

Chapter 7

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

Apple Farming in Bhutan

Bhutan has three broad agro-climatic zones. The great Himalayan zone in the north is about 30 km wide and lies above 4000m; the central inner Himalayan zone is about 70 km wide and lies at 1000 to 4000m, it contains the major forests and apple orchards of the country, and the major inhabited areas; the southern sub-tropical zone, the Himalayan foothills, is about 50 km wide and lies at 160 to 2000m. Agriculture is the main occupation of over 85% of the population (RGOB 1996). The agricultural development strategy of Bhutan lays strong emphasis on achieving self-sufficiency in food grain production, on improving the nutritional level of the rural population, and on increasing per capita income. The main food crops include rice, wheat, maize, and potatoes. Cash crops include fresh vegetables like asparagus, chillies, potatoes, and cardamom. Bhutan's agricultural policy encourages planting apples and citrus on marginal slope land that is unsuitable for cultivation of food crops like rice and wheat. Valleys and more productive land should only be used for rice or wheat farming and there is a rule that states that paddy land cannot be used to plant apples.

Apple farming (along with other temperate fruit crops) was introduced into Bhutan from Himachal Pradesh, India in the early 1960s. In the following years it emerged as the highest income earner among the fruit crops and is now the main cash crop in the country. Apple cultivation has now spread all over Bhutan, with the majority of orchards in the Thimphu, Paro, Bumthang, Ha, and Tongsa valleys in the inner Himalayan zone. The climate of these valleys is moderate at lower elevations and suitable for horticulture. The area under apple cultivation increased dramatically (about nine-fold) in the 15 years from 1980 to 1995 (Ministry of Agriculture 1999) and the total area under apple cultivation in 1997 was about 2,100 ha, about 95% in the western region and 5% in the east-central region. The average annual production increased from 3,500 tonnes in 1984 to 13,600 tonnes in 1997 (Ministry of Agriculture 1999).

Since the 1980s, apples have become an important export crop. Most of the apples that are exported go to Bangladesh. Since the 1990s, efforts have been made to export apples to other countries, especially Thailand and Sri Lanka (Ministry of Agriculture 1999). In 1998 around 4,045 tonnes of apples were exported at a rate of US \$350 per tonne earning US \$1.4 million (Ministry of Agriculture 1999).

Apple Productivity

The average apple productivity in Bhutan is about 6.5 tonnes per ha. Over the past few years, however, apple exports have declined slowly and steadily, from 4,314 tonnes in 1996 to 4,045 tonnes in 1998. The price per tonne has also decreased from US \$ 475 per tonne in 1996 to US\$ 350 per tonne in 1998. This may have been partly the result of a drop in production and fruit quality.

Several factors are likely to be responsible for the low productivity and poor fruit quality of apples in Bhutan. These include insufficient pollination of apple flowers, the physiological conditions of the trees, and unbalanced applications of mineral nutrients.

In order to study the status and problems of apple farming, the survey selected 85 households in the Thimphu and Paro Valleys, the main apple-producing areas in the country. Details of the methodology are provided in Chapter 3 (Table 3.4).

Survey Findings

Changes in climate

The temperature in both valleys generally varies from -5 to 10°C in winter, from 0 to 15°C in spring, and from 10 to 30°C in summer. It usually snows two to three times between November and February. Approximately 40% of the farmers in Thimphu Valley and 20% in Paro Valley felt that the climate had been changing over the past few years. These farmers had noted an increase in temperature during winter and early spring leading to early flowering of apple trees followed by a sudden cold spell with frosts during late spring, which affected fruit set and accelerated fruit drop. Other changes observed included an increase in the frequency of hailstorms, damaging both flowers and fruit, and an increase in the incidence of various diseases and pests as a result of the warming.

Landholding size and land use

The size of landholdings of the farmers in the survey ranged from 0.4 to 8.1 ha in Thimphu Valley and from 1.2 to 14.2 ha in Paro Valley. The distribution is shown in Figure 7.1. In both Thimphu and Paro 65-70% of farmers had medium sized farms of 2 to 5 ha; only 3 of the farmers interviewed, all in Thimphu Valley, had marginal farms of less than 1 ha; 7 farmers in Thimphu and four in

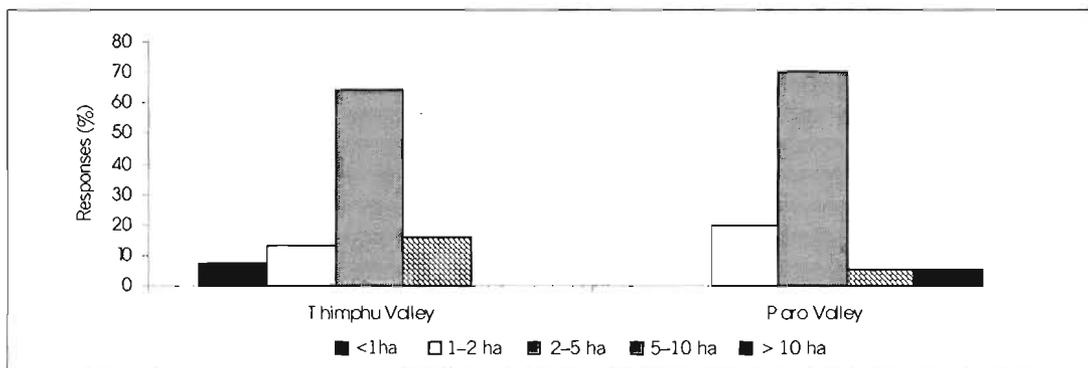


Figure 7.1: Landholding size (surveyed farmers)

Paro Valley had large farms of more than 5 ha. The largest farms were found in Paro Valley. The average landholding size per household in Thimphu Valley was 3.6 ha, of which 25% on average was used for staple food crops like rice and wheat, 14% for cash crops such as asparagus, potatoes, chillies, and fruit other than apples like pears, peaches, and plums (grown by a few farmers on a limited scale), and about 61% for apples. In Paro Valley, the average landholding was 3.5 ha per household, 46% of which was used for food crops, 14% for cash crops other than apples, and 40% for apples. Apples were thus the main cash crop in both valleys.

All the farmers in both valleys had apple trees, but whereas almost all the farmers in Paro Valley also grew cash crops and basic food crops, in Thimphu Valley less than half grew staple food crops and only two-thirds other cash crops (Table 7.1).

Apple farming in Thimphu and Paro Valleys

The scale of apple farming in Thimphu and Paro Valleys is shown in Table 7.2. In Paro Valley the great majority of farmers had between 100 and 300 trees or less, whereas in Thimphu half of the farmers had more than 300 trees and a third more than 500. The main commercial varieties were Royal Delicious, and Red Delicious, and occasionally Red Fuji, Golden Delicious and Jonathan were planted as pollinizers, but the proportion was only 7 to 10%. Apples were the main cash crop for 93% of the households surveyed in Thimphu Valley and for 98% of those in Paro Valley, and a supplementary source of income for the remainder.

Apple production and selling

The average total annual production of apples per household is shown in Table 7.3. Nearly two-thirds of the farmers in Paro Valley produced less than 10 tonnes per year, and nearly a quarter between 10 and 20 tonnes. In Thimphu Valley, where the average area of orchards per household was greater, only one-third of farmers produced less than 10 tonnes per year and nearly a quarter

Table 7.1: Crops grown in Thimphu and Paro Valleys (percentage of responses)

Crops	Thimphu Valley farmers	Paro Valley farmers
Apples	100	100
Cash crops other than apples	64	95
Staple food crops (maize, wheat, rice)	43	98

Table 7.2: Scale of apple farming in Thimphu and Paro Valleys (surveyed farmers)

	Thimphu Valley	Paro Valley
Average area of apple orchards per household, ha	2.2	1.4
Percentage of households with		
Less than 100 trees	11	25
100–300 trees	39	63
300–500 trees	16	5
500–1000 trees	27	0
>1000 trees	7	7
Commercial varieties	Royal Delicious and Red Delicious; a few farmers had planted Red Fuji	Royal Delicious and Red Delicious; a few farmers had planted Red Fuji
Pollinizer varieties	Golden Delicious and Jonathan	Golden Delicious and Jonathan
Pollinizer proportion (%)	7–10	7–10

Table 7.3: The production and sale of apples in Thimphu and Paro Valleys (surveyed farmers)

Parameter	Thimphu Valley	Paro Valley	Remarks
Percentage of farmers producing			
<10 tonnes	34	63	
10–20 tonnes	23	22	
20–30 tonnes	20	5	
30–50 tonnes	18	3	
50–100 tonnes	5	7	
range	4.75	4.65	
Apple market (% responses)			
Exported	95	56	
Sold locally	5	44	
Export destination (% responses)			
Bangladesh only	88	90	
India only	–	5	
Bangladesh and India	12	5	
Price (US\$ per kg)			
Export market	0.26 - 0.43	0.26 - 0.43	The local price was the same as the export price. Some big farmers sold rejected apples locally at a lower price.
Local market	0.26 - 0.43 (0.11 - 0.17 for rejected fruit)	0.26 - 0.43 (0.11 - 0.17 for rejected fruit)	Price depends upon the grade of apple
Home consumption			A few farmers kept some apples for home consumption
Is apple cultivation increasing? (% responses)	100	100	Because apples are the main source of cash income for farmers, the area under apple cultivation is increasing.

more than 30 tonnes. All farmers felt that total apple production was increasing as more and more land was taken for apple orchards.

Almost all the farmers in Thimphu Valley and a little more than half in Paro Valley exported their produce, the great majority to Bangladesh and a few to India or to both countries (Table 7.3). The remainder, mostly farmers with low production, sold their apples in local markets. The price obtained depended on the quality of fruit and was similar whether the fruit was sold locally or exported (Table 7.3). Some windfall and low-grade fruit, including fruit rejected for export, was sold locally at a very low price of about US \$ 0.06 - 0.17 equivalent per kg.

Farmers' understanding of apple pollination

Almost all farmers had a good understanding of apple pollination and its value. Most of the orchards had been planted in the 1980s or later with support from the extension services of the Ministry of Agriculture. Both commercial and pollinizer varieties of apple trees are provided to farmers through the extension system, and at the same time farmers are informed about the ecological and economic value of pollination in apple farming, and the importance of planting the appropriate proportion of pollinizer varieties in the orchard and where these should be located. Only two farmers in Paro Valley, who had planted their orchards in the 1970s, did not know about the importance of pollinizer proportion in their orchards, and these and one farmer in Thimphu had learned about pollination from neighbours rather than government sources.

About 60% of Bhutan is still forested and there is a great diversity and abundance of various insect pollinators. Moreover, since honey hunting is considered sinful, people do not hunt wild honeybee colonies for honey and there are still plenty of wild honeybee (*Apis laboriosa*) nests in these forests. Almost all farmers had seen different types of insect pollinators on apple flowers in their orchards including wild honeybee species, bumblebees, solitary bees, and flies.

Despite the prevalence of insects, only 6% of farmers in Thimphu Valley and 38% in Paro Valley felt that the existing populations of natural insect pollinators were sufficient to pollinate the increasing area under apple cultivation; 42% of farmers in both valleys thought the populations were not sufficient and the remainder had no opinion. As far as the farmers own orchards were concerned, only 11% of those in Thimphu Valley, and 56% in Paro Valley reported that their crop was being adequately pollinated (Figure 7.2). Three of the five satisfied farmers in Thimphu Valley were already keeping colonies of honeybees for apple pollination (one kept *Apis cerana* and two *Apis mellifera*), while most of the satisfied farmers in Paro Valley reported that their orchards were near forests and close to nests of the giant wild bee *Apis laboriosa*.

Close to half of the farmers in both valleys thought that the lack of pollinating insects was an important reason for the inadequate pollination, somewhat less than 20% (also) cited the lack of appropriate pollinizer proportion, and three farmers in Thimphu Valley and two in Paro Valley mentioned a lack of synchronisation of flowering between the commercial and pollinizer varieties (Figure 7.3).

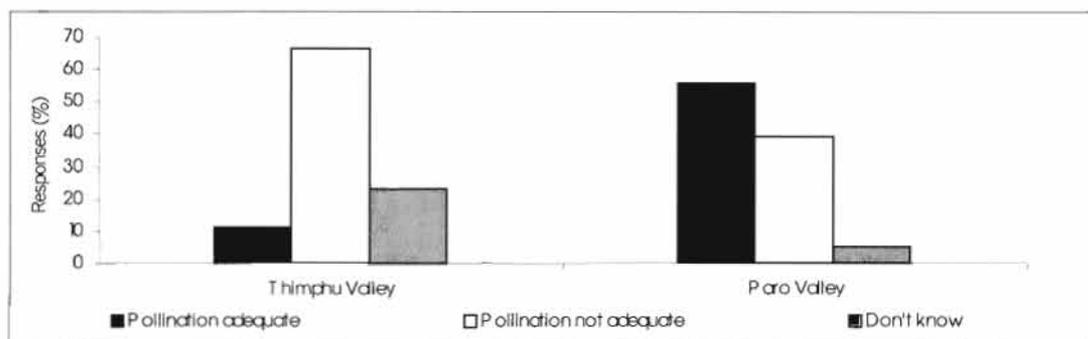
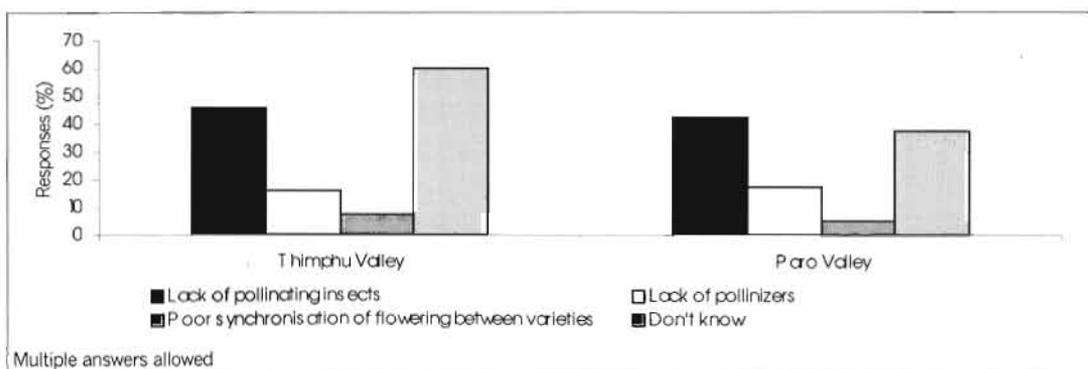


Figure 7.2: Pollination of farmers' own orchards



Multiple answers allowed

Figure 7.3: Reasons given for inadequate pollination of apples

Nearly a third of farmers in Thimphu Valley either kept bees already (4 farmers, 9% of the total) or would like to keep bees for pollination if they were provided with training and honeybee colonies (21%). Of the beekeepers, one had nine colonies of *Apis cerana* and the others had three, three, and six colonies of *Apis mellifera*. No farmers in Paro Valley kept bees, but 15% (6 farmers) said they would like to. There was only one commercial beekeeper in Thimphu Valley and no system for renting honeybees colonies for pollination.

Pesticide use and its impact on natural insect pollinators

All the farmers except one in Thimphu Valley used pesticides in their orchards. All used spray oils (TSO), and in addition a number used melathion, captan (only in Paro Valley), and other chemicals. These pesticides are available from government stores at highly subsidised prices. Some suggestions were made, however, that there were problems of procurement of pesticides by government research centres and that these should be looked into. Generally, government extension workers tell farmers which pesticide to use, when, and how much, but some farmers felt this information was insufficient. All the farmers sprayed 2-3 times in a season, once before flowering and one or two sprays of fungicides after fruit set, depending upon the pest infestation and expert advice. Farmers never sprayed during flowering. Thus pesticide use was much less than in Himachal Pradesh (India) or Maoxian County (China), and this could be another reason why the populations and diversity of natural insects were comparatively high in Bhutan (Table 7.4).

Although farmers were careful with spraying, they were not fully aware of the potential harmful effects. Almost all farmers in Paro Valley and more than half in Thimphu Valley (95% and 55%) thought that pesticides only kill harmful insects and that they do not kill bees and other natural insect pollinators.

Institutional support desired

All farmers reported that they were getting enough support and training on apple farming and most farmers said they would like the institutions to continue such support in the future. Less than half of those in Thimphu Valley and two-thirds in Paro Valley would have liked some financial support, without specifying for what, and a few farmers said they would require financial support if there was a bad crop or total crop failure (Table 7.5). Farmers also wanted agricultural institutions and scientists to study pollination problems and suggest ways of improving it. A small number

Table 7.4: Use of pesticides in apple orchards (surveyed farmers, percentage of responses)

	Thimphu Valley	Paro Valley
Use pesticides	98	100
Pesticides used*		
TSO	100	100
Melathion	16	41
Captan	-	22
Other pesticides	5	12
Number of sprays per season	2-3	2-3
	once before flowering and once or twice after fruit set	once before flowering and once or twice after fruit set
Sources of pesticides	Government stores	Government stores

*Individual farmers used more than one type of pesticide

Table 7.5: Institutional support desired (percentage of responses)

Type of support	Thimphu Valley	Paro Valley
Training in orchard management and the use of beekeeping for pollination	100	98
Financial support	39	73
Increasing awareness	100	98
Conduct proper studies on pollination and the advantages of beekeeping	52	24
Provide training on the use of beekeeping for pollination	5	9
Study causes of low yield and diseases and suggest solutions	68	0

*Some farmers wanted more than one type of support

wanted to have training on pollination management through beekeeping. In Thimphu Valley 68% wanted more information on diseases and pests and their control (Table 7.7).

Summary of Issues

The area under apple cultivation and the total production of apples in Bhutan are increasing, but the productivity (yield per hectare) is not. Farmers have started to realise that productivity could be increased with better orchard management and better pollination, and some are becoming interested in keeping honeybee colonies for apple pollination despite religious taboos. Most farmers in Thimphu Valley and a large number in Paro Valley thought that pollination of their apple trees was insufficient, but the level of concern varied. The low level of pollinizers is also likely to be a contributing factor to the poor pollination but as yet it has not become a subject of concern.

Many farmers still perceive little need to manage pollination. They are satisfied with their present income from apples, which is already more than from any other cash crop. Apples are only planted on marginal slope land unsuitable for cultivation of food crops like rice and wheat, so that any yield may seem to be a bonus. Total production is increasing as more orchards are planted, and this masks the fact that productivity is still quite low.

The pollination problems also appear to be less marked in Bhutan than in some of the other areas in the study. The country still has much natural forest and orchards planted close to these forests benefit from the presence of wild honeybees and other insect pollinators. This could change, however, if too large areas of forest are replaced with orchards. Another advantage is that pesticide use is limited and natural insect pollinators are less threatened by spraying in the orchards themselves.

How to promote beekeeping

Clearly there is still room for increasing apple productivity in Bhutan. Farmers should increase the number of pollinizer trees (or grafts) in their orchards. At the same time the use of honeybees to increase the number of pollinators in the orchards should be encouraged.

The first step in promoting the wider use of honeybees for apple pollination is to create awareness among farmers and institutions about the importance of honeybees in pollination. This can be done through proper research and on-farm demonstrations of the effect of honeybee pollination on apple yield and quality. The second step is to build the capacities of farmers and institutions, which can be achieved through training farmers and extension workers in managing honeybees for crop pollination.