who grow them and studies indicate that in the areas where apples are grown there is now food security and reasonable economic well-being (Sharma 1996). The area of land devoted to apple orchards in the five countries studied ranged from 230,000 ha in India to 2000 ha in Bhutan, with a total annual production ranging from 1,320,000 tonnes in India to 13,000 tonnes in Bhutan (Table 1.1). The beauty of apples is that the trees can be (and are in many areas) planted successfully on cold marginal slope

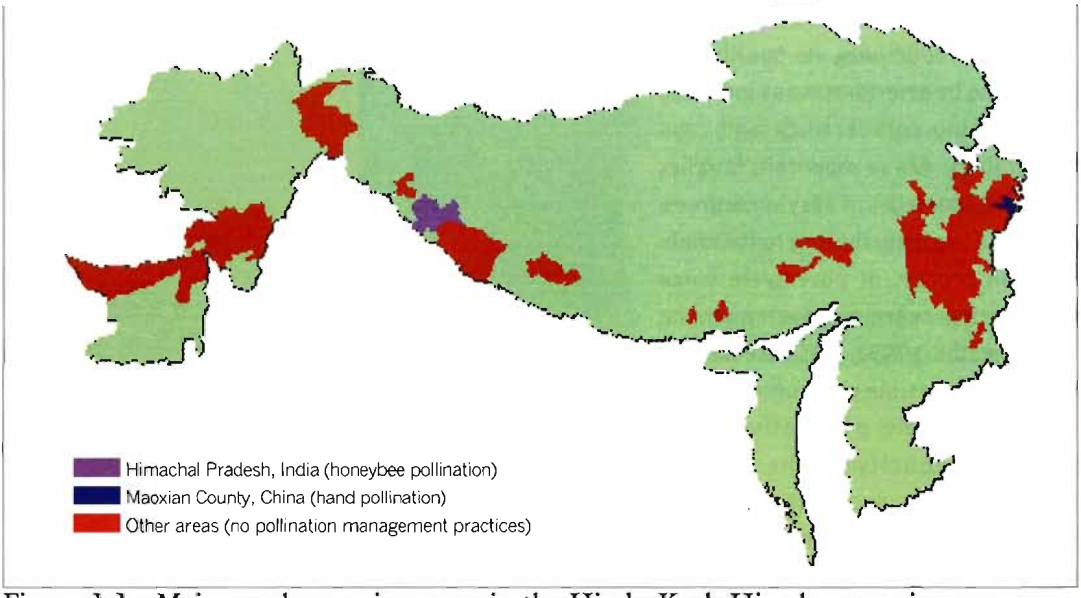

Figure 1.1: Major apple growing areas in the Hindu Kush-Himalayan region

Table 1.1: Area and productivity of apple farming in the Hindu Kush-Himalayan region

Country	Area ('000 ha)	Production ('000 tonnes)	Productivity (tonnes per ha)
Indian Himalayas[1]	228	1321	5.8
Nepal[2]	5	30	6.0
Bhutan[3]	2	13	6.5
Chinese Himalayas[4]	83	208	2.5
Pakistan[5]	49	638	12.9
Total	**367**	**2210**	**6.2**

Sources: [1]National Horticulture Board, New Delhi, India (1998), Department of Horticulture, Himachal Pradesh (1998), Verma (2000); [2]MInistry of Agriculture (1999); [3]Ministry of Agriculture, Royal Government of Bhutan (1999); [4]Government of China (1997), Government of Tibet Autonomous Region (1997); [5]Ministry of Food, Agriculture and Livestock, Government of Pakistan (1998-1999), Khan (1998).

land that is unsuitable for growing crops such as rice and wheat. Apples were grown in more than 140 hill and mountain districts in the countries studied.

Apples bring income not only to farmers but also to many other people linked to the farming, post-harvesting, and trade chain. Labourers working in apple orchards; those involved in picking, grading, packing, carrying, loading, and transporting apples; farmers supplying wood and carpenters making apple boxes; factories making cardboard boxes; truck owners, contractors, wholesalers, and retailers, all earn a good income from apples – as do those working in factories involved in post harvesting processes like making juice, jam, wine, or cider. The estimated total annual production in the HKH of 2.2 million tonnes of apples helped to bring in a gross income of over US $450 million per year to those involved in apple farming and marketing. In Himachal Pradesh alone, the estimated direct annual income from apples in 1999 was US $150-170 million, and the indirect income to the province was far higher, about US $1.5 billion per year (Toderia 2000).

The Emerging Scenario of Declining Apple Productivity

The officially reported average yield of apples in the HKH region varies from 2.5 to 12.9 tonnes per ha (Table 1.1). Our studies suggest that the real values may be even lower, particularly in Pakistan where the productivity at the sites we studied ranged from only 2.3 to 2.9 tonnes per hectare. Even the official figures are very low compared to the average yield of 25-30 tonnes per ha in Europe and other horticulturally advanced countries (Nadda and Tiwari 1998). Over the last seven to eight years, apple productivity has declined in the HKH region in terms of both yield and quality of fruit. In Himachal Pradesh, for example, apple productivity went down from 10.8 tonnes per ha in 1982 to about 4.3 tonnes per ha in 1998 (Department of Horticulture Himachal Pradesh 1998) and is declining further. Similarly, in Maoxian County apple productivity went down from 12.3 tonnes per ha in 1983 to 6.2 tonnes per ha in 1990 (Local Government Report, Maoxian County, 1998).

Several factors have been identified that affect apple productivity in the region. The social, physiographic, and physiological factors are mostly well understood and have been studied in some detail. They include the poor structure and nutritional status of soil (most orchards are planted on marginal land); poor quality of planting material such as rootstock that is susceptible to various diseases and pests; poor planting practices such as inappropriate spacing and the practice of deep planting, thus burying the scion union and promoting scion rooting; poor tree training and pruning, limiting light penetration; and the physiological condition of trees (Schilde and Bourgo 1998; High Value Agriculture Ltd 1998). The importance of pollination for maintaining apple productivity and quality is generally less well recognised, however, and the problems of inadequate pollination and poor fertilisation due to lack of pollinating insects and inclement weather conditions have received little attention in the region in comparison with other factors (Partap and Partap 1997). Although many farmers make all possible efforts to manage other factors, they almost always ignore pollination management.

The Apple Productivity Study

The studies described here were carried out under the aegis of the ICIMOD project 'Indigenous Honeybees of the Himalayas: A Community-based Approach to Conserving Biodiversity and Enhancing Farm Productivity', which is supported by the Austrian Government. One component of this project is crop pollination research; others include the state of pollinator diversity, and the importance of managing honeybees. The pollination programme is intended to address the problem of declining agricultural productivity of crops in the HKH region by raising awareness about the need

Apple flower – waiting for a pollinator

for managing pollination and the use of different species of honeybees. The survey was needed to confirm the previous indication that pollination problems were indeed a major factor in declining productivity, and to assess the extent and distribution of pollination problems in different crops – before making suggestions and implementing trials to improve the situation. Field surveys were performed in apple-growing areas in five countries – Bhutan, China, India, Nepal, and Pakistan. The surveys focused on the extent of apple productivity and pollination problems, the factors causing inadequate pollination, and farmers' management practices. The main objectives were

- to highlight the scale of the pollination problem;
- to document farmers' strategies for managing the problem;
- to analyse the role of bees and beekeeping as pioneer options for managing crop pollination;
- to analyse apple productivity, pollination issues, and options;
- to look at the level of institutional support in addressing the pollination issue; and
- to make recommendations.

A total of 530 apple growers were surveyed, and a number of key informants, including local government officials, scientists, progressive farmers, and beekeepers, were interviewed. The major findings are summarised in Chapter 2, which gives a regional overview of pollination-related productivity issues in the HKH. Both the scale of the problem and the farmers' management strategies were different in different countries. The review of the capabilities and programmes of government institutions in managing apple pollination indicates a clear need to strengthen their capacities so that they can serve apple growers better. Details of the study methodology and country results can be found in Part 2.