1. INTRODUCTION

India produces all deciduous fruits including pome fruits (apple and pear) and stone fruits (peach, plum, apricot and cherry) in considerable quantity. These are mainly grown in the North-Western Indian States of Jammu and Kashmir (J&K), Himachal Pradesh (H.P.) and in Uttar Pradesh (U.P.) hills. The North-Eastern Hills region, comprising of the States of Arunachal Pradesh, Nagaland, Meghalaya, Manipur and Sikkim also grows some of the deciduous fruits on a limited scale. Due to introduction and adaptation of low chilling cultivars of crops like peach, plum and pear, they are also now being grown commercially in certain areas of the north Indian plains. Out of all the deciduous fruits, apple is the most important in terms of production and extent.

Apple was introduced into the country by the British in the Kullu Valley of the Himalayan State of H.P. as far back as 1865, while the colored ‘Delicious’ cultivars of apple were introduced to Shimla hills of the same State in 1917. The apple cultivar ‘Ambri’, is considered to be indigenous to Kashmir and had been grown long before Western introductions. Pears and other deciduous fruits were domesticated successfully in the early part of the 20th century, although some of them were reported to occur under semi-wild conditions much earlier. Apricot was found growing in the drier pockets of north-western Himalayas and two apricot varieties, locally known as ‘Halman’ and ‘Rakchaikarpoo’ are reported to be indigenous to Leh-Ladakh areas of J&K State.

Sweet cherry was introduced from Europe before India’s independence in 1947, while commercial cultivars of sour cherry have been brought mainly from USA in more recent years. The European and Japanese plum varieties are grown both in high and low hill areas. A plum variety ‘Santa Rosa’ reported to be a hybrid between Japanese and American species predominates (70-80%) plantations in the hills. Low chilling cultivars of peach and nectarine such as Flordasum, Flordared, and Sunred nectarine are successful introductions to the north-Indian plains. Some local selections of peach (Shan-e-Punjab, Sharbati), plum (Jamuni, Alubhokhara) and sand pear (Patharnakh) are also cultivated on a commercial scale in sub-tropical - marginal chilling areas of north India.

2. PRESENT SITUATION OF DECIDUOUS FRUIT CROP CULTIVATION

2.1 Crops Grown


2.2 Cultivars

*Deputy Director General (Horticulture), Indian Council of Agricultural Research, New Delhi, India.*
The promising cultivars of different temperate fruits in 3 major deciduous fruit growing States of India are shown in Table 1. Some relevant information on cultivars and cultivar selection is indicated below:

**Apple:** Over 700 accessions of apple, introduced from USA, Russia, U.K., Canada, Germany, Israel, Netherlands, Australia, Switzerland, Italy and Denmark have been tried and tested during the last 50 years. The delicious group of cultivars predominates the apple market. The areas covered under Delicious cultivars are: 83% of the area under apple in H.P., 45% in J&K and 30% in U.P. hills. In more recent times improved spur types and standard color mutants with 20-50% higher yield potential are favored. The important selections are:

- Spur types – Red spur, Starkrimsion, Golden spur, Red Chief and Oregon spur.
- Color mutants – Vance Delicious, Top Red, Skyline Supreme.
- Low chilling cultivars – Michal, Schlomit.
- Early cultivars – Benoni, Irish Peach, Early Shanburry, Fanny
- Juice making cultivars – Lord Lambourne, Granny Smith, Allington Pippin.
- Scab resistant cultivars – Co-Op-12, Florina, Firdous, Shirean.
- New Hybrids – Lal Ambri (Red Delicious X Ambri), Suncheri (Ambri X Golden Delicious), Amred (Red Delicious X Ambri), Chaubatia Anupam & Chaubatia Princess (Early Shanberry X Red Delicious) developed in India.

In H.P. monoculture of a few cultivars such as Royal Delicious, Red Delicious and Richared have started showing negative impact on the apple industry. Serious problems of apple scab disease and outbreak of premature leaf fall and infestation of red spider mite are causing great concern. U.P. Hills, particularly the Kumaon hills division, have the unique advantage of early harvest of apple, mainly due to cultivation of early maturing varieties like Early Shanburry, Fanny and Benoni. The early maturing varieties are harvested 2-3 weeks before the arrival of fresh apple from H.P. and J&K, and hence fetch very remunerative prices.

**Pear:** In pear for higher altitude conditions high chilling requirement varieties (like Bartlett) are mainly grown. In more recent years, red-color strains of pear like Max Red Bartlett, Red Bartlett and Starking are replacing yellow colored cultivars. In warmer sub-mountainous areas of H.P. and sub-tropical Punjab oriental pear cultivars like Baghugosha, Kieffer, China and sand pear Patharnakh are cultivated commercially both for table and processing purpose.

**Apricot:** Generally there are two types of apricot, namely, sweet kernel type and bitter kernel type. About 81 exotic accessions and 19 indigenous cultivars were collected and evaluated. The local types Halman and Rakhaikarlo have been popular, whereas exotic introductions namely, Nari, Kaisha, Shakarpa and New Castle are promising. These cultivars are recommended for dry cold areas. The USA variety Nugget is self-fruitful and bears sweet and attractive colored fruits.

**Peach:** For colder conditions the peach cultivars July Elberta, Elberta, Peshwari, Quetta, Burbank and Stark Earliglo are well adopted. Low-chilling cultivars viz. Flordasum, Flordared, Shan-e-Punjab, Sharbati and Sunred (nectarine) have become popular in subtropical belts of U.P. and Punjab States.
**Plum:** A large number of cultivars (283) have been introduced into the country. European plums performed better in the hills, while Japanese plums are more adopted in sub-mountainous lower elevations. Leading cultivar in the hills is Santa Rosa. In the north-Indian plains small fruited cultivars like Titron, Kala Amritsari, Kelsey, and Alubukhara showed better performance. A good number of low-chilling Florida hybrids (Fla-1-2, Fla 73-4, Fla 85-2, 85-3, Fla 86-4) Sungold, Redgold etc, are under evaluation.

**Cherry:** Many cultivars of sweet cherry have been introduced from Europe, USSR and British Columbia. Promising exotic cultivars like Bigarrean Napoleon, Black Heart, Guigne Noir for J&K and cultivars like Black Tartarian Bing, Napoleon (white) Sam, Sue (White), Shella for H.P. have been identified. For warmer climate, cultivars like Summit, Sunburst, Lapins, Compacat and Stella have been found to be promising.

**Table 1.  Promising Cultivars of Pome and Stone Fruits in Major Production Regions of India**

<table>
<thead>
<tr>
<th>Fruits</th>
<th>J&amp;K</th>
<th>H.P.</th>
<th>U.P.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apricot</td>
<td>Charmagz, Halman, Rachkaikarpo, Nari, Shakarpara</td>
<td>Kaisha, Nugget, Castle, Saffeida, Charmagz</td>
<td>Sharmagz Kaisha, Moorpark, Turkey, St. Ambrose</td>
</tr>
<tr>
<td>Plum</td>
<td>Satsuma, Santa Rosa, Burbank, Grand Duke, Titron</td>
<td>Kelsey, Santa Rosa, Titron, Satsuma, Mariposa</td>
<td>Jamuni, Kelsey, Santa Rosa, Titron</td>
</tr>
<tr>
<td>Peach</td>
<td>July Elberta, Elberta, Quetta, Flordasun, Shan-e-Punjab, Sharbati</td>
<td>Alton, July Elberta, JH Hale, Sharbati, Shan-e-Punjab, Burbank</td>
<td>Sharbati Safeida, Flordasun, Shan-e-Punjab</td>
</tr>
<tr>
<td>Sweet Cherry</td>
<td>Bigarreau Napoleon, Black heart</td>
<td>Black Tartarian, Napoleon, Sue Sam, Lambert Bing</td>
<td>Bedford Prolific, Black Heart, Governor’s Wood</td>
</tr>
</tbody>
</table>
2.3 Rootstocks

- Apple has been propagated mainly on seedling stocks of apple (*Malus pumila Mill*). Clonal rootstocks of M and MM series were introduced from East Malling Research Station of U.K. and M-9, M-26, M-4, M-7, MM-106 and MM-111 were identified as promising. Merton 779 was recommended as a commercial rootstock for apple for Kumaon hills of U.P. However, clonal rootstocks have not found favour among the apple growers. *In-vitro* protocols of M-9, MM-106 and MM-111 have been developed. Clonal rootstocks have been preferred only for high density orchards. Four rootstocks, namely, EMLA-111 for drought prone areas, EMLA-7 for slopy land and EMLA-106 for slopy and less clayey soil and EMLA-9 for high density planting on irrigated deep soils have been recommended. In pears, seedling stocks of *Pyrus pashia* (Kainth) is commercially used. Clonal rootstock Quince A with semi-vigorous growth has some promise. Newer clonal rootstocks like Old Home X Farmingdale series and BA 29C are under evaluation.

- For apricot, seedlings of wild apricot have been found to be good giving a smooth union and vigorous scion growth. Peach can also be tried as a rootstock, particularly for dry and light soils. Myrobalan plum is recommended for high moisture soil conditions.

- Peach is normally grafted on wild peach seedlings, plum (cv. Kabul Greengage) and even on apricot. Wild peach produced healthy and high-yielding plants. For controlling tree size, apricot rootstocks which impart dwarfing may be used.

- For plum, wild peach and wild apricot are commonly used as rootstocks. Among clonal rootstocks, Myrobalan B. was found to be most promising. Wild apricot seedlings and wild peach were also found to be suitable rootstocks for commercial cultivars like Santa Rosa, Mariposa and Beauty.

- Commercial plantations of sweet cherry were raised mainly on Mazzard and Mahaleb rootstocks. Seedlings are raised from late maturing cherry cultivars and stones of Waterloo or Misri cultivars are often used as rootstocks. Rooting of cherry suckers has been made possible with use of rooting hormones like IBA (6000 ppm) in combination with NAA (2000 ppm).

2.4 Area and Production

Deciduous fruits are mainly cultivated in North West Hills Region of India, comprising of States of Jammu & Kashmir (J&K), Himachal Pradesh (H.P.) and Uttar Pradesh (U.P.) and in the North Eastern Hills Region in the States of Arunachal Pradesh, Nagaland, Meghalaya and Manipur. Available data on area and production of apple and pear are shown in Table 2.
Table 2. Area, Production and Yield of Apple and Pear in India

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area (ha)</td>
<td>Production (MT)</td>
</tr>
<tr>
<td>Arunachal Pradesh</td>
<td>5523</td>
<td>9730</td>
</tr>
<tr>
<td>Himachal Pradesh</td>
<td>78296</td>
<td>276681</td>
</tr>
<tr>
<td>Jammu and Kashmir</td>
<td>78007</td>
<td>714834</td>
</tr>
<tr>
<td>Nagaland</td>
<td>64</td>
<td>109</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>55200</td>
<td>210000</td>
</tr>
<tr>
<td>Total</td>
<td>217099</td>
<td>1211379</td>
</tr>
</tbody>
</table>

2.4.1 Apple

Although there has been 5-6 fold increase in apple production during the last 50 years, the productivity level is still very low (5.56 t/ha). Apple cultivation received greater attention by the growers. In H.P, area under apple increased from 3026 ha in 1960-61 to 78296 ha in 1995-96 with a corresponding increase in yield. J&K covers about 78007 ha under apple with a production of 714834 tons. In the U.P. hills (8 districts) apple occupies about 30 per cent of the area under fruits and contributes 46.9 percent of fruit production. The area covered under apple in U.P. hills is 55200 ha with production of 210000 tons of fruits. In the North-Eastern Hills Region, good quality apple is produced only in the rain-shadow belts of Arunachal Pradesh (5523 ha), and in Nagaland a very small area (64 ha) has been brought under apple cultivation.

About 99 percent of India's apple area falls under the North Western Hills region, covering 6 districts of J&K (Srinagar, Budgam, Pulwama, Anantanag, Baramullah, Kupwara), 6 districts of H.P. (Shimla, Kullu, Sirmour, Mandi, Chamba, Kinnaur) and 8 districts of U.P. (Almora, Nainital, Pithauragarh, Tehri, Pauri, Chamoli, Uttarkashi, Dehradun). In the North-eastern Hills region, good quality apple is grown in a small area in Tawang belt of Kameng district in Arunachal Pradesh. The Tawang area is basically a rainshadow belt and therefore, permits a longer period of sunshine and freedom from heavy rains, making it ideal for apple. Apple is also grown in Sikkim and Nagaland but the production is not a major success. Presently, a small quantity of apple produced in India is exported, mainly to Bangladesh and Sri Lanka.

2.4.2 Pear

Pear is grown under a wide variety of climatic regimes, ranging from cold dry temperate hilly conditions to warm humid subtropical conditions on the plains of northern India. Its cultivation is most extensive in J&K State (14012 ha), followed by U.P. (10550 ha). In the plains of Punjab, pear is grown in a specific area (7899 ha), whereas in H.P, it is widespread from the foothills to the highlands (600-2700 m) in areas experiencing 500-1500 chilling hours. Area, production and yield of apple and pear are shown in Table 2.
2.4.3 Others

There is no reliable data on area and production of other deciduous fruit crops. Stone fruits as a group occupy an area of 0.11 million ha, with 0.14 million tons production. In H.P about 28 thousand ha are covered under peach, plum, apricot, almond and cherry. In the North-western Himalayan region, peach holds greater promise because of its utilization for canning purposes. Peach is grown mainly in low and mid hilly areas (1000-2000 m above msl), except the low chilling cultivars belonging to the Florida group, which can be grown very well under sub-tropical conditions.

European plums require more chilling than Japanese plum. Japanese plums are generally grown in low and mid-hilly areas (1000-6000 m) conditions. The climatic requirement of apricot is almost the same as that of plum, while cherries require a colder climate (1000 chilling hours below 7º C). Cherry is commercially cultivated in J&K where the hailstorm problem is not encountered.

In the North-Eastern Hills (NEH) Region, these crops can be successfully grown in Arunachal Pradesh (Kameng, Siang, Tirap and Lohit districts), Meghalaya (Central plateau of Khasi & Jaintia hills), Manipur (Maram, Tadubi, Mou, Ukhrul) and Nagaland (Mokokchung, Wokhla, Thensang, Kohima, Phek districts). The productivity of all the stone fruits is low and estimated yield of peach is 0.50, 0.73, 2.11 and 2.23 t/ha in H.P, J&K, U.P, and NEH Regions respectively. The productivity of cherry in J&K is approximately 1.73 t/ha, while average yield of apricot is 0.42, 0.20 and 0.28 t/ha in H.P, J&K and U.P. hills respectively.

3. PRODUCTION OF PLANTING MATERIAL

3.1 Nurseries

There is a large number of government and private nurseries engaged in multiplication of planting material of deciduous fruit crops. In addition, the State Agricultural Universities and the Research Institutions multiply planting material of improved cultivars for sale and distribution to the farming communities. The Government of India had supported establishment of a large number of fruit nurseries, both in public and private sectors as planned activities. During the 8th Five Year Plan (1992-97) it is estimated that over 55 million nursery plants of different perennial crops, including temperate fruits, have been produced and distributed under the scheme. There was a target for the establishment of 85 big nurseries, 587 small nurseries, and 37 tissue culture units (20 by the private sector and 17 by the Government) of different fruit crops. Exact number of these nurseries engaged in production of pome and stone fruits is not known. However, the existing nurseries (more than 600), covering both public and private Institutions, are sufficient to meet the requirement of planting material of deciduous fruit crops.
3.2 Propagation and Rootstock Information

In all the pome and stone fruits vegetative propagation techniques of budding or grafting are followed for multiplication of planting material on standard rootstocks, raised both from seeds or through clonal methods. Cropwise details are as follows:

3.2.1 Apple

For raising rootstock seedlings, seeds of crab apple or commercial cultivars are stratified during December for 2-3 months at 2-5°C. One year old seedlings are used for budding/grafting.

Clonal rootstocks are raised through mound or stool layering. The mother plants are allowed to grow for one season and cut back to 3 cm from the ground level just before the growth begins. When new growth is about 10 cm, the shoots are covered with soil leaving the growing parts exposed. Rooted layers are cut off close to the ground level and planted in nursery beds for grafting/budding.

In H.P. hills, different types of budding/grafting are recommended:
- Chip budding in mid-June and mid-September
- Whip and Tongue and cleft grafting in February - March
- T-budding in May-June

3.2.2 Pear

Seedlings of Kainth (Pyrus pashia Linn.) or Shiara (P. serotiana Rehd) are stratified in moist sand for 35-45 days at 2-5°C. Tongue grafting in February-March or T-budding during June-July is recommended.

3.2.3 Others

Plum and apricot are generally grafted on wild apricot seedling rootstocks. Peach is also used as a rootstock.

Peach is budded/grafted on wild peach and peach-almond hybrid rootstocks. Hard wood cuttings (treated with 500 ppm IBA) can also be employed for raising rootstocks.

For apricot, peach, plum and cherry shield budding during July-August has been recommended for the hills of J&K.

Micro-propagation through tissue culture technique has not yet been commercialized for temperate fruits, although tissue culture protocols have been developed at research Institutes/Universities. Colt, a rootstock for cherry can be multiplied in large numbers by following the tissue culture technique. Shoot buds are cultured in MS medium containing 1-2 mg/liter benylaminopurine. Individual shoots are rooted on MS medium containing 1 mg/liter Indole Butyric Acid (IBA). The rooted plants are transferred to sterilized sand + soil (1:1) mixture and covered for 7-10 days for hardening.
4. ESTABLISHMENT OF ORCHARDS

4.1. Land Preparation and Planting

Fertile sandy-loam to clay loam soils with pH range from 5.5 to 7.5 and free from water logging conditions are suitable for establishing deciduous fruit orchards.

In flat lands/valleys, square, rectangular or triangular planting may be adopted. In hill slopes, planting on contours or terraces is recommended. In shallow slopy lands, small terraces (half-moon terrace), may be made to establish the plants and large scale disturbance of surface soil need to be avoided.

Planting of deciduous fruit plants is done during winter months from the end of December to mid March. Planting is done in the center of pits (1x1x1m cube or circle), prepared a month before planting. While refilling the pit, 50g of aldrin powder (15%) is mixed with the soil.

After planting, the young plants are supported with stakes and basins are kept free of weeds. Mulching with dry grass or polyethylene is advisable. Irrigation is provided after planting.

4.2 Spacing

Spacing varies from species to species and depends also on the type of rootstocks used. For apple raised on seedlings of crab or other commercial varieties of apple, a planting distance of 6x 6m or 7x7m accommodating 277-205 plants per ha is recommended for J&K hills. On clonal rootstocks like M4, M7, M26, MM106 a spacing of 4.5m x 4.5m (555 plants/ha) is suggested.

For spur type varieties and standard colored mutants of apple, high density planting on dwarfing rootstocks like M9, M4, M7 and MM107 has been found to be feasible. Fruit yield of 30-35 tons/ha has been achieved in 12 year old orchards of color mutants of apple on MM106 under a planting density of 2222 plants/ha (3m x 1.5m) in cooler hills of H.P. Spacings recommended for apple are shown in Table 3.

Table 3. Optimum Plant Spacing for Spur Types and Standard Color Mutants of Apple

<table>
<thead>
<tr>
<th>Type</th>
<th>Rootstock</th>
<th>Spacing (m x m)</th>
<th>No. of trees/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spur Type</td>
<td>Seedling (Crab)</td>
<td>5x5</td>
<td>400</td>
</tr>
<tr>
<td>Spur Type</td>
<td>MM111, MM109</td>
<td>4x4</td>
<td>625</td>
</tr>
<tr>
<td>Standard Type</td>
<td>MM106, MM109</td>
<td>5x5</td>
<td>400</td>
</tr>
<tr>
<td>Spur Type</td>
<td>MM106, M7</td>
<td>3x3</td>
<td>1111</td>
</tr>
<tr>
<td>Standard Type</td>
<td>M9</td>
<td>2x2</td>
<td>2500</td>
</tr>
</tbody>
</table>


In pear, for trees on seedling rootstock under normal conditions, spacing of 5x5m is recommended, but on clonal rootstocks (Quince A) spacing can be reduced to 3x3m.
In peach, a spacing of 4.5 to 5m and for plum, apricot and cherry a spacing of 6m are followed.

5. CARE AND MANAGEMENT OF ORCHARDS

5.1 Training and Pruning

Modified central leader system of training has been recommended for both apple and pear on seedling rootstocks. The proportional heading back and thinning out system of pruning is adopted after the juvenile phase of plant growth. Spur pruning encourages vegetative growth and helps in new spur development in old plantations. For high density planting on semi-dwarfing and dwarfing rootstocks spindle bush, dwarf pyramids and cordon system of training are suggested. Spindle bush on M7 and modified central leader on MM106 rootstocks are successful.

Peach is generally trained to open center system, while in sweet cherry modified central leader system is followed. Pruning is done in such a way so that 20-50 cm new growth in young trees and 25-30 cm in older trees are secured every year. In sweet cherry about 10% of fruit bearing area should be removed annually, whereas in apricot slightly heavier pruning should be practiced to keep the spur system renewed.

5.2 Manures and Fertilizers

Nutrient requirement varies from place to place. In Himachal Pradesh widespread deficiencies of N, P, K, Ca, Mn, Zn and B have been recorded. A fertilizer dose of 700:350:700 g of N, P and K for full grown bearing apple tree has been recommended. It has been observed that VAM (Vesicular arbuscular mycorrhiza) fungi increases P uptake by apple roots. The following corrective measures for nutrient deficiencies have been suggested for apple (Table 4).

<table>
<thead>
<tr>
<th>Elements</th>
<th>Chemical &amp; Dose</th>
<th>Time of Spray</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Urea, 5.0%</td>
<td>Pre-petal fall</td>
</tr>
<tr>
<td>Ca</td>
<td>Ca Cl₂, 0.5%</td>
<td>30-45 days before harvest</td>
</tr>
<tr>
<td>Zn</td>
<td>ZnSO₄, 0.5%</td>
<td>After petal fall</td>
</tr>
<tr>
<td>Mn</td>
<td>Mn SO₄, 0.4%</td>
<td>After petal fall</td>
</tr>
<tr>
<td>B</td>
<td>H₃ BO₃, 0.1%</td>
<td>Before bloom and after bloom</td>
</tr>
</tbody>
</table>

In peach cv. Sharbati, 17.5 g N/tree/year and in apricot 70-100 g N/tree/year have been found to be optimum. For peach, N has been the main limiting element in H.P, while for plum, maximum fruit yield was recorded when leaf N, P and K contents were 2.89, 0.28 and 0.89 respectively.

5.3 Weeding and Mulching

In apple orchards, grass mulching (10cm thick) with one application of post-emergence herbicide Glyphosate (0.8 kg/ha) was found to be effective. The shrubby weeds were, however, best controlled by 500 ppm Gramaxone + 100 ppm 2,4,5 - T application.
Moisture conservation was maximum under grass mulching and, therefore, recommended for apple in H.P. Mulching with oak leaf was effective in U.P.

5.4 Supplementary Irrigation

Trickle irrigation at 75 per cent of field capacity results in better tree growth and higher fruit yield in apple when raised on semi-dwarfing rootstocks.

For apple, most critical period of water requirement is April to August and peak water requirement is just after fruit set. 114 cm of water during whole year through 19 irrigations have been recommended.

Drip irrigation saves water considerably. Field trials indicated a total irrigation requirement of 3840 liters water per tree under conventional system of irrigation; under drip system 1695 liters of water was enough. The application efficiency under drip system is about 2.27.

In Santa Rosa plum, irrigation at 50% field capacity gave better growth and economic returns.

5.5 Pest and Disease Control

5.5.1 Pests

In apple and pear about a dozen pests are causing serious damage to the crops. Most important ones are: San Jose Scale, Woolly apple aphid, Root borer, Blossom thrips, Codling moth and European red mite. San Jose Scale can be effectively controlled with eco-friendly miscible spray oils at 2% concentration when applied during February-March. Woolly aphids can be controlled through soil application of Phorate or Carbofuran granules during May and October/November. For codling moth, pheromone trapping was found to be effective, and certain bio-control agents have also been identified in apple orchards for controlling certain insect pests.

European red mite is becoming a very serious pest for apple in H.P. and J&K. The pest attack causes premature leaf fall. Late dormant sprays of miscible oil provide effective control of eggs. The mite can also be controlled by sprays of Dicotol (0.05%) followed by Malathion (0.05%).

In peach, leaf curl aphid can be controlled by pre-bloom sprays (at pink bud stage) of Dimethoate (0.03%) or Monocrotophos (0.04%).

Fruit fly in peach, apricot and plum can be controlled through foliar spray of baits consisting of Malathion (0.1%) + 1% sugar.

Stem and shoot borers causing damage to peach, plum, apricot, almond and cherry can be controlled by inserting 0.5g of PDCB (paradichlorobenzene) into the holes and plugging them with mud.
5.5.2 Diseases

Apple scab caused by *Venturia inaequalis* is a serious disease causing maximum economic loss. A sound forecasting and early warning system has been developed for prediction of scab attack. Also, a judicious fungicide spray schedule has been devised. Under high disease pressure, systematic fungicides performed better, while under low disease pressure Ergosterol biosynthesis inhibiting (EBI) fungicides were as good as protectants. Ascosporic inoculum produced by over-wintered apple leaves could be substantially reduced by giving post-harvest applications of Bavistin (0.1%) and EBI chemicals Penconazole (0.5%) and Flusilazole (0.01%) as preharvest fungicidal sprays control scab during storage.

Powdery mildew disease can be kept under check by pruning and spraying wettable sulphur (0.2-0.3%) or Karathane (0.05%) during dormancy, bud swell and petal fall stages.

Collar rot and white root rot diseases in apple occur mainly in poorly drained soils. Proper drainage of orchards and soil drenching with 0.1% Carbendazim for white root rot and with 0.3% Mancozeb or 0.3% Ridomil MZ for collar rot are effective.

Virus and virus-like diseases such as mosaic, chlorotic leaf spot, rubbery wood and others have been reported. Virus cleaning through tissue culture and supply of virus free bud wood material are being pursued to contain further spread of the viral diseases in apple.

6. INTERCROPPING

As apple is grown in hill slopes, seasonal intercropping accompanied by working the soil is not encouraged in order to prevent soil erosion. Where slope of the land is more than 10 per cent, various grasses and legumes are grown as permanent covers. The tree basins are kept clean and sod culture in the orchards is practiced in the hills of H.P. The grasses are regularly cut when 7-10 cm high and the residue is left in the orchards for decomposition. The cultivation of legumes and grasses as intercrop is becoming popular in orchards. The important legumes are red clover (*Trifolium pratense*), white clover (*T. repens*) and lucern (*Medicago sativa*). Among the grasses, orchard grass (*Dactylis glomerata*), fescues (*Festuca arundiceae*) and Timothy (*Phleum pratense*) are common. Orchard grass is grown where moisture is high, while fescues is suitable for dry areas or southern aspects. In apple, sometimes filler trees of peaches or dwarf apple plants are grown.

At the young age of orchard plantations, vegetables like cole crops, potato and tomato are grown to supplement the income. However, this practice is abandoned when the orchard starts bearing after 5-7 years to avoid competition. In Shimla hills and Kullu Valley areas of H.P. cultivation of gladioli for flower and bulb production as intercrop is carried out in the apple orchards since it can tolerate shading.
7. HARVESTING AND YIELD

7.1 Harvesting

7.1.1 Apple

_Maturity Standards_

In apple, the number of days taken from full bloom to harvest are 132-134 days for Starking Delicious, 138-140 days for Red Delicious and 147-148 days for Golden Delicious varieties in the high hills (above 2000 m) of H.P. In J&K State, the variety Maharaji requires 160 ± 3 days after full bloom for proper harvest maturity. Apple cultivar Granny Smith takes 180 ± 5 days for maturity. The maturity standards for different cultivars of apple are given in Table 5.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Days from full bloom</th>
<th>Firmness (kg)</th>
<th>TSS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Royal Delicious</td>
<td>125 ± 5</td>
<td>8.2 ± 0.40</td>
<td>13.0 - 15.0</td>
</tr>
<tr>
<td>Red Gold</td>
<td>122 ± 3</td>
<td>8.3 ± 0.20</td>
<td>12.0 - 13.5</td>
</tr>
<tr>
<td>Red Delicious</td>
<td>134 ± 5</td>
<td>8.4 ± 0.40</td>
<td>10.0 - 14.0</td>
</tr>
<tr>
<td>McIntosh</td>
<td>135 ± 4</td>
<td>6.8 ± 0.25</td>
<td>11.5 - 13.5</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>148 ± 6</td>
<td>8.4 ± 0.40</td>
<td>12.0 - 14.5</td>
</tr>
<tr>
<td>Granny Smith</td>
<td>180 ± 5</td>
<td>8.7 ± 0.30</td>
<td>11.5 - 13.0</td>
</tr>
</tbody>
</table>

_Fruit Drop Control_

Pre-harvest fruit drop in apple could be effectively checked with the application of 10 ppm NAA 20-25 days before harvest. Pre-harvest fruit drop is quite serious in early ripening cultivars like Tydeman’s Early, Red Gold and Pippins, where loss of 40-60% crop load is often experienced. Mid-season Delicious group cultivars also experience 15-20% loss.

_Color Development and Enhancement of Ripening_

In apple, fruit color development in warmer and lower (below 1800 m) elevations is generally poor. Application of Ethephon (2-chloroethyl phosphonic acid) about 10 days before harvest improves red coloration. Induction of early maturity by 7-10 days in mid hills situations could be achieved through an application of 500 ppm of ethephon + 10 ppm of NAA 3 weeks before harvesting. In H.P, two pre-harvest sprays of 0.5% CaCl₂, followed by a 0.03% surfactant like Tween 20 for 1-2 minutes have been recommended for better shelf life of apple.

_Fruit Thinning_

In apple, for obtaining better grade fruits of optimum size a post-bloom spray of 100-200 ppm ethephon 2-3 weeks after full bloom has been recommended both in H.P. and J&K.
7.1.2 Pear

Harvesting time of pear is determined by slight change in fruit color and easy separation of fruits. Fruits should not be allowed to ripen to soft condition on the tree and should be harvested when they are still hard. Depending on cultivars fruit may be ready for harvest from 70 days after full bloom (viz. cv. China pear) to 135 days after full bloom (viz. cv. Barlett). The Bartlett pear normally takes 122 ± 3 days in valley (Kuala) areas of H.P.

7.1.3 Cherry

Sweet cherry should be harvested when fruit stalk separates easily from the spur and taste develops typical to the cultivar. From full bloom it takes 45 days in cultivars like Guigne Noir and Gross Lucenta, whereas in cultivars like Bigarrean Napoleon the number of days varies from 65-75 days.

7.1.4 Peach

For harvesting peach at the right time, the proper color development in fruits and pit browning are considered as reliable guides. In yellow fleshed cultivars, deep orange color development on fruits is associated with proper maturity. At least 5% of the pit area also should be brown if the fruit is to develop good flavor at ripening. In the peach variety July Elberta, it takes about 90-95 days after full bloom, whereas on cv. Elberta it normally takes 100-105 days. In low chilling cultivars like Flordasun, fruits should be harvested at 50% color development stage.

7.1.5 Plum

In free-stone cultivars of plum, pit browning up to 5% of the pit area is a good index of maturity. For proper fruit maturity, early cultivars like Sharp Early and Formosa take 95 to 105 days, mid season variety Santa Rosa requires 115-120 days and late cultivars like Grand Duke take 130-135 days after full bloom.

7.1.6 Apricot

Apricot fruits of a single tree ripen for a period of about 3 weeks. The fruits develop detectable flavor when allowed to ripen on the tree. The early cultivar Charmagz matures within 75 days from full bloom, while the late cultivar Quetta requires 125-130 days for proper harvest maturity.

7.2 Yields

There is a wide range of variation in fruit yield in different States and in different cultivars. The average yield of apple and pear have been indicated earlier in Table 2. Although average productivity of apple in H.P. has been shown as 9.4 t/ha, some well managed orchards of Delicious apple in Kotgarh area of the same State yield about 50 t/ha. Similarly, yield record of 35 t/ha has been achieved in 12 year old plantations of colored mutant apple cultivars on MM 106 rootstocks under high density planting system (2222 plants/ha) in a research station in Shimla hills of H.P.

The average yields of different stone fruits have been indicated earlier. In brief, State-wise average yield of different stone fruits are given in Table 5.
Table 5. Average Yield of Different Stone Fruits by State

<table>
<thead>
<tr>
<th>State</th>
<th>Fruit Yield, T/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peach</td>
</tr>
<tr>
<td>H.P.</td>
<td>0.50</td>
</tr>
<tr>
<td>J&amp;K</td>
<td>0.73</td>
</tr>
<tr>
<td>U.P.</td>
<td>2.11</td>
</tr>
<tr>
<td>NEH Region</td>
<td>2.50</td>
</tr>
</tbody>
</table>

8. MARKETING

The biggest wholesale market for apple is the Fruit and Vegetable market at Azadpur, in Delhi. About 70 per cent of the total trade of apple is distributed through this market. The seasons of market arrivals from North Western States are as follows:

- H.P. - July to October with a peak in August - September
- J&K - August to November, with a peak in September - October
- U.P. - June to October, with a peak in July - mid September.

There are a number of marketing channels, of which the predominant are:

a) Farmer - Pre-harvest contractor - Commission agent - Wholesaler - Retailer - Consumer.
b) Farmer - Forwarding agent - Commission Agent - Wholesaler - Retailer - Consumer.
c) Farmer - Commission agent - Wholesaler - Retailer - Consumer.

The sale through pre-harvest contractors is the most important system of marketing. Normally, the small orchardists sell their crop at flowering stage to contractors who organize plant protection practices, picking and packaging of fruits.

The medium and large orchardists prefer to market their produce through channels (b) and (c). In H.P., about 65% of total apple produced is marketed through these two channels. Some Growers’ Co-operatives and Government controlled marketing Corporations (like HPMC in H.P.) also get involved in the apple market. For example, in H.P the volume of trading handled by Growers’ Co-operatives is about 3.5 to 4.0 per cent, while another 2-2.5 per cent of the total produce is marketed by HPMC.

The National Horticulture Board (NHB) of the Government of India regularly publishes and announces the wholesale price and market arrival figures of apple in different terminal markets for the benefit of the growers. Some quantities of apple are placed in cold storage facilities.

The Himachal Pradesh Horticultural Produce Marketing and Processing Corporation Ltd. (HPMC) has set up modern fruit packing houses in different parts of the State. Each packing house has a capacity to grade and pack 55,000 to 275,000 cartons of fruits. Cold storage facilities at the production centers and terminal markets at Delhi, Bombay (Mumbai), Madras (Chennai) and Calcutta have been created. Similarly, the HPMC has undertaken large scale processing of temperate fruits like apples, peaches and others.
In H.P, grading and packing of fruits have been organized reasonably well. In apple, 7 size grades have been prescribed and dimensions of packing boxes, size of wrapping papers and number of layers of fruits for each grade have been standardized. In apricot, plum and peach, three size grades have been prescribed. Presently CFB (Corrugated Fiber Board) telescopic tray pack cartons for apple and smaller size universal CFB cartons for stone fruits are in use. These are available with HPMC at their various packing stations. Plastic crates (both collapsible and non-collapsible) are also used for cold storage and for processing units.

Picking and packaging of fruits are done in different ways at different sites. In U.P hills, trees are generally strip picked into small wicker baskets or small gunny bags which are emptied into larger baskets for carrying to packing stations. Both U.P. and J&K have developed packaging units for different temperate fruits.

India presently exports a small quantity of apple (5.95% of total fresh fruit export), mostly to Bangladesh and Sri Lanka. Apple cultivars like Red and Royal Delicious, Ambri and other new colored cultivars are suitable for the export market. According to the Trade Year statistics of 1993, India exported only 7000 tons of apple during that year.

9. PROCESSING

The HPMC in Himachal Pradesh owns two fruit processing plants with a combined capacity of 30,000 tons annually. The plants are equipped with modern machinery for six-fold juice concentration and aroma recovery. The plants have also facilities for aseptic bulk packaging and pasteurization. The HPMC manufactures mainly primary products like fruit pulps, single strength juices and juice concentrates. It covers fruits like apple, pear, peach apricot and plum. The pomace of the fruits after juice extraction is used for cattle feed, extraction of pectin etc.

In J&K, low grade fruits are processed for various products like apple juice, jam, jelly, fruit bars, rings, vinegar etc. from pome and stone fruits. In U.P. hills also, various types of processed products are prepared from temperate fruits. The units are mainly small and medium in size and not to the scale of HPMC. On the research side, important cultivars of apple were screened for their suitability for preparation of juice, jam, dehydrated rings, chops, cubes and preserves. Golden Delicious cultivar was found to be the multi-use cultivar to meet the FPO quality requirements. A new process for canning of apples called osmo-canning has been developed. Similarly, process for preparation of cider, wine and vermouth have been developed. Utilization of apple pomace for production of pectin and natural colors have been attempted. Although CA storage concept has not yet become popularized, fruits placed in CA store at Shalimar in J&K have shown that this system of storage has great promise for temperate fruits.

10. POTENTIAL FOR DECIDUOUS FRUITS

10.1 Area Expansion

Both North-West and North-Eastern regions of India offer large areas ideally suitable for cultivation of pome and stone fruits. In the North-West India, stone fruits like peach, plum and apricot come up well at elevations between 900 to 1500m with an annual rainfall of 90-100cm. Apple, cherry and pear are commercially successful at elevations between 1500-2700 m above msl. The cold arid regions between 1550-3650m with annual rainfall of
25-40 cm are again highly suitable for dry nuts and drying type of apricots. There are vast tracts of land still available for further expansion of these crops.

In the North-Eastern Hills, excepting the rain shadow belts of Arunachal Pradesh and high altitude Lachung area of Sikkim, apple may not be successful commercially. Other crops like pear, peach, plum and apricot offer good scope for further expansion.

10.2 Widening the Cultivar Base

The low productivity and poor quality of apple are often linked with monoculture of a few old cultivars and their degeneration over the years. The U.P hills, particularly Kumaon division, has the unique advantage of harvesting apple fruits for early market. Similarly, the rainshadow belts in North-Eastern Hills can offer good quality apple for the eastern Indian markets, thus reducing the cost of long distance transportation from North-Western Hills. Part of the markets of Bangladesh can be captured by the fruits of the North-East. There is good scope for introduction of new promising cultivars, replacing the Delicious group. Similarly, use of clonal rootstocks of Malling and Malling-Merton series and even their indexed material ‘EMLA’ selections will greatly change the productivity and quality of fruits. High density planting with spur type cultivars offer good scope. The identification of low chilling peach, plum and pear cultivars offer good possibilities for their cultivation in the low hills and in sub-tropical plains. Some of the new hybrids, including scab resistant apple cultivars need verification trials on a commercial scale.

10.3 Management Practices

Scientific water management and practicing proper training and pruning of trees including introduction of renewal pruning techniques, will make significant impact on increased production even in the existing orchards. Drip irrigation, in-situ water harvesting and correcting macro and micro-nutrient deficiencies will go a long way in bringing notable improvement in productivity as well as fruit quality. By adopting IPM strategy and organic farming practices, selected export markets can be targeted well.

10.4 Processed Products

There is immense scope for increasing various processed products of pome and stone fruits, for which technologies are available. The existing capacity of the most organized processing unit of HPMC is only marginal as compared to the volume of fruit available for processing. The HPMC utilized only 1 to 1.5 percent of total cull fruit available. The present combined capacity of two units of HPMC is 30,000 tons annually, which can be easily raised to 50 to 75 thousand tons.

The expansion of grading and packing stations, their further modernization with mechanical grading equipment, use of CFB boxes and more number of pre-cooling and cold storage units will improve the marketing system and enhance marketability of the produce. Apple has been identified as one of 6 most promising fruits for fresh fruit exports.
11. CONSTRAINTS IN DECIDUOUS FRUIT PRODUCTION

Large number of old orchards (more than 30 years old) are showing decline in terms of growth and fruit yield. Such old trees do not produce adequate extension growth. Large scale replanting is therefore needed.

Delicious group of cultivars constitute the major share (about 83% in H.P.) of apple production in the country. These cultivars are self unfruitful and need cross pollination to ensure good fruit set. Interplanting pollinizer cultivars (Golden Delicious, Jonathan, Red Gold, Lord Lambourne etc.) in the proportion of 25 to 33 percent is necessary for good fruit set, and choice of wrong pollinizers and their inadequacy in number often result to low productivity.

In many countries, Delicious group has been replaced or is in the process of replacement with more promising cultivars. The need for injecting new blood into the apple industry through spread of new cultivars (spur types, color mutants, strains of Gala, Red Fuji; scab resistant cultivars, bud sport selections of Royal Delicious, and some of the promising hybrids) is urgently felt. Some of the spur type and colored mutants are already popular with farmers and high density planting has also caught the imagination of developmental departments and agencies both in H.P. and J&K. The research system has already identified Early, Mid and Late cultivars for different agro-climatic regions.

The low chilling cultivars of stone fruits have also covered large tracts of the subtropical plains of Punjab, U.P and H.P. For the hills, promising cultivars identified need further spread.

Generally, apple is grown in marginal land and fertilizers are not applied according to the requirements of the trees. The water and fertilizer use efficiency is generally poor. Also, spring frost and hailstorms are adverse weather parameters leading to low productivity. Research results have shown that through proper orchard management practices (soil and water conservation and fertilizer application) the fruit yield can be doubled in the existing orchards. The adoption of improved production technology developed by the research system can bring visible and perceptible changes in the temperate fruit industry in India. Technologies like use of clonal rootstocks, introduction of renewal pruning techniques and micro nutrient applications have not been transferred and adopted at a satisfactory level.

Apple scab disease has been the major plant protection problem in apple in J&K and H.P, whilst U.P hills are comparatively free from the disease. Apple scab forecasting system developed and the chemical control schedule prescribed have helped in reducing loss due to apple scab to a considerable extent. Apple growers are adopting the prescribed schedule of chemical sprays to control the disease. For checking entries of diseased material in the free areas of U.P. and North-Eastern Hills, strict quarantine and selection of elite disease-free mother plants are very essential. Often it is not followed strictly. Some of the virus diseases have also been reported in apple for which biological and serological indexing/detection procedures have been developed. Limited quantity of virus-free budwood is also being supplied. Extreme care is now required to be taken to multiply quality planting material (in apple alone approximately 2 million plants/year) for establishing new plantations.

Most of the orchardists still sell their crop at flowering to contractors as there is no well organized marketing system. Transportation in the hills itself is problematic. Post-harvest management problems originating from poor harvesting (strip picking) and improper packing system (non CFB boxes) and lack of proper pre-cooling and cold storage facilities
result in huge (25-30%) loss of fruits. Capacity of the processing sector is also inadequate. Product diversification, value addition and market infrastructure development would require very substantial investment. The existing processing units are quite old and they require modernization for which substantial investment is required. CA storage trials have shown good promise. Its extension in larger growing areas is needed. Technology for storage of apple is now known, as a result of which apple is now available throughout the year.

12. GOVERNMENT POLICIES AND PLANS FOR RESEARCH AND DEVELOPMENT

Research on pome and stone fruits is conducted mainly by three State Agricultural Universities, namely: a) Sher-e-Kashmir University for Agriculture Science & Technology, J&K; b) Y.S. Parmar University for Horticulture and Forestry, H.P.; and c) G.B. Pant University for Agriculture & Technology, U.P. A good number of research stations of these Universities located in major pome and stone fruit growing belts are engaged in temperate fruit research. The Indian Council of Agricultural Research (ICAR) through All India Coordinated Research Projects on Fruits and Post-harvest Technology and another Network project on Apple Scab disease has further strengthened the research activities in deciduous fruits. A few long established temperate fruit research stations namely at Shalimar Bagh in J&K, at Mashoobra in H.P. and at Chaubatia in U.P. hills have made commendable progress in temperate fruits. Both State Governments and the ICAR provide financial support to strengthen fruit research in these Universities. A large number of ad-hoc research projects on pome and stone fruits funded by ICAR are also generating good information on these crops.

During the 8th Government Developmental Plan (1992-1997) the ICAR established a Central Institute for Temperate Horticulture (CITH) with its headquarters at Srinagar in the J&K State, with a regional station at Mukteshwar in the U.P. Hills. Both these research stations will work exclusively on temperate fruit crops. This new Institute will receive major support during the 9th Plan period (1997-2001). In the North-Eastern Hills region, the ICAR Research Complex for NEH Region with its headquarters in Meghalaya State and regional units in each of the 5 other States are engaged in fruit research.

On the developmental side the State governments are engaged in nursery production of quality planting material. For example, in H.P. alone currently there are 600 nurseries in private and public sector producing and distributing more than 0.8 million plants of apple alone, every year. There are ambitious programs in all the States to further expand/ replant with new improved cultivars. Apple scab disease control and post-harvest processing sectors are getting focused attention in Government developmental plans. The Directorate of Marketing and Inspection of the Government of India has framed grade standards for apple, plum and William pear. The organizations like National Horticultural Board (NHB), National Co-operative Development Corporation (NCDC), Agricultural and Processed Food Products Export Development Authority (APEDA) etc., are providing incentives to traders and exporters to improve their infrastructural facilities like grading and packaging centers, refrigerated transport, setting up of pre-cooling, cold storage, auction platforms etc. The NCDC is undertaking procurement and marketing of apple on a limited scale. The NHB has set up a market information service for the benefit of growers.
13. CONCLUSION

Deciduous fruits, covering pome and stone fruits contribute significantly to the horticulture economy of India. Apple production dominates the scene and systematic cultivation and marketing of apple can change the rural economy in the hills of North-Western India. New vision and concerted efforts are required for change in variety mix, supply of quality planting material from elite clones on indexed clonal rootstocks. High density planting, water management including micro-irrigation, integrated plant nutrient management and IPM strategy for plant protection are some of the areas which need greater R&D focus. Adoption of post-harvest management practices and infrastructure development for grading, packaging, pre-cooling and storage of the produce needs focused developmental attention. Value addition and export promotion, particularly of apple are drawing due attention of the developmental agencies in India.
DECIDUOUS FRUIT PRODUCTION IN MYANMAR

Sein Hla Bo *

1. INTRODUCTION

Myanmar is bounded by land on the Northwest, North and East and the remaining sides by sea. It stretches for about 2361 km from North to South and 1078 km from East to West. The total area of the country is about 676,756 sq. km. The Western, Northern and Eastern parts of the country are hilly regions. The country can be divided into two main climatic zones, namely, the tropical South covering over two-thirds of the country and sub-tropical or warm temperate North covering the remaining one-third of the country. The Southwest monsoon brings the annual rains during the months of mid-May to mid-October, leaving the rest of the year relatively dry. During the dry season, there is a cold spell in the months of December to February, after which warm weather sets in. The temperature in the Southern parts of the country differs very little during the different seasons. However, in the central Myanmar plains, seasonal temperature variations in the magnitude of 40.6 - 46.3 °C in the hot season and 10 - 15.6 °C in the cold season are common. The Northern parts of the country usually experience somewhat lower temperatures throughout the year. High altitudes have resulted in the formation of cooler belts. In the Chin hills and Shan Plateau, on account of the higher altitude, the maximum temperature will not exceed 29.2 °C and the minimum temperature will go as low as 7.2 °C. Myanmar receives its annual rains mainly from the Southwest monsoon from mid-May to mid-October. The precipitation however varies depending on the locality, elevation and time of the year. July is generally regarded as the period of maximum rainfall throughout the country. The coastal and hilly regions receive the heaviest rainfall reaching 2540 mm to 5080 mm annually. In the central parts of Myanmar, rainfall is as low as 762 mm to 1016 mm per annum. The agro-climatic conditions within the country are suited to a large variety of crops such as equatorial plantation crops and temperate fruits, besides the common food and industrial crops of monsoon Asia.

2. PRESENT SITUATION OF DECIDUOUS FRUIT CROP CULTIVATION

Deciduous fruits have been grown in Myanmar since the 1930s. Apple, pear (Asian pear), plum (damson plum), and Japanese apricot are major deciduous fruit crops while some others are also grown on a small scale in several areas. Soil, topography and climatic conditions of hilly regions favor the cultivation of deciduous fruits. Although many of these fruits can grow in the hilly areas, only apple, Asian pear, plum and Japanese apricot are common, and the area under these fruits tends to increase year by year. The following Tables 1, 2 and 3 show production statistics of apple, Asian pear and plum in Myanmar.

*National Project Director, Myanmar Agriculture Service, Ministry of Agriculture, Kanbe, Yangon, Myanmar
Table 1. Production Status of Apple in 1996-97

<table>
<thead>
<tr>
<th>State/Division</th>
<th>Cultivated Area (ha)</th>
<th>Harvested Area (ha)</th>
<th>Yield/ Tons/ha</th>
<th>Total Production in Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chin State</td>
<td>3178</td>
<td>987</td>
<td>2.3</td>
<td>2270.1</td>
</tr>
<tr>
<td>Shan State</td>
<td>89</td>
<td>16</td>
<td>2.2</td>
<td>35.2</td>
</tr>
<tr>
<td>Total</td>
<td>3267</td>
<td>1003</td>
<td>-</td>
<td>2305.3</td>
</tr>
</tbody>
</table>

Table 2. Production Status of Asian Pear in 1996-97

<table>
<thead>
<tr>
<th>State/Division</th>
<th>Cultivated Area (ha)</th>
<th>Harvested Area (ha)</th>
<th>Yield/ Tons/ha</th>
<th>Total Production in Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chin State</td>
<td>1120</td>
<td>238</td>
<td>2.3</td>
<td>547.4</td>
</tr>
<tr>
<td>Mandalay</td>
<td>201</td>
<td>182</td>
<td>3.7</td>
<td>673.4</td>
</tr>
<tr>
<td>Shan State</td>
<td>533</td>
<td>526</td>
<td>3.1</td>
<td>1630.6</td>
</tr>
<tr>
<td>Total</td>
<td>1854</td>
<td>946</td>
<td>-</td>
<td>2851.4</td>
</tr>
</tbody>
</table>

Table 3. Production Status of Plum in 1996-97

<table>
<thead>
<tr>
<th>State/Division</th>
<th>Cultivated Area (ha)</th>
<th>Harvested Area (ha)</th>
<th>Yield/ Tons/ha</th>
<th>Total Production in Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kachin State</td>
<td>10.1</td>
<td>10.1</td>
<td>3.23</td>
<td>32.62</td>
</tr>
<tr>
<td>Chin State</td>
<td>91.5</td>
<td>90.3</td>
<td>0.81</td>
<td>73.14</td>
</tr>
<tr>
<td>Mandalay</td>
<td>267.2</td>
<td>234.8</td>
<td>0.89</td>
<td>208.97</td>
</tr>
<tr>
<td>Shan State</td>
<td>608.5</td>
<td>597.6</td>
<td>0.82</td>
<td>490.03</td>
</tr>
<tr>
<td>Total</td>
<td>977.3</td>
<td>932.8</td>
<td>-</td>
<td>804.76</td>
</tr>
</tbody>
</table>

Apple cultivation is limited to the area of the mountains above 1200 m elevation. The existing cultivars inclusive of local cultivars are: Delicious, Kamnang, Kumdong, Kojuku, Leidown, Leiluum, Sainum, Awti and Kammay. Introductions of new apple cultivars were made through the FAO and NGO (GRET) projects mostly from Europe, Japan, and the Republic of Korea. The new cultivars include Gala, Fuji, Idared, Akane, Malrose, Jonagold, Hung Yan Shwe, Delicious, Vistabella, Pommed’Adam and Reinette du Mans. Initially, 27 apple cultivars were introduced through the GRET program and planted in the Chin State for preliminary studies. Among these, 6 cultivars showed promise and these have been under detailed observation for multiplication and distribution since 1996. These introductions were raised on the local Hashabi rootstock.

Asian pear is more popular than apple among Myanmar consumers. All existing cultivars of Asian pear have rounded fruit shapes and are poor in fruit quality. The fruit is lower priced than apple in all growing regions. Local cultivars have been named according to their fruit skin color. There are two distinct local cultivars of rounded green and rounded brown skin types. Traditionally, pears have been propagated by grafting on local, wild pear rootstock.
During the 1960s, some pear cultivars were introduced to Chin State. However, only the Nijuseki cultivar survived. New pear cultivars were introduced again in 1992-93 and 1994-95 through the GRET project and the help of some private individuals. These cultivars included Conference, P. Cornelle, Beure Danjou, Beure Bachalier, Hoshi Nashi, Sinsaki Nashi, Chojuro Nashi, Hwang Kam Bae, Kam Chung Bae and one other cultivar from Southern China. In Shan State, some old pear orchards in poor condition can be seen along the roadsides. Cultivar improvement, training and pruning methods were rarely practiced in most pear growing areas.

Other commonly grown deciduous fruits are the damson plum, Japanese apricot and persimmon. Plum and Japanese apricot are usually produced for preservation, especially as dehydrated and salted preparations and not for the fresh fruit market. Most cultivars produced are local and somewhat inferior in quality. Trees are propagated by seed collected without selection from growers’ own trees. No vegetative propagation methods have been applied to either of these crops. Persimmon trees are usually propagated by grafting using local cultivars as rootstocks. However, the growing area of persimmon is limited to localities where Chinese communities live. The area under Japanese apricot and plum is increasing yearly due to the growing demand for preservation purposes. The hilly regions around 1000 m elevation seem to be suitable for these two fruits in Myanmar. The production area under Japanese apricot is concentrated in Shan State at the border areas with China and Thailand with some production in the Mandalay division. Although peaches can be seen in Shan and Chin States, the plant was earlier grown as an ornamental crop with little use as fresh fruit. The cultivars grown were local and semi-wild with large seed and thin flesh.

3. PRODUCTION OF PLANTING MATERIAL

Except apple, pear and persimmon, other deciduous fruits were commonly grown from seedlings raised by growers themselves. No commercial nurseries were established for these fruits. Cultivar selection, breeding, selection of suitable rootstocks and grafting methods had not been started until recently. The Myanmar Agricultural Service started cultivar selection and a topworking program in 1994-95 for apple and pear in Chin State and Shan State. The GRET project has an active program for apple and pear cultivar selection and adoption of new cultural techniques in Chin State. For apple and pear, the Myanmar Agricultural Service has established 4 nurseries for seedling production and testing of newly introduced cultivars, two in Southern and Eastern Shan State and two in Chin State. Topworking was also demonstrated in the Southern Shan State using the Nijuseki cultivar. Seedlings of selected trees of plum and Japanese apricot were raised in the Government horticultural farms in Shan State for distribution to border areas. A Chinese pear cultivar was introduced and a propagation program was initiated to expand the areas under this crop in Shan and Kachin States.

4. ESTABLISHMENT OF ORCHARDS

Most deciduous fruits are grown predominantly in home gardens. No commercial orchards have been established in the country. Old pear orchards of reasonable extents in Southern Shan State were converted to residential areas or other crops. Apples were mostly grown at elevations above 1200 m on hill slopes.
Terracing, contour bunding and other hillside conservation practices were recently introduced for deciduous fruit culture in Chin, Kachin and Shan States under a program of development for border areas and tribal communities. The planting material, grafted plants as well as seedlings which are at least one year old, are used in most deciduous fruits. The planting season is usually at the start of the monsoon, normally in June. Plants are mostly raised with rain water during the growing period and supplementary irrigation is rarely practiced. No training or pruning had been practiced in old apple and pear orchards. However, the newly established trees are being trained using the open center and central leader systems in apple and the latter system is also used for pears. The Y method of training has also been recently introduced for pears. Plums, peaches and Japanese apricots are grown without any training or pruning in most areas. Major pests of apple and pear in Myanmar are fruit fly, stem-borer and aphids; economically damaging diseases are scab, powdery mildew and canker. For pest control, available insecticides are sprayed and no specific control measures are practiced for diseases.

5. INTERCROPPING

During the early growth period of orchards, usually up to 3 years, intercropping with annual crops is normally practiced in all growing areas. The major intercropping is carried out using crops such as corn, soybean and niger seed. Leafy vegetables and legumes are also grown on a small scale as cash crops in some areas.

6. HARVESTING AND YIELDS

Most deciduous fruits commence flowering in January and the fruits mature during the rainy season in July-August. Apples and pears are harvested when fully mature, when distinct fruit color develops (characteristic of each cultivar). Plums are harvested when fully mature but before fruit color appears. Japanese apricot is usually harvested before the mature stage. Because of the lack of proper cultural practices, quality and yield of all existing deciduous fruits grown in the country leave much to be desired. Yields and total production are given in Tables 1, 2 and 3.

7. MARKETING

Most deciduous fruits are consumed locally. Some apples and pears are transported to big cities for the fresh fruit market. Plums and apricots are usually sold locally for preservation purposes. The demand for apple is gradually increasing in urban markets and good quality fruits are being imported to meet local demand. About 6-10 tons of apple have been imported in 1995-96 from China.

8. PROCESSING

Because of low quality, poor handling and marketing practices, most pears produced in Chin State are used for processing. This includes making alcoholic beverages like wine or processing into jam. Apple juice is made from the local apple in Chin State. Pear produced in Shan State is not used for processing or preservation purposes, but is usually consumed as fresh fruit and fetches low prices. The fruits of plums are usually converted to salted pickles and wine. Japanese apricots are processed locally into dehydrated and salted fruit. All deciduous
fruits grown in Myanmar are processed at home level as there is no commercial canning factory for these fruits. Local growers have been trained in fruit processing methods under the GRET program, especially in Chin State.

9. POTENTIAL FOR DECIDUOUS FRUIT PRODUCTION DEVELOPMENT

Myanmar has limited land resources available for deciduous fruit crops as these crops require specific climatic conditions for proper fruit production. In many hilly areas, improper land use methods adopted during colonial days have resulted in degradation of land to a level that will not allow any crop production. In order to avoid any recurrence of such activities, steps are being taken for strict adherence to terraced cultivation and conservation farming methods in the hilly areas. Most deciduous fruit crops are now being grown on the contour in terraced fields. Expansion of area under deciduous fruits is still possible in these hilly areas. Proper growing techniques should however, be practiced to increase production and improve fruit quality. There is a substantial increase in demand for deciduous fruits in domestic markets which warrant expansion of extents under these crops. Rejuvenation of existing old orchards and topworking with superior cultivars can also help in improving production levels and fruit quality.

10. CONSTRAINTS IN DECIDUOUS FRUIT PRODUCTION DEVELOPMENT

The major constraints in deciduous fruit production development in Myanmar are: a) lack of a serious cultivar selection program; b) lack of suitable rootstocks and propagation methods; and c) lack of proper research and technology transfer programs for each fruit and region.

Farmers at present grow these crops using traditional methods, without any knowledge of new technologies that have been developed for training, pruning, fertilization, fruit thinning, etc. Poor road infrastructure, transport and irrigation facilities are also major constraints in development of remote areas adjacent to the country’s borders.

11. PLANS FOR RESEARCH AND DEVELOPMENT OF DECIDUOUS FRUITS

The Myanmar Agricultural Service of the Ministry of Agriculture and Irrigation has been making efforts to increase the growing area and production of deciduous fruits in the hilly regions where suitable climatic conditions exist for these fruits. Specific sites and potential locations have been surveyed and identified for growing these crops. Fruit production zones have been demarcated according to agro-climatic conditions for each region and crop. The expansion plans include high potential border areas. Demonstration farms and training facilities have been established in these areas. Distribution of planting material of good quality fruit cultivars, training and dissemination of appropriate technical information are major activities in the border areas to promote crop production including deciduous fruits.

Research plans include evaluation of cultivars, fertilizer investigations, training and pruning studies, etc. New germplasm of apples, pears and some peaches was introduced from abroad through Government and Non-government organizations. Changing existing cultivars through a program of topworking has also been carried out. One short-term trained senior scientist has been assigned to coordinate and monitor this program.
12. CONCLUSION

Myanmar with its rich natural resources and favorable agro-climatic conditions can expand the existing deciduous fruit growing area in the near future. The hilly areas have the potential to develop deciduous fruit production. Training of growers in deciduous fruit growing techniques will enhance quality fruit production and improve the economic status of the growers.
1. INTRODUCTION

The kingdom of Nepal is a small and totally land locked mountainous country in South Asia. It is situated between 26°22' and 30°27' north latitude and 80°4' and 88°12' east longitude. It is surrounded by India to the East, South and West and by the Tibetan region of China to the North. The shape of the country is somewhat rectangular measuring 880 km from East to West and 130 to 240 km in width. The total geographical area of the country is 147,181 square km. The population of the kingdom was 21.4 million in 1996/97 with an annual growth rate of 2.1 percent. Per capita GDP was very low in 1996/97 (US$200). The total cultivable area is 3.96 million hectares of which 2.97 million ha are under cultivation. The irrigated area is only 26% of the total cultivated land; the rest depends largely on monsoon rain, 80% of which is received during June to September.

Nepal is a predominantly agricultural country. Agriculture is the lead sector for the national economy and accounts for about 42% of the GDP. About 81.1% of the population or about 3.3 million families are engaged in agriculture. Land holding per family of 5-6 members is 6.5 ha in the hills and 1.8 ha in the terai.

The Nepalese hill economy is characterized by typical subsistence agriculture based on cereal crops, and is practiced on terraces of often very steep slopes which are subjected to a great loss of top soil by erosion during heavy rain. Hilly soil is generally acidic and with poor nutrient content, especially nitrogen.

Administratively, the country is divided into 75 districts and five development regions, namely, Eastern (16 districts), Central (19 districts), Western (16 districts), Mid-Western (15 districts) and Far-Western (9 districts).

Agro-ecological Classification and its Significance to Horticulture

The topography of Nepal is extremely variable ranging from 60-300 m above sea level (m a.s.l) in the southern plains to 8848 m a.s.l in the north, which is the highest point on earth (Mt. Everest). Big variation in altitude occurs within short distances due to which it enjoys all types of climates. Physiographically, the whole country can be divided into five zones (Table 1).
### Table 1. Characteristics of Physiographic Regions of Nepal

<table>
<thead>
<tr>
<th>Features</th>
<th>Terai</th>
<th>Siwaliks</th>
<th>Middle Mountains</th>
<th>High Mountains</th>
<th>High Himal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area (Million ha)</td>
<td>3.1 (44%)</td>
<td>2 (12.7%)</td>
<td>4.4 (29.5%)</td>
<td>2 (19.7%)</td>
<td>2.4 (23.7%)</td>
</tr>
<tr>
<td>Geology</td>
<td>Quaternary alluvium</td>
<td>Tertiary sandstone, siltstone, shale &amp; conglomerates</td>
<td>Phyllite, quartzite limestone and islands of granites</td>
<td>Gneiss, quartzite &amp; mica shists</td>
<td>Gneiss, schist, limestone and Tethys sediments</td>
</tr>
<tr>
<td>Elevation</td>
<td>100-300 m</td>
<td>200 – 1500 m</td>
<td>800 – 2400 m, Relief 1500 m with isolated peaks to 2700 m</td>
<td>1000 – 4000 m, High relief 3000 m from valley floor to ridges</td>
<td>2000 to 5000 m +</td>
</tr>
<tr>
<td>Climate</td>
<td>Tropical</td>
<td>Tropical, subtropical</td>
<td>Subtropical, warm temperate (but tropical in lower river valleys; cool temperate on high ridges)</td>
<td>Warm to cool temperate, alpine</td>
<td>Alpine to arctic (snow 6 – 12 months)</td>
</tr>
<tr>
<td>Moisture Regime</td>
<td>Subhumid in FW+MW DR; humid in W+C and FDR</td>
<td>Subhumid in most of the area; humid in N-aspect of W+C=EDR and Dun Valleys</td>
<td>Humid; perhumid above 2000 m</td>
<td>Subhumid to perhumid</td>
<td>Semi arid behind Himal</td>
</tr>
<tr>
<td>Rainfall Intensity</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Horticultural crops</td>
<td>Mango, lychee, pineapple, jack-fruit, potato, tomato</td>
<td>Mango, papaya, banana, potato</td>
<td>Mango, papaya, banana, orange, lime, lemon, peach plum, nectarine, persimmon, Asian pear, potato, cauliflower</td>
<td>Chestnut, walnut, apple, peach, plum, apricot, cherry, almonds, potato</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
- EDR = Eastern Development Region
- CDR = Central Development Region
- WDR = Western Development Region
- MWDR = Mid Western Development Region
- FWDR = Far Western Development Region

Commercial fruit growing, especially the deciduous type is not traditional in Nepal. Therefore, it is limited largely to homestead gardens and fruits are used mainly for domestic consumption. The local peach, pear, plum and walnut are grown in scattered locations, they are of inferior quality and have very little commercial value. This however, indicates the potential for growing temperate fruits in Nepal. For the first time in Nepal a Department of Agriculture was established in 1925. After this, a number of different fruit species, mostly temperate fruits were introduced to Balaju and Godavari orchards in Kathmandu. Only after 1950 several promotional activities on fruit development were undertaken in Nepal. For the first time a Horticulture Development Section was established under the Department of Agriculture in 1955. Several improved cultivars of Asian pear, peach, plum, persimmon, cherry and apple were introduced to Singh Durbar and Kakani farms and cultivar performance studies and propagation activities were started with bilateral assistance from USAID until 1963. From this time the Government of Nepal placed special emphasis on fruit development in the hills. The period from 1960 to 1973 was a very crucial period.
because this is the time when six temperate horticultural stations were established at different locations of the country with support from the Indian Cooperation Mission (ICM). Many new cultivars of deciduous fruits were introduced into these stations from India. In these stations a number of activities were started including cultivar performance studies, planting material production and distribution, training of farmers etc. As a result, the area under deciduous fruits increased dramatically. A number of new temperate fruits and additional new cultivars were introduced and key horticultural stations were strengthened during 1977 to 1980 under the Hill Agriculture Development Project assisted by FAO.

Until the early seventies, the requirements of planting material of these fruits were met mostly by imports from India but after the mid-seventies several private nurseries were established in the major growing areas and self-sufficiency was almost achieved.

No significant research work on fruits in general, and deciduous fruits in particular, was carried out in Nepal in the past. Only preliminary studies on cultivar evaluation, propagation and insect pest management were undertaken.

2. PRESENT SITUATION OF DECIDUOUS FRUIT PRODUCTION

At present, deciduous fruits are considered as the most important fruit crops of Nepal. These fruits are grown successfully in mid and high mountainous areas from the Eastern to the far Western zone of the country. Sub-humid and dry temperate areas in the inter Himalaya region where the elevation ranges from 1800–2800 m.a.s.l. are considered to be most suitable for particularly high quality apple production. Such rainshadow or low rainfall areas are located in the Western and mid Western mountainous regions. On the other hand, the humid temperate regions where the rainfall is high and are fairly wet throughout the growing period are suitable for the cultivation of other deciduous fruits. Some low chilling (<1000 hrs) apple cultivars are being grown at low altitudes, as low as 1200 m.a.s.l.. Tables 2, 3 and 4 show the total area, production and productivity of fruits in Nepal as well as potential districts for commercial production.

### Table 2. Total Area, Production and Productivity of Fruits in Nepal (1996/97 - End of the Ninth Five Year Plan)

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Total Area (ha)</th>
<th>Productive Area (ha)</th>
<th>Total Production (MT)</th>
<th>Yield MT/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deciduous (Temperate)</td>
<td>13261.00</td>
<td>9402</td>
<td>81640</td>
<td>8.68</td>
</tr>
<tr>
<td>Citrus</td>
<td>15923.59</td>
<td>9330</td>
<td>92994</td>
<td>9.97</td>
</tr>
<tr>
<td>Evergreen (Tropical)</td>
<td>33734.28</td>
<td>23553</td>
<td>253591</td>
<td>10.77</td>
</tr>
<tr>
<td>Total</td>
<td>62918.97</td>
<td>42285</td>
<td>428225</td>
<td>10.13</td>
</tr>
</tbody>
</table>

Source: Agriculture Statistics (MOU), 1998.
If we look at the comparative figures of the last ten years, we will see that the area under fruit crops has increased almost by 50 percent, but due to the scattered distribution it has little impact on commercial scale production and this is especially true in the case of deciduous fruits.

Table 3. Area, Production and Productivity of Deciduous Fruit in Nepal (1997)

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Total Area (ha)</th>
<th>Productive Area (ha)</th>
<th>Production (Mt/ha)</th>
<th>Yield Mt/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>4652</td>
<td>3006</td>
<td>28595</td>
<td>9.51</td>
</tr>
<tr>
<td>Pear</td>
<td>3049</td>
<td>2381</td>
<td>27339</td>
<td>11.48</td>
</tr>
<tr>
<td>Peach</td>
<td>2143</td>
<td>1765</td>
<td>12819</td>
<td>7.26</td>
</tr>
<tr>
<td>Plum</td>
<td>1441</td>
<td>1179</td>
<td>8294</td>
<td>7.03</td>
</tr>
<tr>
<td>Apricot</td>
<td>97</td>
<td>63</td>
<td>431</td>
<td>6.84</td>
</tr>
<tr>
<td>Persimmon</td>
<td>71</td>
<td>45</td>
<td>328</td>
<td>7.29</td>
</tr>
<tr>
<td>Total</td>
<td>11392</td>
<td>8439</td>
<td>77806</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Potential Districts for Commercial Production

<table>
<thead>
<tr>
<th>Fruits</th>
<th>Major Districts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple and Apricot</td>
<td>Mustang, Jumla, Humla, Kalikot, Dolpa, Rukum, Rolpa, Bajhang, Bajura, Baitadi, and Darchula</td>
</tr>
<tr>
<td>Pear, Peach, Plum, Persimmon</td>
<td>Sankhuwasabha, Dhankuta, Sindhupalcowk, Rasuwa, Kavre, Nuwakot, Dhading, Palpa, Baglung, Baitadi, Doti, Dharchula, Bajhang, Rolpa, Parbat, Gorkha, Makawanpur, Bhaktapur, Lalitpur, Kathmandu, Sindhuli, Ramechhap, Bhojpur, Terathum and Illam</td>
</tr>
</tbody>
</table>

2.1 Important Cultivars, Rootstocks and Areas of Production

As mentioned earlier, several cultivars of different kinds of deciduous fruit species were introduced into Nepal at different times and for several programs. These cultivars were imported mainly from India, the United Kingdom, Italy, Israel, Japan and USA. They were planted in different horticultural stations and suitable cultivars were propagated and distributed to the farmers. The important cultivars of different deciduous fruits available in Nepal are given below.

2.1.1 Apple

Both high chilling and low chilling cultivars of apple are cultivated in Nepal. The principal high chilling cultivars are Red, Royal and Golden Delicious, Mc Intosh, Jonathan, Rome Beauty, Granny Smith, Richared, Golden Spur, etc. Among all these cultivars the Delicious group covers a major area as their fruit quality is excellent. The mid chilling cultivars are Katza, Red June, Cox Orange Pippin, Crispin and Summer Pippin. The low chilling cultivars are Anna, Vered, Tropical Beauty, Winter Banana etc.

Rootstocks: Crab apple (M. baccata) seeds are used extensively for raising rootstocks for apple in Nepal. Edy Mayal which is commonly found in the wild is also being used on a limited scale as a rootstock. Clonal rootstocks such as M9, M26, M27 of the Malling series and MM101, MM106, MM111 of Malling Merton series have been introduced to a few
horticultural stations and are used for propagation on a very limited scale.

**Production Areas:** High and mid chilling cultivars are mostly grown in an altitude range of 1800 – 2800 m.a.s.l, where chilling is more than 1000 hours; low chilling types are cultivated at elevations as low as 1200 m.a.s.l and where chilling is 600–1000 hours. As far as elevation is concerned, apple can be grown throughout mid and high mountain areas from Eastern to the far Western region; however, due to high humidity and heavy rainfall during the growing period the most suitable areas for quality apple production are confined to the mid and far Western region where dry to semi humid conditions exist (Table 4).

### 2.1.2 Pear

There are two kinds of pears grown in Nepal. The oriental pear or sand pear locally known as Naspati or Pharping Naspati (*Pyrus pyrifolia*) is very popular as it needs low chilling hours (<1000); it is very well adapted to the warmer temperate region of Nepal.

Japanese cultivars including Shinsui, Shinko, Kosui, Hosui, Chojuro and Okusankichi were introduced into Nepal about 10 years ago under a Japanese Aid Horticulture project. These cultivars are successful under warm temperate conditions and fruit quality is excellent. These cultivars, however, require very careful management.

The European pears (*P. communis*) were introduced into Nepal many years ago. The better adapted popular cultivars of European pear are Bartlett, Quince, Anjou and Conference, which are also usually grown in cool temperate regions.

**Rootstocks:** A wild variety locally known as Mayal (*P. pashia*) is extensively used as a rootstock. Seedlings are raised from seed and grafting is done on them.

**Production Areas:** The pear is a very important deciduous fruit crop in Nepal. It is cultivated in both mid and high mountain areas of the whole country.

### 2.1.3 Peach

So far, a total of 44 improved cultivars of peach have been introduced into Nepal from many countries. High chill cultivars are Peregrine, Triumph, Elberta, Baby gold, Suncrest, Rhodes, Red Haven, Florida Red, etc. Low chill cultivars include Orion, Spring time, French Early, Cardinal, Armgold, Florida, Kuratake Wase, Texas, Spring time, Early Red etc. These are all early ripening cultivars, while J.H. Hale and Late Elberta are popular late peach cultivars in Nepal.

**Rootstocks:** A wild cultivar of peach which is widely found in Nepal is extensively used as a rootstock for cultivated peach, nectarine and almond.

**Production Areas:** In Nepal, peach is a very common stone fruit extensively grown throughout the mid elevations between 1000–2800 m a.s.l. High chill cultivars are performing well in the high mountain areas, whereas low and mid chill cultivars perform very well in mid mountain areas.
2.1.4 **Plum**

Two types of plum are commonly grown in Nepal. European cultivars grown are Green Gaga, Early Transparent Gage, Stanley, Ruth Gestetner etc. Japanese cultivars are Santa Rosa, Methley, Satsuma, Formosa, Mariposa, Burbank, Kelsey, Oishi Wase and Shiro.

*Rootstocks:* A wild plum or peach are commonly used as rootstocks for all plums. Clonal rootstocks of Myrobalan are also used on a very limited scale.

*Production Areas:* Plums are being successfully grown in areas where peaches are grown except those areas where there is early spring frost.

2.1.5 **Apricot**

About 13 cultivars of apricot were introduced into Nepal at different times but unfortunately only a few of them have been successful under Nepalese conditions. These cultivars included Blenheim, Titon, Bulida, Rcale Dimola, Prete, Canino, Kaisa, Charmagz, Shakarpara etc. Shakarpara is the most successful cultivar in Nepal.

*Rootstocks:* Apricot and wild peach are used as rootstocks for apricot.

2.1.6 **Nectarine**

Popular nectarine cultivars are Independent, Panamint, Arm King, Ruby Gold, Fantasy, Nectaret-2 and Neyorkert.

2.1.7 **Persimmon**

Popular cultivars are Euyu, Ziro, Zenjimoru, Hiratanonashi, Hachiya and some local selections.

*Rootstocks:* Local cultivars.

*Production Areas:* Warm temperate areas throughout the country.

2.1.8 **Cherry**

Cultivars grown are Napoleon, Satomishiki, Tokasago, Victoria and Bigara. However, none of these cultivars have shown good performance in Nepal.

3. **PRODUCTION OF PLANTING MATERIAL**

Nepal was importing deciduous fruit plants from India until the mid 80’s. Due to the encouragement from the Government several private nurseries have been established in different regions, and now the country is self-sufficient in the production of planting material of these crops. Due to the expansion of the area under these crops, the demand for planting material is increasing rapidly (Table 5).
Table 5. Deciduous Fruit Planting Material Production (1997) (Number of Plants)

<table>
<thead>
<tr>
<th>Fruit Crop</th>
<th>Government Nurseries</th>
<th>Private Nurseries</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>66130</td>
<td>34760</td>
<td>100890</td>
</tr>
<tr>
<td>Pear</td>
<td>25978</td>
<td>24040</td>
<td>50018</td>
</tr>
<tr>
<td>Peach</td>
<td>23048</td>
<td>11010</td>
<td>34058</td>
</tr>
<tr>
<td>Plum</td>
<td>21828</td>
<td>6020</td>
<td>27848</td>
</tr>
<tr>
<td>Walnut</td>
<td>24944</td>
<td>11075</td>
<td>36019</td>
</tr>
<tr>
<td>Persimmon</td>
<td>3220</td>
<td>600</td>
<td>3820</td>
</tr>
<tr>
<td>Apricot</td>
<td>4410</td>
<td>4360</td>
<td>8770</td>
</tr>
<tr>
<td>Chestnut</td>
<td>1860</td>
<td>0</td>
<td>1860</td>
</tr>
<tr>
<td>Almond</td>
<td>900</td>
<td>0</td>
<td>900</td>
</tr>
<tr>
<td>Grape</td>
<td>2200</td>
<td>0</td>
<td>2200</td>
</tr>
<tr>
<td>Pecan</td>
<td>1280</td>
<td>0</td>
<td>1280</td>
</tr>
<tr>
<td>Total</td>
<td>175798</td>
<td>91865</td>
<td>267663</td>
</tr>
</tbody>
</table>

Government farms continue producing fruit plants and selling them at a minimum price, but a larger volume of planting material is required. It is not possible to meet the growing demand through these nurseries. In the last few years, attempts have been made by private entrepreneurs to establish fruit nurseries. As a result, nearly 100 nurseries have so far been established by the private sector. The method and time of propagation are shown in Table 6.

Table 6. Method and Time of Propagation

<table>
<thead>
<tr>
<th>Fruit Crop</th>
<th>Propagation Method</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>Bench grafting</td>
<td>January/February</td>
</tr>
<tr>
<td></td>
<td>(Whip and Tongue)</td>
<td></td>
</tr>
<tr>
<td>Pear</td>
<td>Bench grafting</td>
<td>January/February</td>
</tr>
<tr>
<td></td>
<td>(Whip and Tongue)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Budding (T or Chip)</td>
<td></td>
</tr>
<tr>
<td>Peach, Plum, Apricot, Cherry</td>
<td>Tongue or cleft grafting (in situ)</td>
<td>May to September</td>
</tr>
<tr>
<td>Persimmon</td>
<td>Chip Budding</td>
<td>January/February</td>
</tr>
</tbody>
</table>

4. ESTABLISHMENT OF ORCHARDS

In Nepal, more than 80% of cultivated land in high and mid mountain regions is on sloping mountainous terrain. In this hilly terrain the contour system of planting is followed. All trees are planted on the contour. The distance between the rows depends on the slope, being closer on steeper slopes and wider spaced otherwise.
On very steep land, terraces are made and the slope of the terrace is kept inwards in order to prevent soil erosion. In such terrain, hexagonal or rectangular system of planting is practiced.

Pits of approximately 1 x 1 x 1 m size are dug during the period of September-October and filled with a mixture of compost and soil. Planting of deciduous fruit trees is commonly done through December to March depending upon the altitudes. Planting distance for all these fruit trees is 6 X 6 m (300 plants per hectare) for most parts of Nepal.

5. ORCHARD MANAGEMENT

Proper training of young plants and pruning of older trees are not strictly followed by farmers in many areas of Nepal. Farmers’ negligence of these very important operations has created a big problem in quality production. However, the most common system of training of temperate fruits practiced in the country is the modified leader system followed by the open center system. Pruning is generally done during December to January.

Soil fertility in the mid mountain regions is extremely low, and crops are mainly dependent upon farm-yard manures and compost, and fruit crops hardly receive fertilizers. However, the recommendation of manures and fertilizers for these crops is presented in Table 7.

Table 7. Fertilizer Recommendations for Deciduous Fruits (per tree)

<table>
<thead>
<tr>
<th>Items</th>
<th>Tree age in Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Compost (kg)</td>
<td>20</td>
</tr>
<tr>
<td>Nitrogen (g)</td>
<td>-</td>
</tr>
<tr>
<td>Phosphorus (g)</td>
<td>-</td>
</tr>
<tr>
<td>Potassium (g)</td>
<td>-</td>
</tr>
</tbody>
</table>

The three-fourth dose of nitrogen and full dose of compost, phosphorous and potash are applied prior to the dormancy break. The remaining one fourth of N is given soon after the fruit harvest. In Nepal, fruit cultivation is done on marginal uplands where irrigation facilities rarely exist; therefore, orchards are entirely dependent on monsoon rain which occurs mainly during May to August.

Mulching around the trees has been highly recommended to fruit growers, but in practice (except in a few cases) it is rarely followed. Hand weeding is the common practice in Nepal. Shallow cultivation with hand tools at the time of inter-cropping is the only way of working the soil in orchards.

Pests and Diseases

In Nepal, reports on plant protection research work on fruit crops are very scanty. The problem of major pests and diseases of these crops is alarming. The main pests and diseases and general practices for their control are given in Table 8.
### Table 8. Major Pests and Diseases and their Control

<table>
<thead>
<tr>
<th>Fruit Crop</th>
<th>Pest</th>
<th>Control</th>
<th>Disease</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>Woolly aphid</td>
<td>Democrone, Sumithion</td>
<td>Apple scab (in humid areas)</td>
<td>Bavistin</td>
</tr>
<tr>
<td>San Jose Scale</td>
<td>Diazinon</td>
<td>Papary bark or pink disease</td>
<td>Bordeaux Paste Bordeaux Mixture spray</td>
<td></td>
</tr>
<tr>
<td>Defoliating Beetles</td>
<td>Parathion</td>
<td>Powdery mildew, Root Rot, Crown gall</td>
<td>Karathane Bordeaux mixture Fumigation</td>
<td></td>
</tr>
<tr>
<td>Stemborer</td>
<td>Parachloro Benzene Powder</td>
<td>Powdery mildew, Root Rot, Crown gall</td>
<td>Karathane Bordeaux mixture Fumigation</td>
<td></td>
</tr>
<tr>
<td>Pear</td>
<td>Pear psylla</td>
<td>Metacid or Aldrin</td>
<td>Fire blight</td>
<td>Cutting out branches &amp; sanitation</td>
</tr>
<tr>
<td>Defoliating beetle</td>
<td>Parathion</td>
<td>Pear decline</td>
<td>Control of Pear psylla</td>
<td></td>
</tr>
<tr>
<td>Bag worms</td>
<td>Metacid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peach</td>
<td>Peach aphis</td>
<td>Diazinon or metasystox</td>
<td>Leaf curl</td>
<td>Benlate or captan</td>
</tr>
<tr>
<td>Defoliating beetle</td>
<td>Light traps, Parathane</td>
<td>Powdery mildew</td>
<td>Karathane</td>
<td></td>
</tr>
<tr>
<td>Plum</td>
<td>Plum aphid</td>
<td>Diazinon</td>
<td>Gummosis</td>
<td>Bordeaux mixture</td>
</tr>
<tr>
<td>Miles</td>
<td>Kelthane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit Moth</td>
<td>Malathion</td>
<td>Root Rot (Phytophthora)</td>
<td>Good drainage</td>
<td></td>
</tr>
<tr>
<td>Sawflies</td>
<td>Dichlororvas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apricot</td>
<td>Treeborer</td>
<td>Thiodane</td>
<td>Brown Rot</td>
<td>Benomyl</td>
</tr>
</tbody>
</table>

### 6. INTERCROPPING

Farmers of Nepal do intensive intercropping so long as there is sufficient space between trees. Farmers usually do shallow cultivation on the surface away from the periphery of the trees. Most of the farmers use maize, pulses, mustard, vegetables, potato and spices as inter-crops.

### 7. HARVESTING AND YIELDS

Harvesting of deciduous fruits is entirely done by hand. Fruits are picked by hand (sometimes beating with stick) and placed in large bamboo baskets. Fruits are collected into one place until they are sent to the market. Actually, no grading is done here except sorting out badly damaged fruits as a result of bad harvesting or due to pest and disease damage.
The actual yield of these crops is quite variable due to many factors. An exact record on yield is, therefore, not available but estimated figures of national average are given in Table 3.

8. MARKETING

Most of the deciduous fruits are cultivated in remote and isolated mountain areas. The majority of these areas neither have access to motorable roads and marketing channels nor any storage and processing facilities. Fruits are packed in simple bamboo baskets, each weighing about 30 kg, or sometimes in jute bags and transported by porters or mules to nearby markets or road collection points. In some places it takes several days to reach these points. Once these fruits reach road heads, they are transported by trucks, buses and even airplanes to large markets. After arriving at the markets they are sold to wholesalers or middlemen. Purchasing is done on weight basis or as whole basket load.

Perishable fruits like peach and plum have great difficulty to find markets in remote areas, and farmers are obliged to sell them at very nominal prices; sometimes they may not get buyers at all. From the most remote areas of the high mountain regions, fruits, especially apples are airlifted by plane in limited quantity to large markets. This is the common mode of transport in Mustang and Jumla areas. In these areas, most of the fruits are sold locally to incoming tourists or to local processors at surprisingly low prices. In these high mountain areas a local method of cellar storage has been developed to store apples. Pre-treated fruits with 0.25% potassium permanganate solution are packed in wooden crates and stacked in rock-lined dark cellars. The humidity in such cellars is controlled by providing running water channels on the floor. In these cellars, fruit can be stored for about 3-7 months depending upon the elevation of the place.

Exports and Imports

Nepal imports fresh as well as dried and processed fruit products, mainly from India, in large quantities. Among the fresh fruit, apple is imported in bulk. A very small quantity of these fruits is exported to India. It is really difficult to get actual data on imports and exports of fruits. Total fresh fruit imported into Nepal in 1996 is reported to be worth about 100.8 million Nepalese Rupees (about US$2 million) whereas only 0.6 million rupees (US$10,000) worth of fruit was exported. Nepal is heavily dependent on imported fruits.

9. PROCESSING

There are about 2000 agro-processing enterprises in Nepal, but only about 150 are fruit and vegetable processing enterprises. Processing some deciduous fruits into alcoholic products has become very popular, especially in remote areas. There are about 130 small processing units in the hill districts, out of which 25 are wineries. The second important processed product of these fruits is jam, locally very popular, and is sold specially to tourists, restaurants and hotels. Air dried apple slices also are becoming quite common. Apple fruits that are not sold are sliced and sun-dried locally in the growing areas.
10. POTENTIAL FOR DECIDUOUS FRUIT PRODUCTION DEVELOPMENT

Agriculture is the backbone of the Nepalese economy and horticulture is recognized as one of the important sub-sectors of agriculture. It contributes about 13% to the total agriculture GDP (AGDP) but covers only 4.4% of the total cropped area.

Due to the wide range of climatic conditions Nepal has a unique opportunity to develop many fruit crops. During the last two decades, Nepal has been under the process of rapid urbanization. Demand for fruits is also growing at a fast rate due to the awareness of balanced diet and changing dietary habits of the people. It is quite evident that fruit farming is far more profitable than cereals, where marketing and other essential facilities exist. Per capita fruit consumption is far below the recommended level and only 45% of the local demand of fruit is met by domestic production, while the rest is imported from India. However, the Agriculture Perspective Plan (1995) quotes that 85% of the total consumption is imported. Soil erosion from the intensive cultivation of land and environmental degradation from the rapid deforestation are detrimental to the environment and agriculture sustainability. Soil fertility decline is apparent throughout the hill region of Nepal. Present soil management techniques adopted are unable to meet the overall production demands of the local population.

Nearly three-quarters of the population depend on agriculture for employment. There is no doubt that fruit farming is moderately employment intensive and contributes considerably to farmer incomes. Ecological niches suitable for commercial cultivation of deciduous fruits have already been identified. These areas are becoming more and more accessible every year because of the construction of new motorable roads.

Based on the successful apple production in some pocket areas, the Agricultural Perspective Plan has identified apple as one of the high value priority commodities in the high hills. Accordingly, the Government has given high priority for developing apple production in suitable pocket areas where transport and market infrastructure have already been developed or are in the process of development. Additional areas will be covered by apple orchards under the ongoing Ninth Five Year Plan period (Table 9).

Table 9. Area Expansion (in Hectares) for Deciduous Fruits during the Ninth Five Year Plan (1997/98-2001/02)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>189</td>
<td>186</td>
<td>240</td>
<td>290</td>
<td>359</td>
<td>1264</td>
</tr>
<tr>
<td>Pear</td>
<td>76</td>
<td>46</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>218</td>
</tr>
<tr>
<td>Walnut</td>
<td>90</td>
<td>85</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>415</td>
</tr>
<tr>
<td>Peach</td>
<td>43</td>
<td>39</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>148</td>
</tr>
<tr>
<td>Plum</td>
<td>27</td>
<td>23</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>116</td>
</tr>
<tr>
<td>Apricot</td>
<td>4</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>29</td>
</tr>
<tr>
<td>Persimmon</td>
<td>6</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td>Total</td>
<td>435</td>
<td>398</td>
<td>411</td>
<td>461</td>
<td>530</td>
<td>2235</td>
</tr>
</tbody>
</table>
11. CONSTRAINTS IN DECIDUOUS FRUIT PRODUCTION DEVELOPMENT

Almost all types of deciduous fruits are being grown in various parts of Nepal but it has not been demonstrated as an economic enterprise. This is because they are constrained by a number of factors which can be broadly categorized as a) Infrastructural, b) Physical and Environmental, c) Agronomical, d) Technical and e) Socio-economical.

a) Infrastructural Constraints

Deciduous fruit growing areas are situated in remote places in the mid and high mountains. These areas are not yet accessible to motorable roads and large markets, so farmers are facing big problems in selling their produce which discourages them from venturing into commercial production enterprises.

Essential inputs such as fertilizers, plant protection chemicals and horticulture tools etc. are not regularly available and on time, in these areas. Farmers have to depend upon compost and farmyard manures which are not readily available to fruit crops. As a result, fruit trees are nutrient deficient, untrained, unpruned and unprotected against diseases and pests. These are some of the causes for low yield and poor quality of these fruits.

Fruit cultivation requires large initial investment which the majority of Nepalese farmers cannot afford to make and have no access to any credit. Organized marketing channels, transportation, storage and processing facilities have not yet been developed in all deciduous fruit growing areas of the country. These are very important limiting factors that hamper profitable fruit farming in the country.

b) Physical and Environmental Constraints

Physically, Nepal is situated in a very difficult region of the world. More than 80% of its geographical area comes under hilly and difficult terrain with very steep slopes, loose soil and rocky structure. It is understandable how difficult it is to establish the basic development infrastructures in these areas for a very poor country like Nepal. It is also being threatened by the alarming situation with regard to environmental degradation and soil erosion that is being created by the rapidly growing population, compounded by unemployment and poverty (> 40% are below absolute poverty line).

It might appear that there would be great opportunities to grow a wide range of fruit species at specific locations in Nepal when one considers the enormous range of climatic conditions. However, certain unfavorable conditions also exist in Nepal such as heavy rain during monsoon period, uneven distribution of rainfall, high wind and hailstorms, spring frost etc. More than 90% of rainfall occurs from June through September, precisely when deciduous fruits are developing and maturing. It is difficult to control diseases and insects during such warm humid summers.

In the dry spring months from March to May when temperatures are high with little rain and no irrigation, fruit trees are seriously stressed due to which productivity is reduced. In most of the deciduous fruit growing areas, spring hailstorms are very common, which cause tremendous damage to developing fruits. Many potential deciduous fruit growing pockets in high mountains experience spring frosts that can destroy the flowers at full bloom stage. This spring frost causes more damage to warm temperate fruits like pear, peach and plum. Some important fruit growing areas like Mustang and Jumla experience strong wind in the spring that causes severe flower and fruit drop.
c) **Agronomic Constraints**

Lack of quality planting materials, mineral fertilizers, and incidence of economically important insect pests and diseases are the most important agronomic constraints to fruit cultivation in Nepal.

It is estimated that more than 270,000 deciduous fruit plants are needed annually. The majority of the nursery plants produced in the country are of inferior quality and not true to type. Most of the private nurseries do not maintain quality mother stock and standard rootstocks. Plants produced in the private nurseries are generally of sub-standard and not healthy.

Another important constraint to fruit production in this country is the incidence of economically important insect pests and diseases. For example, woolly aphis, San Jose Scale of apple, and defoliating beetles of pear and peach, and diseases such as apple scab, pink disease of apple, pear decline, peach leaf curl and foot rot are commonly found.

d) **Technical Support Constraints**

These constraints are summarized as follows:

- Low priority for fruit research
- Poor allocation of fiscal resources
- Lack of trained manpower
- Weak extension system in horticulture
- Inadequate technical information

The Nepal Agriculture Research Council (NARC) is the sole agent responsible for fruit research. Only a little research has been done in fruit crops to solve technical problems which the growers are facing. There is also a total lack of coordination between research and development.

Every district agriculture extension office has horticulture extension staff but they are completely deprived of technical backstopping. The number of deciduous fruit specialists is very limited in the country. Horticulturists working in extension have very limited access to information on new horticulture technologies and they are not exposed to any specialized training.

e) **Socio-Economic Constraints**

- Lack of experience in fruit growing
- Socio-cultural
- Food habits
- Land tenure
Unlike cereal crops, farmers of Nepal are not experienced in growing fruit crops, since commercial fruit growing is not traditional in Nepal. Most of the Nepalese farmers have small and fragmented holdings which are primarily occupied by cereals, and it is really difficult to persuade farmers to grow fruit trees instead of cereals.

12. GOVERNMENT POLICIES AND PLANS FOR RESEARCH AND DEVELOPMENT

Until 1990, both agriculture research and development were the responsibility of the Department of Agriculture under the Ministry of Agriculture. However, in 1991 the Nepal Agriculture Research Council (NARC) was formed as an autonomous organization under a separate act. Now, NARC is mandated for all research activities and the Agriculture Department (DOA) for all extension and development activities.

There are many horticultural stations under DOA and NARC located in different agro-ecological regions of Nepal which are supposed to carry out both research and development activities. However, as far as research on deciduous fruits is concerned, very little work has been done. There are a number of reasons for that such as lack of qualified manpower and infrastructure, poor coordination between NARC and DOA, inadequate research funds, lack of long term planning and vision. Whatever research work has been carried out so far, it concentrated mostly on plant protection, cultivar collection and maintenance.

Horticulture Development Plan and Policies

The Government has recognized horticulture as one of the important sub-sectors of agriculture in Nepal. Horticulture has been considered as a key to high growth rates and accorded priority in most of the past development plans. Despite the development potential and accorded priority, the pace of growth of horticulture has been very slow.

In view of the slow growth in the past and the ever increasing demand for horticultural products and to harness the immense potential of the country a “Twenty Year Horticulture Development Plan” was formulated in 1990 with support from the Asian Development Bank, named as the “Master Plan for Horticulture Development (MPHD)”. 

Despite the implementation of eight development plans in the past, no significant improvement in the living standards of the people has been achieved. Nonetheless, development efforts of the past decades have accelerated some basic infrastructure development. In view of this situation, a long term Agriculture Perspective Plan (APP) has been designed for Nepal that would lead past development towards a dynamic growth path. APP has taken agriculture as the engine of economic growth and that can trigger multiplier effects on the other sectors of the economy. Horticulture, sericulture and apiculture have been treated as high value commodities in the APP.

Based on the successful story of apple production in some areas and its advantages, the APP has identified apple as one of the high value priority commodities in high mountain areas. In the ongoing Ninth Five Year Plan, the Government has taken a policy of developing commercial orchards of apple in suitable pocket areas of western to far-western development regions. Eleven such districts have been recognized as most suitable for commercial apple cultivation (Table 4).

13. CONCLUSION
Considering the suitable climatic conditions, the country can develop deciduous fruit cultivation to a great extent. These crops have been successfully grown in different parts of the hilly regions of the country. If these fruit crops are commercially developed they can make a significant contribution towards poverty alleviation as well as towards the improvement of the national economy.

Many improved cultivars of these crops have adapted very well under Nepalese conditions and have been distributed throughout the country. The market demand for these fruits is enormous. The Government is also fully committed to the development of horticulture in the country. The 20-year Agricultural Perspective Plan (APP), which has accorded high priority for the development of horticulture in mid and high mountain regions, has already been initiated. Despite the development potential and accorded priority for these crops, it has not yet been demonstrated that fruit growing is an economically viable enterprise. This is because fruit production in Nepal is constrained by a number of factors as mentioned earlier. If these difficulties are properly addressed, there is a tremendous potential for further development of deciduous fruits production in Nepal.
REFERENCES


DECIDUOUS FRUIT PRODUCTION IN THAILAND

Suranant Subhadrabandhu *

1. INTRODUCTION

Deciduous fruits, sometimes referred to as temperate-zone fruits, are in heavy demand in tropical countries. The interest in these crops is on the rise. Shortages in hard currency in most tropical countries reduces their import and encourages attempts at local production.

In Thailand, deciduous fruit production has been focused in the Northern region which represents one of the most important areas of the country from the standpoint of socio-economic, agro-ecological and political considerations. The region accounts for about one-quarter of the country’s forest area, and the majority of hill tribes live in this region. The population of the hill tribes has been growing rapidly, causing expansion of slash and burn agriculture as well as shifting cultivation of the opium poppy in the region. This situation has caused damage to natural resources in the form of soil deterioration, flooding in wet periods and critical water shortages in the summer months (Subhadrabandhu and Punsri, 1987). In an effort to improve the highlands, deciduous fruit crops were introduced as substitution crops and are expected to serve as the main source of income for the hill tribes. Perennial fruit trees are believed to have great potential in the highland areas of Northern Thailand, both commercially and socially, as they can provide a steady and reliable income to the hill tribe farmers. If successfully established, these trees will eventually minimize the practice of shifting cultivation by encouraging more permanent settlement of hill tribe people and may curtail the growing of opium poppy. Furthermore, planting of fruit trees is an acceptable practice in reforestation and conservation programs, thus rendering an overall improvement to the environment. However, at present there are many limitations confronting the production of high quality deciduous fruits in Northern Thailand. The problems include among others, lack of suitable cultivars, insufficient chilling and improper cultural practices.

2. SITUATION OF DECIDUOUS FRUIT CROP CULTIVATION

2.1 Peach and Nectarine (Prunus persica L. Batsch)

Peach and nectarine are some of the deciduous fruits that receive much attention for growing in the highland areas of Northern Thailand. Previous reports on the performance of the introduced cultivars were documented (Subhadrabandhu, 1981, 1987). In the highlands of Northern Thailand, peach trees have been grown by hill tribes for many centuries. It is believed that the trees were brought in by villagers migrating from China (Subhadrabandhu, 1973). Over many centuries, the peach trees adapted to the growing conditions in the highland areas by the process of natural selection, resulting in the variety being known as ‘local’ peach. These peaches produce small, low quality fruits that could be eaten fresh. They are cling stone types and the hill tribe growers can only sell the fruits at rather low prices to the processing factories for processing into pickles. Therefore, many peach cultivars of low chilling requirement and having better quality for fresh consumption, have

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been introduced for testing their performance in the highland areas of Northern Thailand using these local peaches as rootstocks (Subhadrabandhu, et al., 1989).

At present, the introduced peach cultivars that have been tested in Northern Thailand and have been extended to hill tribe communities for cultivation are Early Grande, Florababelle and Flordsasun. The average yields of these cultivars exceed 10 kg/tree when over 4 years of age. The average price that the growers receive was about 30 baht per kg (the price varies according to the size of fruits). Thus, the growers can obtain at least 300 baht/tree. The common spacing for peach is $8 \times 8 \text{ m}$ or 156 trees per hectare, giving an income of about 46,800 baht/hectare (Table 1). Thus, the income received from growing peach is very good compared to what they used to receive from growing opium poppy.

Some nectarine cultivars such as Sundowner and Fla 5-14 seemed to be well adapted (Subhadrabandhu, et al., 1989). However, more studies are needed before they can be distributed to growers. Both peach and nectarine cultivars are propagated on the seedlings of local peaches. The production is satisfactory when they are grown in the highland areas of 1,000 m a.s.l. and above in the Northern Thailand areas of Chiang Mai, Chiang Rai and Mae Hong Son provinces. The area under cultivation for peaches and nectarine was about 16 hectares in 1997 with a total production of about 60 tons (Table 2). This figure is in addition to the production of local peaches used in processing factories.

### 2.2 Japanese Apricot (Prunus mume Siebold & Zuccarini)

This plant is native to China, Japan and probably also to the northern parts of Laos and Vietnam (Subhadrabandhu, 1991). It is also cultivated in Northern Thailand, but not elsewhere in South-East Asia. Japanese apricots are eaten in Japan, China and Thailand as pickles and preserves. The fruit trees are extensively grown in Japan, China and Korea. Japanese apricots have been cultivated in lowland areas of Northern Thailand for 30-40 years (Punsri, et al., 1982). Presently, a local variety is found growing as a home garden crop in some villages of Chiang Rai province. It is fast-growing and thrives in poor soil, but the fruits are rather small and of inferior quality. It can be, however, used as a rootstock for introductions (Subhadrabandhu and Punsri, 1987).

Seven cultivars from Japan (Shirakaga, Bungo, Koshyukoume, Koshukuume, Koshuko, Baigo and Kobai) were tested in the highlands of Northern Thailand. After 4-5 growing seasons, their performance was very poor and the trees showed signs of insufficient chilling. They were removed from further study. Two other cultivars, Ping Ting and Jen Tao, were introduced from Taiwan. These two cultivars grew very well under our highland conditions (Table 1). They produced fruits after the fourth year. The average yields of 5-year old and 10-year old trees were 40 and 100 kg/tree respectively. At present, these cultivars are propagated by stem cuttings and marcotting and distributed to hill tribes. In 1997, the production of Japanese apricot was 334 tons covering an area of 42 hectares (Table 2).

In Thailand, hill tribe farmers sell their Japanese apricot fruits for pickles, at the price of about 10-15 baht/kg. The fruits are processed into salted pickles, which are commonly used for cooking. Some fruits are made into Japanese apricot juice which is a popular drink.
Table 1. Average Yield and Estimated Income from Recommended Species and Cultivars of Deciduous Fruits in Thailand (Subhadrabandhu and Punsri, 1987)1/

<table>
<thead>
<tr>
<th>Species</th>
<th>Cultivars</th>
<th>Av. Yield Per Tree (kg)</th>
<th>Plant spacing (m)</th>
<th>Net Price2/ of Fresh Fruit (US$/kg)</th>
<th>Income from 10 Trees (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese Apricot</td>
<td>Ping Ting Jen Tao</td>
<td>80</td>
<td>10 × 10</td>
<td>1.20</td>
<td>960</td>
</tr>
<tr>
<td>Peach</td>
<td>Early Grande Flordabelle Flordasun Ying Ku</td>
<td>25</td>
<td>8 × 8</td>
<td>1.60</td>
<td>400</td>
</tr>
<tr>
<td>Apple</td>
<td>Anna Ein Shemer Dorsette Golden</td>
<td>8</td>
<td>3 × 3</td>
<td>2.40</td>
<td>192</td>
</tr>
<tr>
<td>Asian Pear</td>
<td>Yogoyama Wase Song Mao Pien Pu Pathanak</td>
<td>100</td>
<td>10 × 10</td>
<td>1.60</td>
<td>1600</td>
</tr>
<tr>
<td>Persimmon</td>
<td>Astringent</td>
<td>20</td>
<td>6 × 6</td>
<td>1.40</td>
<td>280</td>
</tr>
</tbody>
</table>

1/ Estimated for 6-10 years old trees, based on the data from 1980-1984.
2/ The price is variable, this is estimated in 1984 value.

Table 2. Production Statistics of Deciduous Fruits in Northern Thailand in 1997

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of Bearing Trees</th>
<th>Acreage (ha)</th>
<th>Total Yield (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese Apricot</td>
<td>4,174</td>
<td>42</td>
<td>334</td>
</tr>
<tr>
<td>Peach</td>
<td>2,433</td>
<td>16</td>
<td>61</td>
</tr>
<tr>
<td>Plum</td>
<td>3,798</td>
<td>25</td>
<td>114</td>
</tr>
<tr>
<td>Asian Pear</td>
<td>2,445</td>
<td>25</td>
<td>245</td>
</tr>
<tr>
<td>Persimmon</td>
<td>6,167</td>
<td>23</td>
<td>124</td>
</tr>
</tbody>
</table>
2.3 Asian pear (Pyrus pyrifolia (N.L. Burman) Nakai)

This species originated in North-East and East Asia; wild plants occur in the Sechuan region of Southern China (Oyen, 1991). Asian pear was first cultivated in China and Japan, which are still the centers of production. Commercial production has spread to Korea, Taiwan and more recently to the United States, Australia and New Zealand. Scattered trees and small orchards of Asian pears are found in most tropical highlands in South and South-East Asia, mainly in North Thailand and the drier parts of Indonesia and the Philippines.

In highland areas of Northern Thailand, the European pear (Pyrus communis L.) grew poorly due to insufficient chilling. Only a few buds opened and a few leaves were produced in a year. Most died in the nursery. Therefore, researchers turned their interest to low chilling cultivars of Asian pears, and a total of 31 cultivars of Asian pears were introduced from Taiwan, Japan and India. Among these introduced cultivars, Yokoyama Wase, Pien Pu, Song Mao and Pathanak had the best performance. The first three cultivars were introduced from Taiwan and the last from India. These cultivars yielded satisfactory crops under highland conditions, but the eating quality of the fruit is inferior when compared to the popular high-chilling Asian pears such as Kosui and Hosui from Japan. At present, the low chilling cultivars are being propagated by grafting onto rootstocks introduced from both Taiwan and India. The grafted trees are distributed to hill tribe growers. In 1997, the production of Asian pear in Northern Thailand amounted to 245 tons and occupied an area of 25 hectares. Most of the Asian pear is sold as fresh fruit and the price varies from 20-50 baht/kg.

2.4 Japanese Plum (Prunus salicina Lindley)

This fruit species originated in China and has been cultivated there and in Japan since ancient times. It is now grown worldwide, mainly in the subtropics and tropical highlands. In highland areas of Northern Thailand, low chilling cultivars of plum have been introduced alongside with low chill peach and nectarine, mainly from Taiwan and Florida. These plums are grown on local peach stock at the present time. After a few years of testing their performance, three cultivars from Taiwan and one cultivars from Florida (Gulfruby) gave satisfactory yields. The fruit quality is acceptable to Thai consumers. They are distributed to hill tribe growers, 2-3 cultivars to each grower as the Gulfruby plum is self-unfruitful and need pollen from the Taiwan cultivars for successful fruit set. At present, the introduced Taiwanese plums do not have a proper name; they are known as Ban Luang Red (red flesh) and Ban Luang Yellow (yellow flesh).

In 1997, the production of Japanese plum in Northern Thailand amounted to 114 tons and occupied a growing area of 25 hectares. About 80 percent of the production was sold as fresh fruit while 20 percent was sent to factories for making plum juice.

2.5 Persimmon (Diospyros Kaki L.F.)

The persimmon is one of the classical fruits of China, from where it was introduced in ancient times to Japan. China and Japan are the main areas of commercial cultivation but smaller centers have developed in Italy, Israel, Brazil, California (U.S.A.), Australia and New Zealand. In South-East Asia it is grown on a limited scale in Java, Sumatra, Malaysia and Northern Thailand.

In Thailand, about 50 cultivars of persimmon were introduced from Taiwan, Japan and California. They were tested for their performance in the highland areas. After six years
of study, only one cultivar of non-astringent persimmon produced fruits of satisfactory quality, but with rather poor yield. It was later found that the low yield was due to lack of pollinators, as most of the non-astringent persimmon cultivars need pollen from other cultivars for good crops. Many astringent cultivars bear good crops but the fruits have to be treated, to get rid of astringency, before sending them to the market. At present, due to the high yield, astringent persimmons, such as Tanenashi, Nightingale, Szu Chou, Xichu, Hachiya, Thien Shan and Ang Sai have been released to hill tribe growers, along with techniques to reduce astringency. These persimmon cultivars are grafted or budded on D. glandulosa and D. lotus stocks which are commonly grown in these areas.

In 1997, the production of persimmon in Northern Thailand amounted to 124 tons, and occupied an area of 23 hectares (Table 2). Almost all of the fruits were sold as fresh fruits while a very small amount was used for experimentation for producing dried persimmon.

2.6 Apple (Malus domestica Borkh.)

This is the most well known deciduous fruit crop. In South-East Asia, apple is commercially grown is East Java, Indonesia, which produced 50,000 tons from 7.6 million bearing trees in 1988 (Kusumo and Verheij, 1991). Apple growing proved to be successful at high altitudes in Northern Thailand and is gaining popularity in the Philippines.

In Thailand, 45 cultivars of apple were introduced and the overall growth was observed for five growing seasons. Low chilling cultivars such as Anna, Ein Shimer and Dorsett Golden grew well at Royal Ang Khang Station at an altitude of 1,400 m.a.s.l (Subhadrabandhu and Punsri, 1986). These cultivars seemed to have no problem in floral bud initiation. They flowered readily and the fruit set was satisfactory. However, fruit set of Anna was much better if cross pollinated with Dorset Golden or Ein Shimer.

Due to the long storage ability of high quality apple from the high chilling cultivars grown in U.S.A, Australia, New Zealand and China, imported apple fruits are commonly sold in local markets of Thailand at rather low prices. This makes the production of apple in the highland areas not so attractive to hill tribe growers as they can only sell their fruits at rather low prices in order to compete with imports, whereas the cost of production is almost the same as the other deciduous fruits. Because of this reason, extension of apple cultivation by the hill tribe growers has ended, and research work on apple has been suspended.

3. PRODUCTION OF PLANTING MATERIAL

The highland areas of Northern Thailand are the main areas where deciduous fruit trees are grown. These areas cover the head watershed areas in the North of Thailand where, in the past, dense evergreen forests were found and had been the main water supply catchments to the lowland in the North itself as well as the central region through to Bangkok. The situation has now changed, and at present only about 20 percent of the mountainous land of the North remains as forest. The majority of the hill area has been destroyed by the traditional practices of shifting cultivation by tribesmen living in these hill areas. Recently, it was estimated that at least 700,000 tribesmen are living in the highlands of Northern Thailand which cover many watershed areas (Subhadrabandhu, 1984). These people normally grow annual crops such as upland rice and corn for their own food and their main cash crop is opium poppy, the crop that has high notoriety world-wide. In general, these people are poor and have a difficult existence. His Majesty the King is the first to display a willingness to help these people by setting up the Royal Project (now named the
Royal Project Foundation) which aims at minimizing hunger among these tribesmen (Bhisadej Rajani, 1977). The main purpose of the Royal Project is to help these people to produce enough food or to produce enough income from agricultural crops, in place of opium poppy, in order to attain a reasonable standard of living. Thus, deciduous fruit is one of the most sensible replacements decided by local agricultural diversification planners.

Under Thai Law, the lands in any watershed areas are preserved and protected from any private ownership. The hill tribes, having lived in the areas for centuries, are allowed to stay on but, legally, they have no ownership or rights to the land, and the government wants them to practice settled agriculture without moving around. The Royal Forest Department has the task of looking after these watershed areas.

For the above reasons, there are no private nurseries producing planting materials of deciduous fruit crops in these areas. Also, due to the tight governmental budget, there are no governmental organizations responsible for producing these plants. The planting materials are produced by the Royal Project Stations scattered among villages in these areas. At the beginning, budded and grafted plants were planted in the stations in experimental plots. Their yield performances and the income from selling the fruits were recorded. The better cultivars were then made ready for distribution to hill tribe growers.

As for extension work, in the first phase of the project, the grafted and budded plants were provided to hill tribes. Local peach seedlings were used as rootstocks for peach, nectarine and plum. Local Japanese apricot seedlings from the Chiang Rai area were used for Japanese apricot together with Japanese apricot plants from marcotting and stem cuttings. For Asian pear, the seedlings from rootstock plants of Indian and Taiwanese origin were used. Diospyros glandulosa and D. lotus seedlings were used as rootstocks for persimmon. MM 106 was used as a rootstock for apple. However, when more hill tribe growers joined the project and needed more planting materials, only stock plants (ungrafted plants) were provided to them, and later they were grafted or budded in situ. Short training courses for growers on orchard management, pruning, propagation, harvesting etc. have been conducted many times each year. The sites of training are at the Royal Project Stations as well as at village level.

4. ESTABLISHMENT OF ORCHARDS

Generally, the deciduous fruit trees are planted in the lands that used to grow opium poppy or field crops like maize and beans, where there is very little land preparation needed. In some villages where the local peach trees existed, top working or frame working with good cultivars of peach or plum has been done. Clearing the forest to plant the deciduous fruit trees is forbidden as it is against the law, which is one of the reasons for the low hectarage of deciduous fruit trees grown in the area of Northern Thailand (Table 2).

As mentioned earlier, almost all kinds of deciduous fruit trees perform well in areas above 1,000 m where opium poppy is produced. Of these, the very steep areas with greater than 30 degree slopes are used for natural forests or for re-forestation work. The plain areas and those with less than 30 degree slopes are considered for planting crops including deciduous fruit trees. In sloping lands, deciduous fruit trees are planted in the terraces that are about 2 m wide. Growers prepare the terraces with assistance from the Land Development Department. Usually, the trees are planted at 4-6 m apart.

In the highland areas of Northern Thailand, a dry spell of about 4-6 months is experienced, and most of the orchards are grown under rainfed conditions. Therefore, the
planting season is during the rainy period. The general practice of hill tribe growers is to plant their trees at the beginning of the rainy season, so that the trees can utilize the moisture in the soil for fast establishment.

For planting, some growers dig the planting holes 2-4 weeks before the planting operations begin. This is normally carried out at the beginning of the rainy season. Usually, holes are prepared manually to a size of about $50 \times 50 \times 50$ cm. For refilling the holes, organic material and fertilizers are recommended. The mixture is usually composed of topsoil and well decomposed organic matter in an equal ratio, and this is used to refill the holes after planting.

5. CARE AND MANAGEMENT OF ORCHARDS

The routine operations in caring and management of deciduous fruit orchards are pruning and training. As the weather is rather warm, especially in the day time even in winter months, and the growing period is long and growth is rather vigorous, pruning is essential to keep the tree in good shape to get a satisfactory yield. After planting, the young trees are generally trained into an open center system which is used for stone fruits and persimmon. The training systems for Asian pear and apple are a modified bending system, where all bearing branches are bent horizontally by tying the branches with bamboo poles.

Due to their fast growing habit, deciduous fruit trees are pruned two times a year. The first pruning is done straight after harvest, i.e. summer pruning; this is to get rid of weak and unproductive branches, leaving the new shoots less competition for food. Complete fertilizer of N P K (15 : 15 : 15) is applied at the rate of 2-5 kg per tree at the beginning of the rainy season. The second pruning or winter pruning is done when the trees are dormant. This is to cut off excessive branches and to shape the trees. The second application of chemical fertilizer is applied during the fruit development stage by repeating the amount and rate of fertilizer applied in the first application. Animal manure or compost is also added to the trees at the rate of 5-10 kg per tree. This application is usually done before the growing season.

Weeding is occasionally done under the tree canopy and due to the long dry period mulching is generally practiced. The weeds taken out are used to make compost. The frequency of weeding depends on the growers and site of orchards; usually it is done once or twice a year.

The majority of deciduous fruit orchards are grown under rainfed conditions. In the areas where there is ample water supply (from creeks or streams) drip irrigation system has been installed in some orchards, but it is costly and sometimes beyond the reach of hill tribe farmers.

The major insect pest affecting deciduous fruits is oriental fruit fly (Dacus dosalis and D. sonatus). The flies lay eggs in the young fruits, and the larvae feed inside the fruit. The damaged fruits drop to the ground and the insects grow into a pupated stage in the soil during winter. When the weather becomes warmer, the adult flies emerge and can start damaging the crops again. The preventive measure to control this insect is to individually bag immature fruits, as well as hanging bottles with insect pheromones such as methyl eugenol, together with an insecticide such as malathion. This is to attract the male flies and destroy them in order to reduce the population. Two common diseases are rust (Tranzchelia pruni-spinosae) and anthracnose (Collectotrichum sp.) which can be controlled by a prophylactic spray of a fungicide before the damage reaches epidemic proportions.
Chemical spraying to control pests and diseases is generally not recommended, as deciduous fruit trees are grown in the watershed areas. The precaution of not using chemicals in the watershed areas is sensible as it helps to protect the environment; also, to prevent contamination of the water supply of people in the lowlands as well. Therefore, biological control together with preventive orchard management techniques are the two key measures adopted in these areas.

6. INTERCROPPING

Deciduous fruit trees are perennial and they usually require 4-5 years to become productive; during the initial stage the farmers have to grow cash crops such as vegetables, cut flowers and others for their livelihood. Research conducted by the Royal Project showed that many kinds of vegetables, flowers and field crops can be successfully grown in these areas. These crops have been introduced to hill tribe growers as an insurance against risk and uncertainty in the highlands. The emphasis is primarily on food security and efficient use of farm resources, although seasonal cash income would be derived from fruit trees. In fact, the integration of deciduous fruit tree species into the land use system in the highland areas is the most preferable agroforestry practice adopted by The Royal Project, as we need hill tribes to stay in one place and develop permanent land use systems, as well as to stop the practice of shifting cultivation.

7. HARVESTING OF FRUITS AND YIELDS

The yield of each deciduous fruit species is given in Tables 1 and 2. The figures are rather low in comparison to those grown in other temperate areas. However, when considering the income that the growers can get from their crops, this seemed to be economically feasible, as their earnings are much higher than what they normally obtained from cultivating opium and other field crops.

There are many reasons behind the low quality fruits and low yields obtained at present from deciduous fruit tree orchards. Apart from the level of technology practiced by hill tribe growers themselves, the cultivars of the fruits grown are also inferior, as the growing areas limit the cultivation to only low-chilling types which, in general, are lower in eating quality than those deciduous fruits found in European and Japanese markets. The long dry period during fruit development of peach, plum and Japanese apricot also contribute to low yield and low fruit quality. The remoteness of areas and difficulties in transportation also hinder the production of high quality fruits.

8. MARKETING

Nothing much can be said about marketing of deciduous fruit in Thailand. All that is produced is locally consumed, and there is no problem in marketing of fresh fruits as there is a ready demand for them. The Royal Project Foundation has established the Marketing Section, which takes the responsibility of selling the fruits for hill tribe growers who derive high returns. These deciduous fruits are sold under the brand name of “Doi Kam” in the market. At present, about 60 percent of the fruits produced in these areas are sold through this channel. The balance 40 percent is sold directly by growers, mostly to tourists visiting the villages.
9. **PROCESSING**

Under-sized peaches and all Japanese apricot fruits are processed into pickles. They are sold to private factories in Chiang Mai for processing and the products are sold under various brand names. The Royal Project Foundation has 3 canning factories to absorb the excess produce. The project purchases the fruits during peak harvest, so that the prices will not be too low for the hill tribe growers.

10. **POTENTIAL FOR DECIDUOUS FRUIT PRODUCTION DEVELOPMENT**

At this stage, there is some potential for deciduous fruit growing in the highlands of Thailand. This is due to the increasing demand for these fruits in the country. The reduction in importation of these deciduous fruits in order to save foreign exchange during the economic crisis currently faced by the country has also encouraged their production. The major drawback facing deciduous fruit production development in Thailand is the scarcity of land in the highlands as all the suitable land areas are under governmental control in order to preserve the watershed forest area. The second factor of importance is the unskilled nature of hill tribe growers and the difficulty to train them. This hinders the introduction of modern production technologies into the area.

11. **CONSTRAINTS IN DECIDUOUS FRUIT PRODUCTION DEVELOPMENT**

The problems facing the development of deciduous fruits in Thailand are briefly outlined as: a) scarcity of land at the altitude of 1,000 m.a.s.l. and above which can provide sufficient chilling hours for the existing cultivars; b) scarcity of suitable species of high quality fruits that can be productive in the area; c) difficulties in educating hill tribe growers; d) people from the lowland are prohibited to venture into the hilly areas and cultivate the land there; and e) insufficient water resources to irrigate the deciduous fruit orchards.

It will take some time before the hill tribe communities can be trained to work with the new technologies. At present, the need to introduce social development measures such as schools, health units, distance learning programs and better communications is being addressed by the Government. These programs also aim to encourage the younger generation to conserve natural resources, protect the environment and produce quality food.

12. **GOVERNMENT POLICIES AND PLANS FOR RESEARCH AND DEVELOPMENT ON DECIDUOUS FRUITS**

It is difficult to expect the Government to allocate a substantial budget for the development of deciduous fruits in the highlands of Thailand. Reasons attributed to this situation are the financial difficulties currently faced by the country and the fact that the hill tribes, totalling a population of nearly 700,000 people, are treated as a minority with many of them not having Thai citizenship as they move freely across the country’s border. It is therefore questionable and not justifiable to allocate large amount of Government funds earned from legitimate tax payers for hill tribe development.

Until now, almost all of the research work on deciduous fruit trees has been done with financial support from the Royal Project Foundation. Past research on deciduous fruits was done in collaboration and with support from foreign organizations such as USDA, UNDP, FAO, Retired Servicemen of Taiwan, etc. as well as from other private organizations. In the future, more research will be needed, especially on searching for better cultivars as well as better production techniques. The success of the needed research will
depend on the support, both financially and morally, that the volunteer researchers from universities, ministries, private sector etc. receive to develop deciduous fruit production in Thailand.

13. CONCLUDING REMARKS

The idea of producing deciduous fruits in the highland areas of Northern Thailand has been initiated by H.M. The King. He established the Royal Project with the objectives of helping hill tribe people in the area to produce enough food or to produce enough income from agricultural crops (in place of opium poppy) in order to achieve a reasonable standard of living. It is quite a difficult task for the Royal Project to pursue the growing concept of watershed management with regard to restoration of natural resource conservation on one hand, and also to satisfy the dietary needs of the hill tribes living in these watershed areas. Besides, the Royal Project also aims to stop the production of opium poppy by growing substitution crops such as deciduous fruits. All combined, these tend to enlarge the scope of highland development in Thailand. Production of deciduous fruits is one of the contributing factors towards this development. Being perennial trees, deciduous fruit crops can substitute or partly substitute the forest trees in restoring the environment and the ecology in the watershed areas. Also, fruits harvested from these deciduous fruit trees can be sold to enhance incomes of hill tribe communities and help to solve the economic problems of these people. Thus, only the sociological problems such as education, welfare, health care, etc. which are directly applicable to hill tribes, await to be solved.
REFERENCES


1. INTRODUCTION

Many deciduous fruits originated from South-East Asia and for this reason these fruits are still being cultivated in the highlands of Vietnam. These are currently grown in the provinces of Ha Giang, Cao Bang, Lai Chau, Lao Cai, Tuyen Quang, Lang Son, Bac Thai, Son La, Vinh Phu, Quang Ninh, Hoa Binh and also in the Dalat region (Lam Dong province) in the South (Table 1). During the French colonial occupation, some of the native cultivars were studied and described by Mieville (1921) and Chevalier (1923). Several European cultivars were introduced during that time but disappeared later.

Deciduous fruits are cultivated today by the ethnic minorities who inhabit the mountainous areas. Large areas are in production but traditional practices have prevented any improvement in yield and quality. These crops, however, present an important challenge to the Government which would like to achieve the following:

- improve the living conditions of ethnic groups and fight against poverty;
- satisfy a greater part of the domestic demand for deciduous fruits;
- modernize traditional production practices and intensify production systems;
- discourage the production of the prohibited opium poppy crop;
- encourage the ethnic groups to engage in settled agriculture instead of resorting to destruction of forests from their shifting cultivation practices.

The improvement of the deciduous fruit industry has been incorporated into the next 10-year plan (2000-2010) which aims at increasing the area of all fruit crops up to one million ha (in 1995 the area under fruits was 380,000 ha), of which 100,000 ha have been earmarked for development of the highland provinces with deciduous and sub-tropical fruit species (in 1995 there were 32,443 ha).

2. PRESENT SITUATION OF DECIDUOUS FRUIT CROP CULTIVATION

Various deciduous fruit species are grown in the highlands of the country. Some information on these species is given below:

2.1 Japanese Plum (Prunus salicina)

Only this species or its hybrids are grown in Vietnam between 700-1000 m altitude. The Japanese plums are produced only for the domestic market. Three cultivars, namely, Man Tam Hoa, Man Hau and Man Duong predominate. In fact, these three cultivars appear
to be from one main variety that originated in South China. They all have the following disadvantages:

- lack of a long harvest period, which leads to a serious oversupply to local markets, and a sudden drop in prices immediately after the harvest in June;
- they have small-sized fruit (average fruit size is 20-30 mm);
- they have very poor keeping quality.

In 1995, a thousand certified disease-free plum rootstock seeds of Myrobalan B were received from France and planted in Hanoi, Moc Chau (Son La Province) and at Sapa (Lao Cai Province). In August 1996, four certified disease-free cultivars of *Prunus salicina* were introduced from CTIFL-France and budded on the Myrobalan rootstocks for evaluation. These are Blackamber, Friar, Simka and Fortune.

**Table 1. Acreage of Fruit Crops in 1995 and Planned Acreage for the Year 2010 for 11 Mountain Provinces (in hectares)**

<table>
<thead>
<tr>
<th>Province</th>
<th>1995 (ha)</th>
<th>2010 (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ha Giang</td>
<td>3,503</td>
<td>10,000</td>
</tr>
<tr>
<td>Tueyen Quang</td>
<td>1,070</td>
<td>7,000</td>
</tr>
<tr>
<td>Cao Bang</td>
<td>720</td>
<td>6,000</td>
</tr>
<tr>
<td>Lang Son</td>
<td>3,290</td>
<td>10,000</td>
</tr>
<tr>
<td>Lai Chau</td>
<td>560</td>
<td>8,000</td>
</tr>
<tr>
<td>Lao Cai</td>
<td>2,690</td>
<td>6,000</td>
</tr>
<tr>
<td>Yen Bai</td>
<td>720</td>
<td>7,000</td>
</tr>
<tr>
<td>Bac Thai</td>
<td>10,780</td>
<td>10,000</td>
</tr>
<tr>
<td>Son La</td>
<td>5,557</td>
<td>12,000</td>
</tr>
<tr>
<td>Hoa Binh</td>
<td>833</td>
<td>10,000</td>
</tr>
<tr>
<td>Quang Ninh</td>
<td></td>
<td>14,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>32,443</strong></td>
<td><strong>100,000</strong></td>
</tr>
</tbody>
</table>

Source: Research Institute of Fruit and Vegetables, Vietnam (RIFAV)

### 2.2 Japanese Apricot (*Prunus mume*)

This fruit is smaller than the European apricot (*Prunus armeniaca*) but it is an old introduction and its cultivation is widespread in the country. Due to its hardiness, it has been recommended in the past, particularly for reforestation programs. In 1993, this crop occupied an area of nearly 1638 ha in the North-East and was second only to citrus. The fruit has some potential as a fresh fruit as well as for processing into dried fruit which has a ready market. The principal cultivars of Japanese apricot are Mo Vang Bach Thong (yellow apricot), Mo Vang Moc Chau (yellow type) and Mo Ma Dao (Pink apricot).

### 2.3 Peach (*Prunus persica L.*).

This fruit species has its center of origin in South-East Asia and is cultivated above 700 m altitude in North Vietnam. It is well adapted to local climatic conditions and is moderately resistant to several diseases. Under good growing conditions, cultivars like Hmong peach or Dao Meo can produce reasonably large fruits like the European types, but most locally grown cultivars give small fruit and have a very short harvest season. In addition to a selection program for this species, it is also necessary to improve the cultural...
practices. For future introductions, emphasis should be given to low chilling cultivars which would allow expansion of existing areas where humidity may be a limiting factor. A testing program for apple, peach, plum and apricot at Bac Ha in Lao Cai province in 1991, carried out under the auspices of FAO, showed that a peach introduction from Bulgaria (cultivar DA2) performed well (Tranh, 1996). Other promising peach cultivars were Dao Sapa and Dao Mau Son.

2.4 **Asian Pear (Pyrus pyrifolia)**

Introduced into Vietnam from China many years ago with the Hmong migrations in the 1960s as well as through a cooperative bilateral program, the species spread into many parts of the mountainous areas. The spread of this species is, however, limited as it has a short harvest season. Other species of limited adaptability are *Pyrus pashia* which gives fruits of poor quality and some hybrids of *Pyrus communis* x *P. pyrifolia* such as the Kieffer pear introduced by Mieville in 1921. This late hybrid has low chilling requirements, moderate tolerance to fire blight (*Erwinia amylovora*), intermediate quality as a fresh fruit and good cooking quality. The principal pear cultivars are Le Tao and Le Duong which are both derived from *P. pyrifolia* species.

2.5 **Apple (Malus doumeri)**

A semi-wild species which has spread from North to South in areas above 1400 m altitude is popularly called the Meo apple. It is well adapted to local conditions and is highly resistant to many diseases. It is a tall variety which is well adapted to agro-forestry programs and grown on an orchard scale. Its fruits are smaller and of poorer quality than *Malus domestica*. This species has, however, never been subjected to any selection programs or application of any modern production techniques such as the use of rootstocks and pollinators, pruning etc. to improve production.

In 1995, several varieties of *Malus domestica* were introduced into Sapa State Farm in Lao Cai province at an altitude of 1500 m. The initial successes motivated the Government to formulate a development project for improvement of deciduous fruits. The cultivars Fuji and Granny Smith were found to perform well when grafted on M9 rootstock (Tuyen, 1997). The market for apple is assured all year round and current demand is met by imports from China, USA, New Zealand and Europe.

2.6 **Persimmon (Diospyros kaki)**

This fruit is traditionally cultivated in all areas of the country above 700 m altitude and is popular among consumers. Its strong astringency is normally controlled by selection of good quality cultivars or by several post-harvest treatments. The most popular cultivars are Hong Thach That, Hong Son Duong, Hong Li Nhan, Hong Luc Yen, Hong Bao Lam and Hong Kuan Ba. There are also many more cultivars grown in the South in Lam Dong province.
3. PRODUCTION OF PLANTING MATERIAL

Only a few ethnic communities have mastered the technique of grafting in some private nurseries. In general, most of the deciduous fruit plants are propagated by seedlings and in some instances by marcottage that does not yield sufficient planting material in quality. Lack of good planting material is the main limiting factor to expansion of deciduous fruit production. In the Bac Ha region (Lao Cai province), however, peach is propagated by grafting, but budding techniques are not used at all. The lack of expertise in grafting/budding is also a serious impediment to research studies on virus transmission and control of common virus diseases. Whilst vegetative propagation techniques are frequently practiced on mango, citrus and lychee, they are only recently introduced and developed for deciduous fruits at the Sapa state farm. Although the price of grafted planting material is only 20-40 US cents/plant, it provides a substantial income to nurserymen. Since 1996, researchers, extension staff and nurserymen have been trained in modern propagation techniques under a technical assistance program sponsored by CIRAD-FLHOR. Although these activities are currently insufficient to meet local demand for planting material, a start has been made by introducing rootstock seed for training and demonstration in propagation and production of disease-free certified planting material.

4. ESTABLISHMENT OF ORCHARDS

There is no significant preparatory work in the establishment of orchards. The practices followed leave much to be desired. Even the soil preparation to establish new orchards is somewhat superficial, preparing small planting holes to receive new plants. The plant density is often 400 trees/ha at a spacing of about 5m x 5m.

5. CARE AND MANAGEMENT OF ORCHARDS

Management of the orchards consists mainly of the control of weeds and application of fertilizers, which depends on the level of resources available to farmers. Pruning and training techniques are virtually unknown to most farmers. As a result, trees have a multitude of branches and fruit loads on trees are not controlled, resulting in smaller fruit and poorer yields. However, local cultivars can survive under poor management although the quality of fruit is deplorably low.

In the same way, very little effort is made to control pests and diseases even if they are identified and well known to researchers. Although systems of pest and disease control is the mainstay of the agricultural practices in Vietnam for other crops, the situation is still unsatisfactory for deciduous fruits. Since these species are highly sensitive to high humidity prevailing in many fruit growing areas, the control of pests and diseases becomes problematic. The presence of pests, particularly fruit fly (Dacus sp.) appears to be a serious problem. In the case of peach, fruit fly attacks are severe at the beginning of the fruiting season. Fruits that appear normal, harbor the larvae that destroy the fruits. The pest has not been studied well enough to recommend any effective control measures. Population dynamics, life cycle, chemical and biological control mechanisms and economic significance need to be properly assessed to control the spread of the pest.

The status of viral and bacterial diseases is uncertain. Recent interest on deciduous fruits and the lack of understanding of the serious phytosanitary risks due to introduction of foreign material could make the present situation much worse. These risks are even underplayed by responsible researchers. This attitude has been brought home by those researchers who received their training in Central Europe. Consequently, the past
introductions of crops like plum from Bulgaria, from an area notorious for high infection pressure from Sharka viral disease, have been conveniently ignored. This material has already been released to most parts of North Vietnam from the Bac-Ha Station.

6. INTERCROPPING

Most deciduous fruit orchards are intercropped with special vegetables called ‘Cai Meo’ during the first three years after establishment. These crops give growers an income until the bearing of the trees commences and orchards become economically viable.

7. HARVESTING AND MARKETING

Apart from poor crop management practices, the situation becomes worse at harvest time. Fruit maturity is determined only by the arrival of a prospective buyer. Consequently, fruits are harvested immature and the situation gets exacerbated by the lack of facilities for handling, lack of temporary storage and equipment for packing and temperature control, inaccessibility of fruit farms to roads and communications etc. Quite often, fruits are harvested 3-8 weeks before ripening stage. This often results in considerable losses. Primitive packing devices such as used fertilizer bags carry immature fruits to Hanoi market from long distances. Under these conditions of low quality, rich consumers resort to purchase of imported fruit. The plum and peach crop is also marketed as dried fruit that is processed in traditional ways. For most of these reasons, deciduous fruits can only find a domestic market. In the summer months, apricot juice is a popular product preferred by most consumers.

8. POTENTIAL AND CONSTRAINTS IN DECIDUOUS FRUIT PRODUCTION DEVELOPMENT

The climatic conditions in the mountainous areas of Vietnam above 700 m altitude provide sufficient chilling for the production of several deciduous fruits. The range of cultivars presently available with the production system should be widened in order to spread the harvest season and produce quality fruits. Emphasis should be placed on the testing and popularization of low-chilling cultivars which are currently available in the world germplasm collections elsewhere. A systematic program of introduction of certified virus-free material should be undertaken under strict quarantine regulations and a vigorous testing under varying conditions needs to be carried out.

Introduction and testing should also be followed by training in nursery techniques and orchard management with assistance from countries with better resources and technologies in growing deciduous fruits in tropical highlands. Pest and disease control methods should also be included in such training programs.

Since the communication network in the country has already been improved, other aspects of the industry such as skills in handling, storage and processing should be developed through cooperative programs with other countries in the region.

The demand for deciduous fruits already exists and the domestic market should be supplied with new and better produce at reasonable prices. For these reasons and the existence of a potential future for the deciduous fruit industry, the Vietnamese Government has drawn up plans and targeted an expansion program for 100,000 ha in the Northern highlands during the next decade (2000-2010).
9. GOVERNMENT POLICIES AND PLANS FOR RESEARCH AND DEVELOPMENT OF DECIDUOUS FRUITS

Within the framework of the development program in the highlands, the Vietnamese Government has placed a high priority on fruit crop expansion which has already recorded a positive impact on the income of farmers. The advantage of the unique ecological conditions in the highlands will be profitably exploited by growing deciduous fruit crops that require a degree of chilling for successful production.

Several surveys conducted jointly by CIRAD-FLHOR experts and the Ministry of Agriculture have highlighted many limiting factors confronted in the mountainous areas. Based on these problems, the Government has requested assistance from the World Bank through a project proposal for deciduous fruit crop development. This Pilot project for fruit crop development in the Northern areas of Vietnam has been agreed upon by the World bank for funding, totaling a sum of US$1,090,000 for a 5-year period. The project involves also other crops in addition to deciduous fruits. It involves all aspects of production development, including the establishment of experimental sites in five provinces of the North (Son La, Lang Son, Lao Cai, Vinh Phu and Bac Thai). In addition, the Ministry of Agriculture and Rural Development (MARD) is expanding its activities through an Apple Development Project for the Sapa state farm, where nearly 200 ha are being developed for the production of apple by the year 2000. The outputs from this research and development program will help farmers in high altitude areas of Vietnam.

10. CONCLUDING REMARKS

Development of deciduous fruit crops is a challenge that the ethnic minorities are undertaking with the assistance of the Vietnamese Government. In terms of socio-economic impact, these development programs will improve the efficiency of farmer production systems and bring about an enhancement of incomes to the farmers. The Government also hopes to solicit the assistance of developed countries to transfer production skills through training and demonstration. The introduction and adaptation of low-chilling cultivars as well as the transfer of new technologies would be an essential component of this program. The behavior of such cultivars need to be critically assessed under Vietnam conditions. It is also envisaged to launch a hybridization program using the introductions and the locally popular hardy cultivars to improve yield and quality.

CIRAD has already embarked on a cooperative program with MARD for deciduous fruit research and development. This program involves germplasm introduction, improvement of local skills in production techniques, and generation of technology to suit local conditions.
REFERENCES


