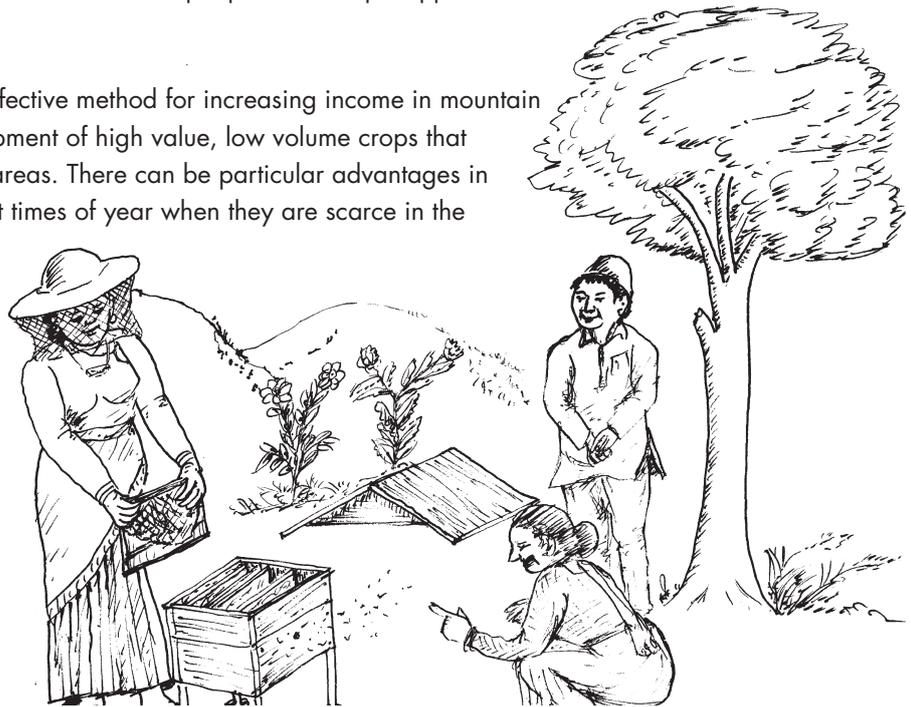


Income Generation through High-Value Cash Crops, Horticulture, and Beekeeping

Developing realistic opportunities for income generation is one of the most challenging tasks of development in mountain areas like those of the Hindu Kush-Himalayan region. People in mountain areas are faced with numerous physical and social constraints that restrict the development of large-scale cultivation of a single cash or food plant. On the other hand, mountain areas can offer special opportunities. The presence of diverse, rich, and complicated niche areas – areas which as a result of their specific terrain and climate are ideal for growing specific crops – provide mountain people with unique opportunities for developing some cash plants.

Cultivation of cash crops has proven a useful and effective method for increasing income in mountain areas. Mountain people should focus on the development of high value, low volume crops that can only be grown, or that grow best, in mountain areas. There can be particular advantages in seasonal crops, which grow well in the mountains at times of year when they are scarce in the adjacent plains areas. However, selection of the most appropriate cash crops for a specific area is not easy. There is little information available on cash crops that are specifically suitable for mountain areas; and it is difficult for people who are barely able to maintain their own existence to decide to invest in cash crops before the benefits have been demonstrated. Many of these crops take a number of years to come into production so that individual farmers are not in a position to run their own trials.



The activities at the ICIMOD site focus on testing and demonstrating a range of (mostly perennial) crops and comparing them in terms both of the suitability of the crop for the specific climate and soil conditions and the risks and potentials of the crop product; testing specific methods for the propagation of plant material; and testing the application of different technologies for improving yield. Plants and seeds have been obtained from ICIMOD's partners in different countries of the HKH. Material from successful trials is passed on to farmers upon request; where feasible, the actual crops are sold locally (providing another means to test the market). The major activities are summarised briefly below.

Beekeeping (Map Site 5.1)

Farmers benefit greatly from honeybees. They produce honey and other bee products which can be sold, consumed, or used as medicine, and they play an important role in pollination of crops and other plants, thereby enhancing farm productivity and conserving biodiversity. Beekeeping with the indigenous hive bee *Apis cerana* is an integral component of HKH mountain farming. *Apis cerana* is well adapted to the climatic conditions at higher altitudes: it can survive under low winter temperatures and extreme temperature fluctuations and continues to work on dull days. In recent times, however, the introduced species *Apis mellifera* has been promoted in the region for commercial honey production because of its higher honey yield, and lack of awareness of the other important roles that bees play. Populations of *Apis cerana* and other indigenous honeybees are declining in the region, leading to problems with pollination of early flowering crops and loss of native plant species. ICIMOD's Beekeeping Project is conducting a number of activities to promote sustainable management of *Apis cerana* and other indigenous honeybees. Various techniques are demonstrated at the Godavari site including *Apis cerana* selection and management and integration of pollination in farming systems. The bees are kept near to the plant nursery and a number of fruit orchards, thus supporting pollination on site.

Fruits, Nuts and Spices (Map Sites 5.2a-e)

A wide range of different fruit and nut trees and fruit vines have been planted at intervals since 1993, they include citrus trees, temperate fruit trees, sub-tropical fruit trees, nut trees, and other fruit and spice crops from trees, vines, and perennial plants. A few are described in the following.

Propagation and top-working of lapsi (*hogplum*) (Map Site 5.2b)

Lapsi (*Choerospondias axillaris*) is an important fruit-bearing tree in Nepal. The fruit has a high vitamin C content and is consumed fresh, pickled, or processed. The species is dioecious, that is the male and female flowers are borne on different plants, but it is difficult to recognise the female plants until they bear flowers or fruit, which usually takes years. Cultivation trials are in progress to explore the possibility of grafting and other vegetative methods of propagation of fruiting trees. Female plants have been successfully grafted onto rootstocks, which opens the way for large-scale orchard type cultivation.

Kiwi fruit (Map Site 5.2c)

Kiwi fruit (*Actinidia deliciosa*), or Chinese gooseberries as they used to be called, are deciduous trailing climbers. The vine can grow up to 9 metres (28 feet) long. The kiwi fruit itself is a brown, large egg-sized oval fruit covered with fuzz. When sliced, the fruit yields an attractive emerald green flesh with rows of small dark edible seeds and a light cream coloured centre. The flavour is reminiscent of a blend of strawberry and pineapple. The kiwi fruit is high in vitamins; it can also be used as a meat tenderiser. The fruit is picked while still hard and ripens off the vine. The economic yield can be as high as 40-60 kg per mature vine (five to eight years old), or 20-25 tonnes per hectare. This is a valuable niche crop for mountain areas, especially those close to urban and tourist markets.

Productive Trees (Map Sites 5.3a-c)

Multipurpose trees (Map Site 5.3a)

Multipurpose trees play an important role in mountain farming. Products from a tree can include leaves, fruits, seed, and wood bark, as well as firewood and timber, both for direct use and to increase income and employment. These trees are useful in an agroforestry system in pumping nutrients from the deep soil which are then available for crops. The ICIMOD plot is being used to screen and test popular indigenous multipurpose tree species and study important aspects like natural regeneration, growth, timing and techniques of harvesting, and utilisation and marketing of products that can be used to increase productivity.

Fodder trees (Map Site 5.3b)

Fodder trees play an important role in animal husbandry in mountain areas. Tree fodder provides a major part of the diet of cows and buffalo, especially during the long dry season when grass is scarce, and is thus very important for milk production. The ICIMOD plot is being used to screen and test popular indigenous fodder tree species and study important aspects like growth, harvesting (lopping, and pruning techniques), regimes (intensity, timings), coppicing capabilities, and silvicultural treatments that can be used to increase productivity.

Paulownia (Map Site 5.3c)

Paulownia is a medium tall large-leafed fast-growing deciduous tree from China. The trees are mainly grown for timber, but are also used for fodder, shade, crop protection, prevention of land degradation, as a fast-growing landscape tree, and for carbon sequestration. The trees withstand a wide range of temperatures but need reliable rainfall or irrigation in the growing season. Paulownia was planted at Godavari to determine whether it would grow in the Himalayan mid-hills, and the optimum conditions. It has proven highly successful, with almost 20m of growth in ten years from saplings, and is recommended for growing for soft timber.

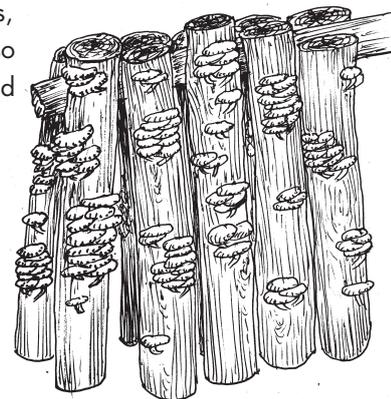
High Value Cash Crops (Map Sites 5.4 a-j)

Cultivation of medicinal and aromatic plants under agroforestry (Map Site 5.4a,b)

Medicinal and aromatic plants are not only conserved to maintain biodiversity and natural resources; indigenous and economically viable species are also cultivated within agroforestry systems (Map Site 5.4a). This can provide a source of income to community forest user groups and others, as well as enhancing the existing natural resources. ICIMOD is developing and demonstrating cultivation methods for a range of perennial medicinal and aromatic (spice) plants, whose leaves, fruits, or bark can be collected and sold. These include two large sites of the spice large (black) cardamom planted under (nitrogen-fixing) *Alnus* trees (Map Site 5.4b).

Shitake mushroom (Map Site 5.4c)

Shitake mushroom (*Lentinus edodes*), known as 'migra' in Nepal, is found in hill region forests growing on hardwood logs near streams. When young, it is umbrella-shaped; at maturity it has white spots on its surface. A mature mushroom weighs about 80-100 gm. Delicious and nutritious, it is a popular food in China, Bhutan, Myanmar, and Taiwan. There is a great potential for cultivating shitake in mountain areas of Nepal and other parts of the Himalayan region. The technology is demonstrated at Godavari as it can be a good income-generating crop for forest user groups, private entrepreneurs, and ordinary farmers. Usually, oak billets (logs) are used, but many other hardwood billets can also produce shitake (except pine species). Essentially logs are felled in autumn or winter and inoculated with *Lentinus edodes* mycelium by injection into small holes drilled at intervals along the log that are then sealed. The inoculated logs are stacked in criss-cross piles in the shade and left covered with straw or sacking for about 2 months. After rainfall, the pile is uncovered briefly to allow the bark to dry and prevent growth of other unwelcome fungi. After two months, the billets are restacked in a loose crib stack or a lean-to stack. The spawn run is nearly complete when fuzzy white blotches appear at the ends of the billet or mushrooms sprout after rainfall, about 10 months after inoculation. The mushrooms are harvested after the veil breaks while the caps still have curled edges and are less than 10 cm in diameter. During cool weather, the mushrooms can be left on the billets for many days. When it is warm, growers harvest early and often to minimise bug damage and discoloration from spore discharge. Shitake mushrooms flourish in 60% or higher shade outdoors (not darkness) where ventilation is good. Water is needed several times a year but not continuously (the bark should dry out between watering to avoid destructive surface moulds). Shitake yards should be in places that can be visited daily, not too remote from other activities. Fresh Shiitake will keep for 2-3 weeks in the refrigerator, but should be marketed within 4 to 5 days of picking. The mushroom contains a good blend of vitamins (A, C and D) and minerals. As little as five grams of shitake taken daily can dramatically reduce serum cholesterol and blood pressure; it also produces interleukin compounds which strengthen the immune response against cancer and virus infections.



Broom grass (Map Site 5.4d)

In Nepal and other countries in the HKH region, there is quite a large market for broom grass (*Thysanolaena maxima*), a special grass used for making brooms for sweeping. The grass thrives best on marginal lands. As well as providing cash income when sold as brooms, it provides green forage for livestock, the roots promote soil conservation, and the dried stems can be used as stakes to support growing vegetables.

True potato seed (Map Site 5.4e)

Potatoes are an important cash crop in mountain areas. Propagation has so far depended on the use of potato tubers as seed material, but these have the disadvantage of being bulky and perishable. Using true potato seed (TPS) is an alternative method of potato production developed by the International Potato Centre (CIP) in Lima, Peru. ICIMOD has been testing the TPS technology under the Godavari conditions in collaboration with CIP since 1995.

Seed production (Map Site 5.4f)

Production of seed for sale can be a valuable niche activity for mountain farmers as the product is low volume and can be stored for a long time until it can be taken to market. Seed production of indigenous species is also an activity supporting genetic resources conservation. Seed production is demonstrated at ICIMOD both as an example of an income generating activity and to produce seeds for distribution to farmers and farmers groups and projects – especially rehabilitation projects, government agencies, and partner organisations from ICIMOD's member countries.

Bamboo management (Map Site 5.4h)

Different species of bamboo are widely used for a variety of purposes by mountain people. They are used in construction and fencing; for basketry, mats, and furniture; as food and animal fodder; and for many minor products. Bamboo makes an important contribution to the socioeconomic development of mountain people. It is important to manage bamboo clumps well to ensure good development of culms in size and number. Without proper management, the clumps become underproductive and susceptible to fungi that can reduce their vigour and even destroy them. In the conventional harvesting method, the peripheral culms are removed, which later leads to congestion at the centre of the clump and leads to extraction problems. Farmers generally prefer to cut bamboo culms at ground level and not leave a stump. However, in reality it is better to cut a bamboo culm above a node or few internodes above ground level so that it will produce more new shoots. The bamboo culms need to be harvested at around

3-4 years of age; after 4 years, fewer shoots are produced and the quality of the bamboo slowly deteriorates. The bamboo management plot was established to demonstrate better ways of managing bamboo clumps to produce more shoots and higher quality bamboo. The management methods demonstrated at the centre (traditional vs tunnel method) were tested by research institutes in China and the Forest Research and Survey Center, Nepal.

Floriculture – landscaping with indigenous and exotic flowers (Map Sites 5.4i)

An increasing number of houses and public buildings are being built in the newly expanding urban areas of Nepal, opening up a new market for decorative flowers and garden plants, and a new possibility for income generation for farmers with access to these areas. The activities at the site focus on propagation of indigenous and exotic plants for use in landscaping and decorative gardens. The results are being used in practice in the landscaping of the new ICIMOD Headquarters building and the Godavari site.

Cultivation Support (Map Sites 5.5a-c)

Polythene film technology (PFT) (Map Site 5.5a)

Polythene (plastic) film technology (PFT) is a method for increasing production of field crops by covering the soil between the plants with a sheet of polythene film 0.003 to 0.014 mm thick. Covering the surface of the soil increases the temperature, helps retain moisture, promotes seed germination and emergence, accelerates the growth and development of the roots and the whole plant, and leads to improved quality and higher yields of crops. The method is demonstrated with appropriate crops on selected terraces within the site.

Polypit and hotbeds (Map Site 5.5b)

One of the problems that mountain farmers face is raising of forest or horticultural plants in nurseries and growing high value vegetables during the off-season, especially in regions with high annual variation in temperature and relatively severe winters. Low temperatures and frost delay germination and subsequent growth, and lead to high plant mortality, poor plant quality, lack of uniformity in plant size, and overall low plant productivity. These constraints can be overcome to a great extent using 'polypit' technology. A polypit is a rectangular pit, usually about 1 m deep, dug in the ground and covered with semi transparent polythene sheet, preferably UV stabilised, supported by a bamboo frame. A mud wall about 30 cm high is built on one side so that the cover slopes. The polythene sheet is sealed on the (higher) side, leaving three sides unsealed. These are normally held in place with stones, but can be lifted to access the pit. The base and sides of the pit are left rough without any plastering (even with mud). In general, the polythene cover is opened from 11 o'clock in the morning to 4 o'clock in the afternoon, except on rainy and very cold days. The size of the pit can vary according to availability of space and the kind of crops or plants to be raised. A hotbed can be constructed inside the pit using different layers of dry straw or biomass, animal manure, and good top soil. The bed generates heat slowly and can support plant growth in winter. The polypit technique has several advantages: 1) it is a simple, inexpensive, practical, and effective technique for raising plants and protecting them from severe winter temperatures; 2) CO₂ enrichment inside the polypit leads to a gain in plant biomass and growth; 3) plants raised inside a polypit are better acclimatised to the outside environment as the polythene cover is removed everyday; and 4) the frequency of irrigation is reduced.

Bio-pesticides and plant tonics (Map Site 5.5c)

Biopesticides are plant proteins with broad biocidal properties against insects, pests, and fungal and bacterial pathogens; they offer a good alternative to chemical pesticides in controlling crop diseases and pests. Application of chemical pesticides is increasingly associated with negative impacts to human health and the environment, whereas biopesticides are safer and environmentally friendly. Insect repellent plant species such as titopati (*Artemia vulgaris*), bojho (*Acorus calamus*) and neem (*Azadirachta indica*) can be used as a base. Around 30 kg of the insect repellent plant species is chopped into small pieces and mixed with 30 kg fresh cow dung and 100 litres fresh cow urine in a 200 litre plastic drum. Approximately 10 gm yeast and a little salt is added to speed fermentation. The mixture is stirred for five minutes every day for a week and then once a week for 4-5 weeks. It is then filtered through a plain cloth to give concentrated bio-pesticide solution. The concentrated solution is diluted 1:10 with water before applying to plants. The procedure used to prepare biopesticides can also be used to prepare a plant tonic (liquid fertiliser) by substituting an appropriate plant species. Any kind of grass that is not edible by livestock can be used (e.g. banmara or *Eupatorium adhenophorum*). The bio-pesticides and plant tonics should be used within six months of preparation.