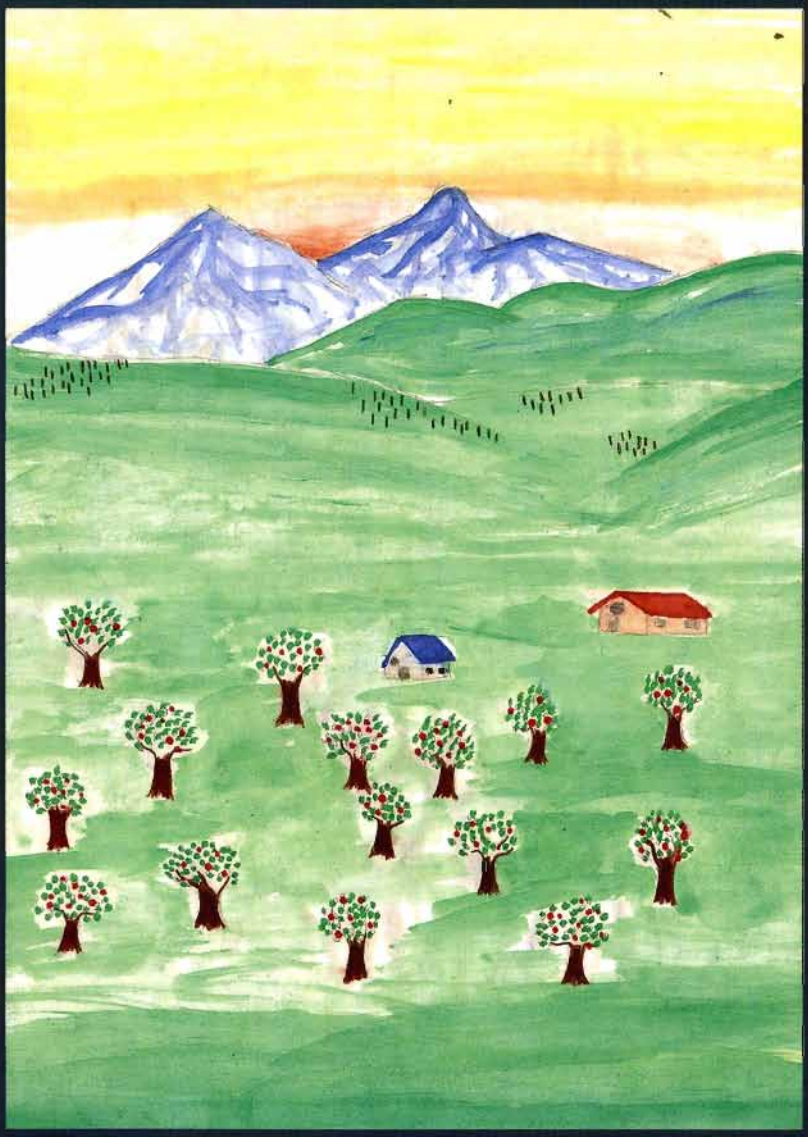
WARNING SIGNALS

From the Apple Valleys of the Hindu Kush-Himalayas

Productivity Concerns and Pollination Problems



Uma Partap
Tej Partap

Abridged Edition

ICIMOD

about ICIMOD

The International Centre for Integrated Mountain Development (ICIMOD)is an international organisation devoted to development of the Hindu Kush-Himalayan region covering all or parts of eight sovereign states, Afghanistan  , Bangladesh  , Bhutan  , China  , India  , Myanmar  , Nepal  , and Pakistan  . The Centre is located in Kathmandu, Nepal. The primary objective of the Centre is to promote the development of an economically and environmentally sound mountain ecosystem and to improve the living standards of mountain populations. The Mountain Farming Systems' Division at ICIMOD was established to promote improvement of farm productivity on small mountain farms without degrading the resource base.

Warning Signals from the Apple Valleys of the Hindu Kush-Himalayas

Productivity Concerns and Pollination Problems

(Abridged Edition)

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Foreword

The great majority of people in the Hindu Kush-Himalayan (HKH) region depend upon agriculture as their main source of livelihood; most are mountain farmers with small farms covering less than two hectares of cultivated land. Thus the well-being of mountain people is to a great extent determined by the state of mountain agriculture; and the potential for economic improvement by the ability to grow crops for sale rather than consumption.

Mountain agriculture in the HKH is slowly transforming from traditional farming of cereal crops to farming of high value cash crops. Cultivation of cash crops like temperate and sub-tropical fruits and vegetables is increasing in several pocket areas. The growing of cash crops on small plots of land has provided a certain measure of relief and income security to marginal and small mountain farmers and has helped alleviate poverty in some mountain areas. In recent years, however, this agricultural transformation has posed new challenges in terms of improving crop productivity and quality. The challenges include crop failure and reduced productivity resulting from inadequate pollination.

As a part of its focus on improving the livelihoods of mountain people, ICIMOD is implementing a project on 'Indigenous Honeybees of the Himalayas: A Community-based Approach to Conserving Biodiversity and Enhancing Farm Productivity' supported by the Austrian Government through Austroprojekt. The main aim of this project is to promote sustainable management of *Apis cerana* and other indigenous honeybees by mountain communities as a way of increasing farm productivity whilst contributing to biodiversity conservation. Research on pollination issues in mountain crops is an important component of this beekeeping project. The main objective of the pollination programme is to address the problem of declining agricultural productivity resulting from pollination failure. The programme aims to raise awareness of the need to manage pollination, and in particular the value of using honeybees for pollination purposes.

The regional case studies of pollination problems and farmers' management approaches described in this book are among the results of this work. Apples were selected as an example because they are the main cash crop in several areas of the region, and because pollination failure was identified as an emerging problem in previous work. The studies were carried out in India, China, Bhutan,

Nepal, and Pakistan, thus providing a detailed view of the commonalities and differences across the region. The advantages of using bees for pollination, and the appropriate approach and steps needed to introduce pollination management through bees in the different areas, is summarised in detail.

The publication is intended to raise awareness among agricultural planners, policy makers, and researchers about the pollination problems faced by mountain farmers, as well as suggesting strategies for change. It highlights the role of government institutions in apple pollination management and the need to strengthen their capacities and their programmes to help apple farmers. I hope that this book will prove useful in raising awareness of the need to incorporate crop pollination management as an essential component of agricultural extension programmes and packages of practices. I also hope that it will help promote increased use of bees and beekeeping for pollination of mountain crops.

Binayak Bhadra
Director of Programmes, ICIMOD

Acknowledgements

This book is the result of the efforts of a large number of people, all of whom we would like to thank.

The collaborating partners that helped us in these surveys – people and institutions in Bhutan, China, India, Nepal and Pakistan – deserve special appreciation. In particular, we wish to express our thanks to the members of the field survey teams.

We are particularly grateful to the mountain farmers, agricultural scientists, extension workers, local leaders, and others who supported us so well by taking time out of their busy schedules to provide us with valuable information related to their experiences with apple cultivation. We owe them our special thanks, particularly the farmers, for their cooperation and help.

Many others provided crucial support during the field studies. We are particularly thankful to Mr. Om Parkash, an apple farmer and lawyer in Kullu, Himachal Pradesh; Dr. Khyal C. Thakur from the International Potato Centre; Dr. Neelima R. Kumar and Professor Dhani R. Gautam from the Dr. YS Parmar University of Horticulture and Forestry; Professor Liaq R. Verma, Department of Biosciences Himachal Pradesh University, Shimla, and Former Vice-Chancellor of the Dr. YS Palmer University, who made the logistical arrangements for the survey in Shimla; Ch. Zulfiqar Ali Khan, Chief of Khush-Hali Associates, Pakistan; and Dr. Muhammad Islam of the Arid Zone Research Institute in Quetta, Pakistan. Professor Liaq Verma also critically reviewed the manuscript and we owe him special thanks for his suggestions, which improved the quality of the publication.

The draft of this book was prepared and discussed with colleagues in ICIMOD and outside. We would like to express our gratitude to many members of staff, in particular Dr. Farooq Ahmad, Mr. Min B. Gurung, Dr. Surendra R. Joshi, Mr. Anirudha N. Shukla, Mr. Satananda Upadhaya, and Ms Shova Bhandari, of the Beekeeping Project; Dr. Tang Ya and Dr. Nyima Tashi of the Mountain Farming Systems Division; Ms Greta Rana, Dr. A. Beatrice Murray, Mr. Sushil Joshi, and Mr. Asha K. Thaku of the Information, Communications and Dissemination Division; Ms. Phuntshok Tsering of the Mountain Enterprises and Infrastructure Division; and Dr. J. Gabriel Campbell and Dr. Binayak Bhadra of the Directorate for their extensive support, encouragement, and help.

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Finally, we thank our daughters, Bhoomika and Uttara, who supported us with their patience and understanding while we spent time that we would otherwise have spent with them. We also very much appreciate the efforts of our elder daughter Bhoomika in preparing the artwork for the cover page.

Uma Partap and Tej Partap
March 2001

Executive Summary

One of the most rapidly increasing and widespread cash crops in the HKH region is apple, not least because apple trees grow best in cool areas and can grow successfully on marginal sloping land that is otherwise unsuitable for growing food crops. At present, apples are grown on some 370,000 ha of mostly marginal land in over 140 hill and mountainous districts in India, Pakistan, Bhutan, China, and Nepal. Apples have emerged as the main cash crop in several areas of the region, accounting for as much as 60-80% of total household income for some apple farmers. Apple growing provides a major source of income not only for growers but also for many other people – including labourers working in apple orchards; those involved in picking, grading, packing, carrying, loading, and transporting apples; farmers in nearby plains areas who plant poplar wood for apple boxes; carpenters who make apple boxes; people working in factories that make cardboard boxes; truck owners and their staff; and fruit trade commission agents, wholesalers, and retailers. It is estimated that the annual production of apples in the HKH region is over 2.2 million tonnes, which helps bring in an income of over US $450 million per year to farmers and others involved in apple farming and marketing.

Although apple growing is often thought of as a major success story, over the last decade farmers in the HKH region have experienced a steady decline in apple productivity, both in yield and in quality of fruit. Farmers estimate that apple productivity has declined by about 50%, and feel that the trend continues. Studies have indicated that there are several factors affecting apple productivity. These include poor structure and nutritional status of the soil (most orchards are planted on marginal land); poor quality of planting material such as rootstock which 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, affecting light penetration; the physiological condition of trees; and insufficient pollination and fertilisation due to lack of pollinating insects and inclement weather conditions. Most of these factors have remained constant in past years; what seems to have changed is the level of adequate pollination.

ICIMOD coordinated a series of studies in selected apple-growing valleys of the HKH region to assess the problem of declining productivity, the pollination situation, factors responsible for inad-

equate pollination, and farmers' management approaches; and to suggest ways of tackling the pollination problem. Semi-structured interviews and a survey questionnaire were used to collect information on various parameters related to apple pollination, productivity, and management practices. Apple valleys were selected and field study teams were formed in each of five HKH countries: Bhutan, China, India, Nepal, and Pakistan.

This publication presents the findings of the region-wide survey. It is divided into three parts. **Part I** contains an introduction to apple pollination issues and a brief account of the scale, definitions, and concepts related to the pollination problem. It briefly describes ICIMOD's programme and its focus on creating awareness about 'managed pollination' and using honeybees for pollination to improve crop productivity. The second chapter provides a synthesis of the results and implications of the regional case studies and an overview of the HKH regional problems. The prospects for using honeybees to manage pollination, and the constraints and limitations in promoting beekeeping for pollination are discussed, together with other options like managing non-*Apis* pollinators for pollination, and hand pollination.

Part II presents the detailed findings of the studies. The first chapter (Chapter 3) describes the approach and methodology used for the field studies. Chapters 4 to 8 describe the detailed results of the field studies carried out in each country: Himachal Pradesh (India), Maoxian County (China), Balochistan Province (Pakistan), Thimphu and Paro Valleys (Bhutan), and Jumla District (Nepal). Information is provided on the scale of apple farming, livelihood dependence on apples, the scale of the pollination problem, farmers' management approaches, and the use of honeybees for pollination, as well as pollination issues and implications in each country. Both the scale of the problem and farmers' management strategies were found to vary widely in the five countries.

In **Himachal Pradesh, India**, pollination problems were mainly related to the change to large-scale planting of a single variety, Royal Delicious, starting in the eighties. There were insufficient pollinizer trees to ensure pollination, and at the same time natural insect populations had declined greatly, partly as a result of pesticide use (including on crops grown beneath apple trees), and partly as a result of loss of habitat. The pollination problem had already been recognised and close to a half of the farmers surveyed were practising some form of pollination management. Efforts were underway to increase the proportion of pollinizers using pollinizer bouquets, grafting, and tree replacement, and to promote the use of bees for pollination by promoting systems for both renting and buying colonies. The present demand for honeybees could not be met with the present resources, however.

In **Maoxian Valley, China**, scarcity of land had also led to planting of monocultures of mostly Royal Delicious. Farmers had turned to hand pollination rather than increase the proportion of pollinizers. Commercial beekeepers were unwilling to hire out bees as farmers used high levels of insecticides, and sprayed during blossoming. In the long-term, hand pollination is unlikely to be a viable solution, however. Integrated pest management, grafting of pollinizer varieties, and beekeeping for pollination are likely to provide a more practical long-term solution.

In **Balochistan, Pakistan,** the pollination problem was less marked, although the productivity reported by farmers was markedly lower than that reported in the official statistics and farmers had observed a decline. There was very little awareness of pollination, but there were more pollinizers: orchards were planted with a mixture of varieties, particularly Red Delicious and Golden Delicious. A high proportion of the land is left wild, and farmers still benefited from extensive populations of natural insect pollinators, but the problem of insufficient insect pollinators was increasing. Migratory beekeepers brought hives into Balochistan, but did not place them near orchards. Future efforts are likely to focus on the use of these migratory bees to support apple pollination.

The pollination problems were also less marked in **Thimphu and Paro Valleys in Bhutan** than in some of the other areas. Most farmers had a good understanding of pollination issues, pollinizer varieties were planted, although generally fewer than the optimum, and the country still has much natural forest and low levels of pesticide use, so that there are reasonable populations of wild insect pollinators. Productivity could still be improved, however, and the available natural insect pollinators will be insufficient if larger areas of forest are replaced with orchards. Some farmers were already interested in keeping bees for pollination, but there were none available for renting.

The farmers in **Jumla Valley in Nepal** had only a limited knowledge of pollination. Although productivity was fairly low, this was not of great concern as the marketing possibilities from this remote area were also limited. Recent provision of marketing support had increased interest in productivity issues. As there was less commercial focus, orchards contained a mixture of trees and most probably had a reasonable number of pollinizers. Many farmers kept *Apis cerana* bees in traditional log hives for honey production, although they were not usually placed directly in the orchards, and the low levels of pesticide use mean that there are extensive populations of natural insect pollinators. Even so, there was a clear scope to improve pollination through appropriate management and placement of bees.

Part III contains the Annexes, with a bibliography, and the questionnaire used in the field surveys.

The abridged edition contains only Part 1 and Annex I.

Abbreviations and Acronyms

AKRSP	Agha Khan Rural Support Programme (Pakistan)
BKDO	Beekeeping Development Office
HMG	His Majesty's Government
HH	households
ICIMOD	International Centre for Integrated Mountain Development
INGO	international non-government organisation
IUSSI	International Union for Studies on Social Insects
masl	metres above sea level
MoA	Ministry of Agriculture
NA	not available/not applicable
NARC	National Agricultural Research Centre
NGO	non-government organisation
NWFP	North West Frontier Province
PARC	Pakistan Agricultural Research Council
PPD	Policy and Planning Division
RGB	Royal Government of Bhutan
REID	Research Extension and Irrigation Division
SD	standard deviation
4S	Surya Social Service Society
TSO	tree spray oils
UNDP	United Nations Development Programme
USA	United States of America
USAID	United States Agency for International Development
YSP	Dr. Y.S. Parmar University

Note

For convenience, all values in local currency have been converted to US$ at the rate prevailing at the time of the surveys. The exchange rates used were

1 US$ = IRs 46.05
1 US$ = Nu 46.05
1 US$ = Yuan 8.40
1 US$ = PRs 59.50
1 US$ = NRs 73.60

Glossary

Anther: Part of the stamen that produces pollen grains

Bee Colony: A social community of several thousand bees usually containing a queen and with or without drones

Cross-pollinated: Plants fertilised by pollen from other plants or varieties of the same species (also called 'self-sterile')

Fertilisation: Union of the male nucleus of a pollen grain with the female nucleus of the egg of an ovule

Forage: Food, i.e. for bees pollen and nectar

Foraging: Collection of pollen and nectar by bees

Hermaphrodite: Bisexual, i.e. a flower having both male (stamen) and female (pistil) parts

Insecticide: A substance that prevents, destroys, repels, or mitigates insects

Nectar: sweet, sugary liquid secreted by a special gland (the nectary) of a plant

Nectary: A nectar-secreting gland often associated with the petals of flowers (many plants have extra-floral nectaries)

Ovary: The part of a pistil that bears ovules

Ovule: Forerunner of the seed, present inside the ovary

Pest: Any organism that harms a crop

Pesticide: A poisonous chemical used to control or destroy pests or to prevent them from multiplying

Pistil: Female part of a flower, contains the stigma

Pollen: Granular mass (powdery substance) present in the anther of a flower

Pollinizer: A source plant for compatible pollen for a favoured (commercial) variety

Pollination: The transfer of pollen grains from an anther to a stigma of the same flower (self-pollination) or of a different flower (cross-polllination)

Pollinator: An agent that moves pollen from the anthers to the stigmas of flowers, thus enabling pollination

Self-compatible (self-fertile): A variety that can be fertilised and produce seed with pollen from flowers of the same plant or another plant of the same variety, mostly self-pollinated

Self-Pollinated: A plant in which a flower can be fertilised by its own pollen

Self-incompatible (self-sterile): A variety that requires compatible pollen from a different variety of the same species for fertilisation

Species: An interbreeding population which is reproductively isolated from other similar but morphologically distinguishable populations

Stamen: Male part of a flower, contains the anther

Stigma: The part of the pistil that receives pollen

Variety: Individuals of a species that differ in terms of size, form, colour, and/or other attributes; variety is the next classification below the species' level

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(abridged edition)

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4 Apple Farming and Pollination Issues in Himachal Pradesh, India

5 Apple Farming and Pollination Issues in Maoxian Valley, China

6 Apple Farming and Pollination Issues in Balochistan, Pakistan

7 Apple Farming and Pollination Issues in Thimphu and Paro Valleys, Bhutan

8 Apple Farming and Pollination Issues in Jumla Valley, Nepal

PART 3: ANNEXES

Annex 2: Questionnaire Used in the Field Surveys (English Version)

The complete edition is available from ICIMOD, ISBN 92 9115 605 1.