

III. FRUIT CROPS

The history of fruit cultivation in this region is short and the area under cultivation is small compared to other regions. As far as we know from recorded information, there were no orchards in Tibet until 1924 when about 10 species of fruit trees were introduced from India and were mainly planted in Yadong county and other border areas; but due to various conditions, especially low socio-economic status and backward cultivation techniques, progress was slow. Since the establishment of the Tibet Autonomous Region in 1960 fruit crops growing has made good progress. The government introduced a great number of fruit saplings from the provinces of Hebei, Liaoning, Sichuan and Shangong etc., and a series of large scale plant experiments have been done in Qamdo prefecture. Because of the weak basis for fruit cultivation and lack of management experience of the local people, the orchards in the region are almost all state-owned plantations at present, and household fruit trees are sporadically planted around the villages. Therefore, most of the plantations are on a small scale. Investigation has revealed that only ten orchards have more than 1,000 fruit trees in Tibet.

In the Himalayan-Hengduan mountain region, most of the cultivated fruit trees are planted on terraces along the valley and gentle slopes which have suitable temperature and rainfall, together with plentiful sunlight and rich soil for tree growing.

In the Himalayan area, fruit trees began to fruit about 1968. Since then, fruit production has increased very fast. Based on statistical data, in 1971 fruit production in the area was only 150 T, but it reached 2000 T in 1974, then 3258 T (1981) and by the end of 1986, the fruit plantation area was 666 ha. and the yield was 4373 T with apple 3637 T (about 83 per cent of the total), pear 326 T (about 7.5 per cent of total) and the other fruit 410 T (9.3 per cent of total).

Species of Fruit Tree

In the Himalayan-Hengduan mountain region, there are various types of vegetation and crops among which fruit trees are abundant, due to the very complex natural conditions. There are about 100 species of fruit trees in this region and can be roughly divided into two categories: (i) tropical and sub-tropical fruits, such as oranges (Citrus sp.), bajiao banana (Musa basjoo), lemon (Citrus limon), pome-granate (Punica granatum), yangtao (Actinidia chinensis), chinese flowering quince (Chaenomeles sinensis); and (ii) temperate fruits, such as apples (Malus pumila), pears (Pyrus), peaches (Prunus persica), plums (P. salicina), cherry (P. pseudocerasus), walnut (Juglans regia), grape (Vitis vinifera), Chinese pear shaped crab-apple (Malus asiatica).

Chinese flowering quince is generally scattered along river valley areas at elevations below 3000m asl. It is an important fruit to use as rootstock for apple. Through experiments in recent years, horticulturists have found that it can make apple trees flower and bear fruit early. Now more studies on this rootstock are in progress.

In the Himalayan mountain area, there are about 60 cultivars of apple, 20 of pear, 6 of peach and 4 of grape vines. Most of these cultivated fruit trees were introduced from the interior of China and can produce high and stable yields, as well as maintain the good characteristics of cultivars grown in their native place when transplanted to suitable areas in Tibet. However, in certain cultivars introduced, fruiting period has changed and quality has deteriorated.

In Tibet only apple and pear have important commercial significance, other fruits, such as orange, peach, grapes, are not produced in sufficient quantity to be commercially viable. A brief introduction to the apple cultivars is given in the following Table.

Table 1. Characteristics features of Apple Cultivars Grown

Species Name	Bearing Age (year)	Fruit Quality	Harvest Time	Storage Property (day)
American Summer Pearmain	4-5	very good	first ten days of Sept.	
Golden Delicious	4-5	very good	middle or late October	150
Starking	5	very good	middle ten days of October	150
Jonathan	5	very good	middle ten days of October	150
White Winter	4-5	excellent	middle ten days of October	120
Pearmain Rall's	6	good	last ten days of October	150
Huanong No. 1	4	good	middle ten days of October	150
Yellow Transparent	3-4	average	first ten days of August	15
Red Transparent	3-4	average	early or middle August	15
Mcintosh	4-5	good	middle ten days of September	100
Cravenstein	5	good	middle ten days of September	20
Ben Daris	4-5	good	middle ten days of September	90

Distribution of Cultivated Fruit Crops

With an area of 800,000 square kilometers, the Himalayan-Hengduan Mountain Region has a wide range of ecological conditions from north to south and from east to west. Because the natural conditions are extremely complex, with vertical variation of landform and temperature, varying degrees of influence by the monsoon, this region can be divided into 3 areas, except for the northwest part of the region which has no fruit crops.

Hot-humid area in the south

All the area, except Zayu County, is located to the south of the Himalayas. Mountains, valleys and canyons have developed because of serious down-cutting of the river. Influenced by the warm, damp air current from the Indian Ocean, with high temperature and abundant annual rainfall (usually more than 1500mm), this area at elevations lower than 1000 meters, is suited to tropical and sub-tropical fruit crops such as banana, mango, litchi, longan, orange, papaya and jackfruit.

Temperate semi-arid and sub-humid area in the middle

The middle and lower reaches of the Yarlung Zangbo River with an elevation of over 3000 meters is mostly located in the sub-humid and semi-arid zone with annual rainfall of 700 to 400mm from east to west, heat ($> 10^{\circ}\text{C}$ accumulated temperature is 2000-6000 $^{\circ}\text{C}$) abundant sunlight (annual sunshine 1500-2500 hours), large daily temperature differences (9-17 $^{\circ}\text{C}$) and lower humidity (relative humidity below 70%). The natural conditions here are suitable for temperate fruit crops specially apple, pear, grape peach etc. With the favourable climate, fruit trees in the area bear earlier, with high and stable yields and good quality fruit with good flavour. Besides the cultivated fruit trees, there are also many wild fruit trees, such as walnut, in this area.

Hot-arid river valleys in the east

Located south of the Sichuan-Xizang highway and east of the Himalayas, this area belongs to the Hengduan mountain region and includes the valleys of Jinsha River, Lancang River and Nujiang River. Due to its topography, cultivated fruit crops are limited to the valleys and gentle slopes. The broad valley bottoms and basins, where the climatic condition is hot and dry, are suitable to develop deciduous fruit trees such as pomegranate, grape and walnut. At high elevations and long gentle

slopes, where the climate is temperate, peach, pear and apple are grown. Although there are some sub-tropical cultivated fruit crops, such as orange, on the south valley bottoms of the Hengduan Mountain Region, the transplanting of fruit trees has been restricted because of low yield and poor quality.

Resource Assessment of Leading Fruit Crops

Apple

Apple, a temperate fruit, of which the native habitat is the inland area of Eurasia, is suitable to these natural conditions: mild temperature (average annual temperature is 7.5-14°C), appropriate rainfall (about 550mm) abundant sunshine (annual sunshine 1600-1800 hours), sunny gently sloping land on the lee side with deep rich soil.

With favourable climatic conditions, most valleys in the Himalayan-Hengduan Mountain Region, especially in Nyingchi, Mainling, Bomi, Nangxian of the Tibet Autonomous Region and Maowen, Xiaojin, Yanyuan, Batang etc of Sichuan Province, are suitable for apple growing (Table 2). In these counties, the average annual temperature is 8.5-13°C and sunshine time of more than 2000 hours, can meet the needs of various varieties (i.e. early, medium and late maturing varieties); with appropriately lower temperatures in winter, the apple tree can pass its dormant period normally; apple trees can be kept from freezing although the extreme lowest temperature is -12°C; annual rainfall of 500-800mm mainly occurring in April to October, can satisfy the demands of apple growing and bearing on the whole; it is favourable to the sugar accumulation in apples because of the high elevation (usually above 2500m in this region and in other apple growing places lower than 500m asl) and because of large daily temperature differences. In most arid valleys of the region, the sugar content is high (usually 10-20 per cent) and acid content is lower (less than 0.5 per cent) in apple fruits (Table 3). Apple production of some valley counties in Hengduan Mountainous Region is shown in Table 4 next page.

Table 2: Comparison of Climate Data of Apple Growing Areas Between Arid Valleys in the Himalayas - Hengduan Mountains and Selected Other Locations

Growing Area	Average Annual Temperature °C	Average Temperature in January °C	Extreme Lowest Temperature °C	Average Temperature in July °C	Annual Rainfall mm	Annual Sunshine hours	Relative humidity %
Nyingchi	8.7	0.4	-11.4	15.8	587.7	2053.5	63
Bomi	8.6	0.2	-13.3	16.5	792.7	1596.9	72
Maowen	11.2	0.4	-11.6	20.8	492.7	1565.9	72
Xiaojin	11.9	2.0	-11.7	19.9	617.2	2188.7	52
Yanyuan	12.6	5.3	-9.7	18.4	490.0	2600.1	59
Batang	12.4	3.6	-12.8	19.5	516.8	2437.7	47
Yantai*	12.6	-1.9	-15.0	25.8	623.2	2624.5	65
Xiangyue**	9.2	-9.2	-30.4	22.4	657.7	2777.5	65
New York/ U.S.A.	10.2	-0.9	-23.3	22.3	1065.0	/	66
Yakima***	9.9	-2.5	/	21.7	199.0	/	50

* Yantai is in Shandong Province, east of China

** Xiangyue in Liaoning Province, north east of China

*** Yakima is in Washington State, U.S.A.

Table 3: Sugar and Acid Content in Apples Grown in Arid Valleys of Hengduan Mountain Region

Area	Variety	Inducing sugar percent	Invert Sugar percent	Total sugar percent	Total acidity percent
Xiaojin County	Starking	13.05	2.70	15.75	0.22
Maowen County	Starking	12.18	0.99	13.17	0.16
Xiaojin County	Richard-a-Red	11.66	3.39	15.05	0.16
Xiaojin County	Golden Delicious	10.15	2.76	12.9	0.20
Batang County	Golden Delicious	8.32	4.58	12.90	0.23
Xiangcheng County	Golden Delicious	6.90	4.84	11.7	0.37

Table 4: Apple Production of Some Counties in Hengduan Mountainous Region (1985).

County	Production tons	County	Production tons	County	Production tons
Lixian	2,061	Wenchian	905	Maowen	6208
Heishui	948	Jinchuan	706	Xiaojin	2318
Maerkang	609	Kangding	663	Luding	787
Danba	377	Jiulong	24	Yajiang	44
Daofu	93	Ganzi	1	Baiyu	25
Derong	20	Daocheng	218	Xiangcheng	91
Batang	349	Huili	38	Mianning	191
Yanyuan	2,253	Muli	251	Hanyuan	4978

Pear

Not strictly limited by natural conditions, pear trees can grow in any place where the elevation is lower than 2500 metres. In the Himalayan-Hengduan Mountain Region, pear trees are mainly distributed in the warm-arid and temperate-arid valleys, especially concentrated in areas such as Xiaojin, Jinchuan, Danba, Hanyuan counties in the basin of Dadu River. There are about 140 cultivars of pear, which belong to three kinds of species system: *Pyrus bretschneideri* Rehd, *Pyrus pyrifolia* (Burm) Nakai (*P. Serotina* Rehd) and *Pyrus communis* L (*P. sativa* DG), in this area. Growing at altitudes of 1900-2500m in the belt along Jinsha River, Jinchuan white snow pear is very famous for its size, appearance, and its spicy, and juicy taste. According to incomplete statistics, there are about 733 ha of pear in this region with a production of about 6,300 tons. Of this, about 330 tons is produced in the Himalayas and the rest in the Hengduan Mountainous Region (Table 5).

Major Fruit Crop Pests and Diseases

Plant Diseases and Their Control

There are about seven major types of fruit plant diseases. A brief description follows:

Sclerotium rolfsii Sacc.

This disease occurs mainly in the orchards of Zhamu, Danqia, Zhalong and Yigong etc. in Bomi county. The incidence of the disease is 30 per cent in the orchard of Zhamu Forest Station and 36 per cent in Zhamu Orchard. Almost all fruit species are affected by this disease and most of the infected trees die.

Sclerotium rolfsii Sacc. appears first on the root collar of the tree and makes the root cortex soften and rotten, then it infects the leaves and makes them wither, and afterwards, the fruits stop developing and at the same time, white fungus hypha appear on the cortex and the tree can fall with little push.

The reason for the spread of the disease is the cultivation of fruit trees under sclerophyllous oak trees. In order to control this disease, the following two points should be observed: (1) avoiding cultivation of fruit trees in sclerophyllous oak forests; (2) regularly inspect fruit trees. When a diseased tree is discovered, it should immediately be taken out. The treatment to contain the disease includes: cutting off the rotten roots; changing the soil around diseased roots, coating with solution of 2.5 per cent phenyl mercuric acetate (1:300).

Apple Scald and Canker

This disease can harm any part of the fruit, leaf, or branch of both apple and the pear. The incidence of the disease is about 46.7 per cent in the orchards of Nyingchi County, and because of the disease, about 5,000 kg of apple is lost every year in Danqia Orchard in Bomi County.

Control Measures: to spray every 10 days with lime-sulphur mixture during florescence (from late April to late May in the region), about 4-5 times every year; to trim fruit tree rationally for the sake of air ventilation and light transparency in the canopy, to apply fertilizer and to inter-till and weed to enhance disease resistance.

Apple Mildew

This disease is found mainly in the counties of Bomi, Nyingchi, Mainling and Luokong, and infected varieties are Jonathan, Ralls, American Summer Pearmain and Huanong No. 1. It is very harmful to inflorescence, new growth of phyllotaxy and fruit. The disease usually occurs from the middle of April to the first ten days of June and the harmful process lasts for about 50 days.

Control Measures: removal of wild Chinese flowering crabapple, which is the source of the disease; cutting off disease-infected branches and buds; spray with lime-sulphur mixture (0.5 degree) 4-5 times (once everyday); improve orchard management; apply phosphate and potash fertilizer to ameliorate the soil.

Apple leaf spot

This disease may occur anywhere in the Himalayan Mountainous Region, but the most seriously affected areas are Zayu County and Bomi County. The leaves will fall 30-45 days earlier than normal if the fruit tree is infected by this disease. Among the various varieties, Ralls, Jonathan and Golden Delicious are the cultivars most susceptible to the disease.

Control Measures: to put prevention first which includes (1) clearing away the source of the disease; (2) cutting the disease-infected leaves and branches (3) improve water and fertilizer management; (4) taking plant quarantine, etc; spray with pesticide 10 days before the disease occurs and then to spray once every 10 days. The commonly used pesticides are Bordeaux mixture (1: 2-4: 200) and 50 per cent thiophanate methyl (1:800).

Taphrina deformans (Berk.) Tul.

This disease occurs in the orchards of Bomi County and Nyingchi County and mainly harms leaves, new growth and branches. When a tree is affected, its leaves crumple and the colour turns from green to pink, even to crimson, and after which the leaves will be coated with a layer of white - grey powder.

Control Measures: spray with Bordeaux mixture (1: 100) to eliminate the source of the disease in early spring; sprinkle leaves with lime-sulphur mixture (0.5 degree) once every 10-15 days after the tree blooms; cut off disease-infected branches in winter and burn diseased leaves when they are discovered.

Rotten disease

This disease can cause two major types of symptom: one kind of ulcerous and in the other, the branches wither.

Control Measures: improve cultivation management; ameliorate the soil by improving soil water conservation; apply phosphate and potash fertilizer to enhance disease-resistance and drought-resistance; coat the stock with white powder to decrease radiation intensity.

Sun heat scathing

Generally, this disease occurs in the high mountain valleys with an elevation of above 3000m such as Lhasa, Xigaze, Gyangze and Qamdo. It harms the inner part of the trunk stem and makes trunk, canopy and branches wither. The disease of trunk rot often takes place in the damaged parts of the tree.

Trunk-rot results from intense sun radiation and physiological drought in spring. Germs (pathogenic bacteria) intrude into the trunk through the infected parts, while the bark is burnt and injured, when brown disease spots will appear on the trunk surface. The controlling measures for this diseases are the same as for Rotten disease. The tree will wither and die when the disease-spots encircle the trunk.

Fruit Pests and Their Control

Red mite

Red mite is a very prevalent pest in the area of semi-arid valleys of Lhasa and Xigaze. Red mite mainly attack old orchards.

This pest is always seen around the main veins on the backs of leaves. They spin a type of cobweb that directly influences the flowering and fruit setting of fruit trees.

Control measures: bind grass on the crotch of a tree, as surviving place of the pest during winter and burn it to kill the mite; spray high concentration liquid of dichlorvos to kill the pest; clear away the source of the pest; spray lime-sulphur mixture (0.6 degree) or 45 per cent Rogor liquid (1:2000) just before flowering.

Eye-spotted bud moth

This pest mainly occurs in the counties of Nyingchi, Bomi, Mainling and Lhasa. The affected part

is leaf and blossom but young fruits are also harmed to some extent.

Control measures: spray with a mixture of DDT emulsion and wettable benzene hexachloride powder once every 10-12 days at fruit forming stage.

Excepting the two main types mentioned above, other pests and their countermeasures are listed in Table 7.

Table 7. Some Pests and their Countermeasures in Orchards of the Himalaya-Hengduan Mountain Region

Pest	Distributed Area	Countermeasures
apple longicorn beetle	Qamdo	to pour BHC liquid into pest holes
peach fruit borer	Yadong	to spray sulphur-phosphorus mixture and dust with BCG powder
apple aphid	Lhasa, Nyingchi	to spray BHC liquid (1:200)
cocoid (scale louse)	Lhasa, Nyingchi	to spray diesel oil emulsion (1:100) or to sprinkle DDT
clearing moth	Zayu	to scrape warped bark and kill the pests
green yellow eggar (lappet moth)	Yigong	to sprinkle 50 per cent dichlorvos liquid (1:1000)
greenish brown hawk-moth	Nyingchi, Bomi	to spray DDT liquid (1:200)
Peach aphid	Nyingchi, Bomi	to spray wettable benzene hexachloride (1:200)

Fruit Harvesting, and Post-Harvest Operations

Fruit Harvesting

The fruit harvesting season is dependent on the biological characteristics of fruit species and varieties concerned, but is also influenced by climate, soil conditions, management levels and cultivation techniques, as well as by relevant fruit use. Take apple as an example; in the Himalayas, the picking season for most varieties is the middle or late October, excepting yellow transparent and red transparent for which picking season is early or middle August.

The fruit should be kept free from any form of damage such as by nail, rough handling, rub-wounds and pressure injury at the time of harvesting. Different picking methods should be adopted for different kinds of fruit and their biological characteristics. For example, we can pick apple, pear etc. by hand because it is very easy to remove carpodium from the branch; but when harvesting grapes, the fruit should be cut with shears to separate it from its branch.

When harvesting, the picking order should be lower fruits first then the upper, and the outer fruits earlier than the inner.

Fruit Packing

It is necessary for safe transportation to pack fruits suitably. But in Xizang, very little fruit packing is done except when the fruit is put on long-distance transport. Even when fruit is packed, the packing containers are very simple and crude, and mainly made from wicker.

Packing methods vary with different kinds of containers. For round containers, fruit should be circularly arranged. For example, apple is circularly arranged layer upon layer in baskets. For rectangular containers, such as pear boxes, fruit is usually placed in rows.

Fruit Transportation

In Tibet, fruit transport mainly depends on highway transportation. According to available data, there are about 15 arterial highways, and 315 feeder highways with a total length of 21,551 km. But most of these highways are rudimentary, often jeopardized by glaciers, frozen earth, landslides and mud-rock flow. So even now, pack animals are used for fruit transport in many places.

Fruit Storage

There are two types of fruit storage, cold storage under natural conditions and artificial refrigeration. In Tibet, the main kind of fruit preservation is natural cold storage for the relatively small quantity of fruit. The early maturing varieties such as Red Transparent, Yellow Transparent can be stored for shorter periods than mid or late maturing varieties such as Jonathan, Delicious, White Winter Pearmain, which can be kept for a long time.

Marketing

There is little or no surplus fruit available in Tibet. Much of the fruit production is sold in Lhasa and a very small amount is marketed at local county towns.

Fruit Processing

There is no fruit processing industry in Tibet at present because of lack of transportation, the non-availability of raw materials such as glass, and tin plate and lack of equipment for processing which is difficult to buy and to transport; the other reasons are the backwardness in science and technology and the lack of technical personnel in Tibet. This is a major drawback for fruit production in Tibet and more attention should be paid to this immediately through suitable measures to improve conditions and by overall planning.

Measures to Increase Fruit Production

Improve local conditions

Better transport services and stronger technical advice and management in areas, such as Bomi, Nyingchi, NanXian, Jiacha and Mainling, should enlarge orchard area, improve management and solve the problems of processing and storage of fruits and thus become the bases for fruit supply. The government should positively create factors to support the development of collective orchards, and also encourage individual cultivation, so as to ameliorate the present situation of produce supplied by only a few places. This would not only enliven the economy of the mountain area, but also improve the people's nutrition conditions.

In order to guarantee a longer period of fruit supply every year, advantage should be taken of the fact that Tibet ranges widely from south to north and its topography undulates. For variety selection, attention should be paid to having an appropriate mixture of early, medium and late varieties to regulate the market supply.

Strengthen the management of orchards. raising the output and quality of fruit produce.

This includes cutting tree branches, increasing applications of manure and irrigation, preventing plant diseases and insect pests, and timely harvesting of the fruits.

Relax policy restrictions, encouraging peasant families to grow fruit trees.

Agricultural production is mainly carried out by peasant families. For this reason, the production and management of fruit trees must take this into account. The government should implement a protective policy for the development of horticulture. There should be proper arrangements for training and guidance in cultivation and management, essential inputs should be provided.

Introduction of imported plant material

In the initial stages of fruit production it is essential to import a large number of fruit plants. However, there are also cultivated and wild varieties of fruit trees in Tibet which should be collected. Trials should be carried out on the imported plant material before introducing it on a commercial scale. Cultivars should be of good quality with high productivity suitable to local conditions resistant to frost, drought, plant diseases and pests.

Assessment of Fruit Sector

Establish professional study on production and problems of fruit sector to solve the various problems that occur and develop the breeding, planting and popularizing of good varieties so as to accelerate development.

Introduction of dwarf trees.

The dwarf tree has the advantage of maximum utilization of solar energy, manure and water, is convenient to manage, has feasibility for mechanization and is reasonable in land use. Having begun with wild Chinese flowering quince as apple stock, Tibet should now continue to experiment and cooperate with other areas for exchange of information and plant material.