APPLE PRODUCTION : CHALLENGES AND PROSPECTS

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ABSTRACT

Apple development in Nepal was geared up only after 1960 with technical and financial support of Indian Aid Mission. Many cultivars have been introduced so far and some have adapted very well under Nepalese condition having Red Delicious a main leading apple cultivar. These cultivars have been propagated and distributed throughout the country both by government as well as private sectors. As a result the area covered by apple and its production were increased dramatically since 1975 and the current production and productivity of apple are estimated at 28595t and 9.5 t/ha respectively.

It has been well established that apple production in Nepal has been very successful in dry temperate region in remote areas and has been considered as one of the high value priority commodities in the high hills. However, the commercialization of apple production has been challenged by infrastructure, physical and environmental, agronomic and technical support constraints. Provided these deficiencies are removed, there is a tremendous prospect of commercialization of apple industry in the country.

INTRODUCTION

Apple is the most important temperate fruit crop of Nepal. It is grown in areas in the mid as well as high hills from the east area to the far western of the country. It is cultivated in two distinct agro-ecological zones namely dry temperate and humid temperate areas. The river valleys in the inner Himalayan areas are characterized by sparse rainfall during the growing season and are considered to be most appropriate for cultivation of top quality apple. Such dry temperate regions lie mostly in the rain shadow areas and are located in western and mid-western mountain districts of Manang, Mustang, Dolpa, Kalikot, Jumla, Mugu and Humla etc. In contrast, the humid temperate regions are fairly wet throughout the growing season in the rest of the country and are suitable for the cultivation of apple for home consumption.

Successful cultivation of apple is also delineated by altitude limits and chilling needs. Generally, it thrives well in an altitude of 1800-2800 m. above sea level (masl). Some cultivars with high chilling requirements (> 1000 hrs) crop well in altitudes upto 3000 masl. The lower chilling types (< 1000 hrs) survive and produce fruits even at 1200 masl (Ranjit, 1990).

The apple is considered to be a native of south west Asia, eastern Europe and south west Siberia (Singh, 1986). Though certain types of wild apple such as Edi Mayal and Surkhilo are indigenous to the inner Himalayan region like Karnali Zone of Nepal (Shrestha and Shrestha, 1985), improved cultivars of apple have only been introduced in Nepal for the last four decades. But, within this short period, apple is well established. It became so popular that the area under apple cultivation is increased every year.

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REVIEW OF APPLE CROP IN NEPAL

The review of works done on research and development is briefly described under:

Apple research : No groundwork has yet been laid in Nepal to initiate any systematic research work on fruits in general and apple in particular. Research work on apple has been very fragmentary and primitive. Whatever little has been undertaken so far is reviewed below in the following order.

Germplasm Collection : Improved cultivars of apples were first introduced in Nepal from India in the early nineteen hundred and sixties and planted for evaluation in different horticulture farms at Kirtipur, Kakani, Daman, Helambu, Mustang, Jumla and Baitadi etc. Later on, exotic varieties were also introduced from the United Kingdom, Israel, Italy and Japan etc. More than eighty cultivars of apple were thus collected (Table 1) in different horticulture farms.

Apple cultivars are generally grouped according to their chilling requirement. The principal high chilling apple cultivars available in Nepal are Delicious (Red Delicious, Royal Delicious and Richared Delicious), Golden Delicious, McIntosh, Jonathan, Rome Beauty, Granny Smith & Sweet Ambri (Chocolate) etc. The mid-chilling cultivars available are - Crispin, Katza, Red June, Cox Orange Pippin, King of Pippin and the low chilling cultivars available are -Anna, Vered, Naomi, Gallia Beauty, Winter Banana and Tropical Beauty etc. (Ranjit & Pun, 1990).

Varietal Evaluation: In the name of varietal evaluation, phenological trials have been conducted on apple in Nepal for a long time without any concrete recommendations. Few trials have been initiated but not properly concluded and reported. The first study was carried out on the performance of seventy apple varieties at Kirtipur in 1973. Vegetative vigour and reproductive characteristics such as flowering period and fruiting of the bearing trees were reported. (Bhomi, 1973)

Performance studies on apple were continued later on and findings of four such studies were reported in the National Horticultural Seminar conducted at Trishuli in 1985. Two studies were carried out at Kirtipur whereas one each was conducted at Helambu and Rasuwa respectively. Reports from Kirtipur indicated that the performance of most of the high chilling cultivars of apple were not good but most of mid chilling ones such as Katza and Crispin & the low chilling ones such as Anna and Vered were acceptable. The varietal characteristics of these four cultivars were described. The studies conducted on high chilling cultivars of apples such as Delicious, Golden Delicious etc. came up with contradictory results. At Rasuwa, Delicious group yield better than Golden Delicious whereas the opposite was true at Helambu. Similarly, three phenological studies on apple were reported in the Proceedings of the National Horticultural Seminar held at Dhankuta in 1986. The findings from Helambu had already been reported at Trisuli the previous year. At Kirtipur the development stages of blooming of 16 cultivars of apple were determined and correlated with the prevailing temperatures during the spring season. The cultivars were grouped together into three categories namely early (full bloom in the last week of March), mid season (full bloom in the first week of April) and late (full bloom in the second and third weeks of April). All the varieties studied seemed to have escaped frost injury. It was very important for a particular variety of apple to escape spring frost injury which is caused by minimum temperature falling below a critical point of - 3.9^0 C during the blooming period between full pink and anthesis

Table 1. Apple germplasm collected in different government /private farms

S. N.	Name of the farms	Apple Germplasms
1	Horticulture Farm Phaplu, Solukhumbu	Red Delicious, Royal Delicious, Rich-a-red Delicious, Golden Delicious, Jonathan, Stark Earliest, McIintosh, Summer Pippin, Granny Smith, Fuji, Red Gold
2	Agriculture Research Station Pakhribas	Anna, Vered, Katza, Summer Pippin, Crispin, Ain shemir, M9, MM-106, MM 27 and MM 109
3	Horticulture Farm Bonch, Dolakha	Golden Delicious, Royal Delicious, Red July, Golden Spur
4	Horticulture Farm, Godawari	Anna, Vered and Katza
5	Horticulture Farm, Kirtipur	Red Delicious, Royal Delicious, Golden Delicious, Anna, Vered, Crispin, Katza, Malus prunifilia Fuji, Sansa, Janagold Grany Smith, Idared
6	Horticulture Farm, Daman, Makwanpur	Red Delicious, Royal Delicious, Golden Delicious, Fuji, Sansa, Jonagold
7	Horticulture Farm, Marpha, Mustang	Red Delicious, Royal Delicious, Rich-a-red Delicious, Golden Delicious, Jonathan, Benony, McIntosh
8	Agriculture Res. Station (Horticulture) Jumla	Red Delicious, Royal Delicious, Rich-a-red Delicious, Golden Delicious, Jonathan, Benony, McIntosh, Janathan, Torekullu, Masadi, King of Pippin, Cox Orange Pippin , Ambri
9	Horticulture Farm, Humla	Red Delicious, Royal Delicious, Golden Delicious, Benony, McIntosh
10	Horticulture Farm, Baitadi	Red Delicious, Royal Delicious, Rich-a-red Delicious, Golden Delicious, July Delicious, Winter Delicious, Stark Earliest, Red June, Stark Early Blaze, Worcester Pearman, Tydeman Early, Tydeman Late, King of Pippin, Jonathan, Winter Banana, Kashmiri Ambri, Benony, McIntosh, Red Gold, Rome Beauty, Granny Smith, Siberian Scarlet, Stark Crimson, Lord Lamborium, Indo, Trail, Jonathan
11	Sherpa Bagwani Farm, Solunimar - 8, Solukhumbu	Golden Delicious, Jonagold, Boskoop SH, Jonathan, Vista Bella, Summer Red, Prime Rouge, July Red, Berner Rosen, Gold Parmane, Granny Smith

(Ballard et at, 1971). Since apples are grown successfully in temperate areas which are prone to spring frost damage, such blooming studies should be conducted before any variety is recommended.

A phonological study was also carried out on six apple cultivars at Baitadi. The results of the study indicated that based on vegetative as well as reproductive data four cultivars namely King of Pippin Golden Delicious, Delicious and Red June could be successfully grown under Baitadi conditions.

Most of the varietal evaluations have been carried out in the wet temperate areas so far. Systematic varietal trials on apple have not yet been conducted in the important apple growing areas such as Mustang and Jumla. However, the average production of fully mature tree of a Delicious group at Marpha, Mustang has been estimated at 135 Kg and the chemical analysis of fruits of 15 apple varieties has been performed. (Bagbani Sandesh, 1991).

Plant Propagation: The apple sapling is generally propagated in Nepal by bench or in situ grafting on seedlings of crab apple, Edi Mayal or clonal rootstocks such as Malling series (M 9, M26, M27), Malling Merton series (MM 101, MM 106, MM111) or Malus prunifolia. Some research works on vegetative propagation of apple have already been published in Nepal. A study on the effect of different concentrations of rooting auxin (Indole butyric acid or IBA) on the hardwood cuttings of different apple rootstocks such as M25, MM 106, MM 109 and Malus prunifolia indicated that an overnight dip at 50 to 100 mg IBA per liter could induce from 35 % to 63 % rooting depending on the variety of the rootstock. (Ranjit and Manandhar, 1997). The rooted cuttings of such important clonal rootstocks of apple can either be established separately in nursery rows for in situ grafting or used as mother stocks on stool beds for mound layering. Stool beds should be shifted once every eight years to fresh ground to invigorate the plants. (Hartmann and Kester, 1983). The stool beds should never be used directly for in situ grafting as being practised at Kirtipur. (Howard, 1974). Similarly, a micro propagation technique has been developed to rapidly propagate some apple rootstocks such as Malus prunifolia at Kirtipur. (Ranjit and Upadhya, 1987). A comparative study between bench gnafting and in situ grafting of apple conducted at Kirtipur indicated that in situ grafting was superior to bench grafting in the sense that standard grafted saplings of apple could be prepared by the former method within one year in areas which are suspected of crown gall infestation (Ranjit, 1988). To ameliorate the problem of crown gall infestation, replacement of bench grafting by in situ grafting of apple was also recommended by Van Slotten, 1979 and Howard, 1973. In a study carried out with Malling rootstocks in Mustang, it was found that M 26 induced most dwarfing, highest yield and lowest woolly aphid infestation on Delicious group of apple compared to other clonal rootstocks such as M 7, M9, MM 104 and crab apple (Bagbani Sandesh, 1991).

Orchard Management: Reports on apple orchard management research in Nepal are very scanty and mostly restricted to plant protection. The most important diseases of apple have been identified to be apple scab (in humid area), powdery mildew and papery bark or pink disease. Similarly, the most serious apple pests are identified as woolly aphid, San Jose scale, defoliating beetle and apple borer. A fungicidal trial on the control of apple scab in Helambu indicated that fortnightly sprays of 0.2 % Bavistin during the growing season were most effective to bring down the infection rate from 33.2 % to 9.7 % (NHS, 1985). Apple trees were reported to be free from apple scab in Jumla and in the dry areas of Mustang (Cassidy, 1976).

The papery bark or pink disease has been a major problem in all the apple growing areas of the country. The effective control measures are to apply Bordeaux or Chaubattia paste (50 g each of red lead and copper carbonate in 100 ml of raw linseed oil) after the removal of affected bark or to spray Bordeaux mixture (6:6:50) at an interval of 20 days, Some apple Cultivars such as Golden Delicious, Jonathan, Benony, Cox Orange Pippin and Anna are very susceptible to powdery mildew which can be effectively controlled by spraying with 1% Kerathane or dusting with lime suplhur (Ranjit & Pun, 1990).

As far as apple pests are concerned, the most important one is considered to be woolly aphid which was first reported in Nepal by Rana & Sharma, 1966. A st dy conducted in Jumla in 1982 indicated that Demacron at the rate of 0.04 % and Sumithion at the rate of 0.1 % were most effective in controlling the aphids (NHS, 1986). Effective chemical control can also be obtained by using Metasystox (0.1 %) or Malathion (0.01 %). However, an integrated pest management using resistant rootstock varieties such as Malling Merton series, Malus prunifolia or Edi Mayal and making use of natural parasite such as Aphinus mali has been recommended (Ranjit & Pun, 1990).

San Jose scale has recently been reported on apple from Jumla and Mustang . It is potentially a very dangerous pest affecting both the stem and fruit of apple. It can be controlled either by dormant sprays of diesel oil and rosin or summer sprays of Diazinon at 0,03 %. A spray schedule of diesel oil and other insecticides such as Sumithion, Diazinon & Thiodan from February to July has been very effective in controlling San Jose Scale at Marpha (Bagbani Sandesh, 1991).

Defoliating beetles and stem borers are another economic pests of apple which can be controlled by sprays with Parathion at 0.05 % or stuffing the borer holes with parachloro benzene powder at 1 gm/cm^2 or kerosene cotton plugs.

Post-harvest management : Post-harvest management research on apple is very limited in Nepal. Since most of the apples are grown in remote areas, there is no access to markets immediately after the harvest. So, the fruits should be kept in storage for a long time. In order to enhance the storage life of apple, a few storage trials have been conducted. One such trial conducted in Helambu indicated that treating the fruit with 0.2 % Bavistin solution and wrapping with polythene induced minimum loss during storage for seven months (NHS, 1986). But such post-harvest treatment of fruit with fungicide may render it inedible and hazardous to health. Pre-storage washing of fruits for five minutes with cold water and treating them with 0.25 % potassium permangnate solution for 2-3 minutes were found to enhance the storage life of apples in Mustang. An indigenous method of cellar storage has been developed in dry areas like Mustang whereby well graded and pre-treated apple fruits are packed in wooden crates which are stacked in racks in dark cellar stores where the temperature and humidity are maintained at 5 – 7^{o} c & 85 - 95 % respectively by providing running water channels on the floor. Apples have been found to behave differently after seven months in such cellar storage depending upon the cultivar. Generally, Delicious apples incurred net weight loss upto 12 % and storage damage upto 53 % compared with 17 % & 86 % respectively by Cox Orange Pippin (Bagbani Sandesh, 1991).

A recent post-harvest study on Rasuwa apples indicated that if wrapped in polythene bags, they can be safely stored for a month under room temperatures, for two to three months in the cellar storage and for upto four months in cold storage (Shrestha, 1995).

Lack of reliable transportation from the source of production to the market centres is also a very important problem for apple growers in the high hills. In this regard, a study was conducted on transporting Marpha apples to Pokhara by mules. Three means of packaging materials namely jute sacks, wooden boxes and cardboard encaged in high density polythene pipe frame were used. After six days of transportation, only 7.5 % apples were damaged in cardboard packs compared with 30.5 % in wooden crates and 90.2 % in jute sacks (Bagbani Sandesh, 1991).

Apple Development

His Majesty's Government of Nepal has placed special emphasis on fruit development in the hills. Development of apples has been prioritized in different periodic development plans. In this regard, support of Indian Aid Mission in Horticulture Development Programme of Nepal (1960-1973) was quite crucial. During this period many horticulture farms were established in different agro-ecological zones of the country and suitable apple cultivars were introduced from India. The demonstration effect of the horticulture farms situated in Jumla, Mustang, Baitadi, Rasuwa, Helambu and Daman led to the establishment of private apple orchards in the command areas. The area under apple was expanded dramatically during Agriculture Year in 1975 when grafted apple saplings were distributed to apple growers free of cost.

In the beginning, most of the demand for grafted apple plants was met by imports from India. Later on government farms started producing grafted plant of improved and adopted cultivars & distributed them to the farmers.

Until the early seventees, the in-country situation of the demand and supply of grafted apple saplings was not well established and the supply of apple saplings was supplemented by imports from India. In the same way, the supply of crab apple seed for apple rootstocks was dependent on the importation from India. During the seventees, a great deal of effort was made to encourage private nurserymen to establish apple fruit nursery in the apple growing pocket areas. As a result, a number of apple nurseries were established all over the country and by late seventees self-sufficiency was achieved in the production of grafted apple plants. At present 21 Private Nurseries are actively functioning (FDD 1997/98) but the quality of saplings produced by the private is still poor. The saplings produced and sold by the private nurseries have been of unknown progeny and are often diseased and unhealthy.

Apple germplasms have been collected and maintained in the different horticulture farms which are scattered in different agro-ecological zones of the country. Most of the horticulture farms have tried to maintain these germlasms but few have been lost for ever due to adaptability problem, disease & neglect. For example some of the important germplasm of Malling & Malling Merton rootsstocks of apple have been lost from Horticulture Centre, Kirtipur.

The main activities of the government farms include maintenance of germplasm, production of grafted plants of important & adapted cultivars development of appropriate technology of orchard management & post harvest operation.

The major post-harvest activities in apple consist of cleaning, grading processing, transportation and storage. The average loss in weight of apple after these operations has been estimated to be as high as 25 % (Gupta, 1992).

The major factors affecting post-harvest losses in apple have been identified as the improper stage of harvest, lack of grading, lack of proper packaging materials and technique in packing, lack of transportation and storage facilities. Some efforts have been made on processing of apple such as making apple cider, apple jam and dry apple slices and on establishing cellar storage in apple production areas. But the problems of transportation and marketing of apple have not been tackled.

There is a good market of Indian apple in Nepal as indicated by apple import (fresh apple and processed) worth Rs. 1.9 m rupees from India in 1992/93 (FTS 1992/93) but apple produced in the country is still facing a problem of market. It is not because there is lack of market but because there is lack of marketing system and market management. There is no

market access to apples produced in remote areas of the country. The networking of internal market are not yet properly established. Nepalgunj and Pokhara are main outlets of Jumli apple and Mustang apple respectively. A good start was made when Agro Enterprises Centre (AEC) initiated marketing of Mustang apple through Helicopter charter in 1995 by bringing about 32t of apple from Mustang to Kathmandu but such efforts could not be continued on a sustainable way.

Similarly, apple are transported by air from Jumla to Nepalgunj using empty space of the return flights chartered by Nepal Food Corporation. Even for empty space apples have to compete with other goods such a dried herbs that fetch better price. In order to make apple more competitive, they should be graded and packed better than in jute sacks.

PRESENT STATUS

At the end of the Eighth Five year Plan (1997), the total area under apple has been estimated at .4652 ha with the production of about .28595 tons which comprises 6.7 % of total fruit production in Nepal. The current productivity of apple is estimated at 9.5 t/ha. (Agriculture Statistics Division MOA, 1997). (Table No. 2)

Table 2 : Area, Production and Productivity of Apple

Year	Area (ha)	Productive Area (ha)	Production (t)	Productivity (t/ha)
1996/97 (End of 8th plan)	4652	3006	28595	9.5
2001/02 (End of 9th Plan)	6927	3264	34924	10.7

Source : ASD, MOA 1996/1997, FDD Kirtipur.

Based on the successful story of apple production in Jumla and Mustang , and its advantage, the Agriculture Perspective Plan (APP) has identified apple as one of the high value priority commodities in the high hills. Accordingly in the Ninth Five Year Plan, HMG/N has taken a policy of developing commercial orchards of apple in suitable pocket areas where transport and marketing infrastructures have already been developed or are in the process of developement. Similarly, homestead apple production for family consumption is being encouraged in the high hills in other districts. In order to exploit the commercial potential of apple, 11 districts have been identified as apple priority programme districts specially in Karnali zone. Additional areas of 2,000 ha and 275 ha will be covered under apple under commercial and general programmes respectively during in the Ninth Plan period. (Table No. 3). The area and production of apple are estimated to reach 6927ha. and 34,924t respectively by the end of the Ninth Plan . (Table No.3).

Under the commercial programme, the farmers will be provided with 50 % subsidy towards the cost of planting materials and horticulture tools such as secateurs and pruning saws and 25 % subsidy towards the cost of sprayers in addition to full subsidy on transport and packaging charge of the planting materials.

Production and supply of apple nursery plants are being encouraged in private sector by establishing 3-5 nurseries according to need of the district. By 1996/97 about 98 private fruit nurseries (temperate fruits) have been established (FDD 's Brochure 1997). Out of that only 21

private nurseries are found to be active in 1997 (Balance sheet of FDD, 1997). At present, about 84,000 apple saplings are being produced from Government and private sector.

Extension activities are generally carried out through farmers' groups. The improved technologies are transferred through apple demonstration orchards which are established in different apple .pocket areas. Agriculture loan is provided in time to apple growers by Agriculture Development Bank,

Table 3 : Area expansion under Apple during the Ninth Five Year Plan (1997/98 to 2001/2002)

District	Situation at the 1996/97		Additional Areas (ha) during Ninth Plan					Ninth Plan Total
	Area (ha)	Prodⁿ (mt)	1997/98	1998/99	1999/2000	2000/2001	2001/2002	
1. Mustang	380	2693	4	4	4	4	4	20
2. Jumla	349	2465	15	25	40	120	160	360
3. Humla	112	789	12	15	25	62	100	214
4. Kalikot	159	1124	10	15	30	120	160	335
5. Dolpa	142	1006	10	15	20	25	30	100
6. Rukum	352	1862	15	20	30	80	100	245
7. Rolpa	116	614	15	20	40	100	100	275
8. Bajhang	121	848	10	15	20	30	50	125
9. Bajura	75	532	11	15	20	30	50	126
10. Baitadi	193	1018	5	10	15	25	30	85
11. Darchula	102	720	10	15	20	30	40	115
11 Districts Total	2100	13671	117	169	264	626	824	2000
National Total	4652	28595	189	234	319	671	862	2275

Source : Working paper presented to working committee of High Value crop of NPC by FDD, 1996/97.

Agriculture Inputs are supplied by Agriculture Inputs corporation (AIC) through its dealers and private agro-enterprises.

Post harvest losses are still high in apple. The containers mostly used by the farmers are bamboo baskets. Very few farmers use wooden boxes, plastic crates or corrugated cartoons for packaging apples. Sorting and grading of apple are generally not practised by the farmers. After harvest the apple growers generally take their product to the nearby local markets e.g. airport areas of Jumla, Dolpa, Mustang and Bajura during flight days. Some farmers' group take their produce to distant markets also e.g. Jumla apple to Nepalgunj and Mustang apple to Pokhara. Businessmen are not yet attracted to production areas to get involved in the marketing management of apple.

Apple is transported mostly by porters (Doke) and sometimes by aeroplanes. Transport system is not well organized as there is no road access and no responsible organization.

Cellar storage is being succesfully used by apple growers for on-farm storage of apple, such storage structures are getting popular among the apple growers. Cold storage facilities are not sufficiently built and multi chambered cold storage facilities are not available in the country. HMG/N has planned to encourage and assist the private sector's involvement for the construction of collection centres, cellar storage, cold storage and other market structures.

Processing of apple is done on a very limited scale. Apples are sliced and dried into apple sukuti. Apple is also processed as apple jam, apple cider and apple brandy specially in Mustang.

CHALLENGES

Though apple is produced successfully in some parts of Nepal, its widespread cultivation has been constrained by a number of factors which can be broadly categorized as a) Infrastructure constraints b) Physical and environmental constraints c) Agronomic constraints and d) Technical support constraints.

Infrastructure Constraints : At present successful apple cultivation is limited to remote areas in the high hills with dry summer and wet winter. These areas are not yet accessible by road and are not located near urban areas and districts headquarters. Regular supply of essential inputs such as chemical fertilizer, plant protection chemicals and horticulture tools and implements is not dependable in these areas. Apple trees do not have prioritized access to even the locally produced compost and farm yard manure over cereal crops. In addition, marketing infrastructure are often quite inadequate and primitive. Similarly, storage and processing facilities are not well developed in all the apple growing areas of the country.

Physical and Environmental Constraints : Apples are grown mostly in marginal land where grain crops are not suitable for growing. In such areas the soil is often shallow, highly leached, acidie and low in nutrients especially nitrogen. Application of manure, compost and stubbles is not supplemented with chemical fertilizer which causes decline in soil fertility. So, the low natural fertility of soils and the lack of supplemental fertilizer are the main physical constraints. There is often a lack of rainfall and irrigation water in spring, early summer and winter to soak the root zone. This causes poor fruit set and low yield.

Adverse climatic conditions such as monsoon rains and cloud-ness during fruit development and maturation, uneven distribution of rainfall, dry spring and winter, hailstone, spring frost and winds have impeded apple cultivation in Nepal.

Agronomic Constraints : Agronomic constraints for apple production in Nepal mainly consist of lack of superior planting materials and incidence of economically important insect pests and diseases.

Improved apple is often produced by grafting cultivar scion on seedling crab apple which imparts excessive vigour on the tree characterized by very vertical growth and absence of cropping (Howard, 1974). Even the purity of crab apple seeds cannot be guaranteed sometimes, because they tend to get mixed with seeds of improved cultivar. So, clonal rootstocks such as Malling series, Malling Merton series, Edi Mayal or Malus prunifolia are preferred. They are not readily available in all the horticulture farms and the private nurseries. Sometimes the private nurseries do not have access to the superior scion woods collected from healthy and precocious mother plants.

Another important constraint to apple production is the occurence of economically important pest such as woolly aphid, San Jose Scale, defoliating beetle and apple borer; and diseases such as applescab, powery mildew, papery bark and sooty blotch which have been already dealt with.

Technical Support Constraints : Apple cultivation in Nepal is presently facing a grave problem of a total lack of research and technology development and stagnation in the technical career development of the technicians. Though Nepal Agriculture Research Council is the sole agent responsible for apple research and technology development, currently only a little research of any significance is going on towards solving the technical problems the growers

are facing in the country. There is no co-ordination between research and development either. Though there are horticulture extension staff working in all the districts of the country today, they are completely deprived of technical backstopping when it comes to solving a burning technical problem on apple cultivation. Today the number of apple specialist is very limited in the country. They have no opportunities to remain actively involved in technical and research work and have relatively little contact with the outside world of horticulture, either through access to literature or by personal contact. Due to the lack of special training on apple they will not be able to perform when they are called upon to solve the specific technical problems of the apple growers (Ranjit, 1990).

PROSPECT

In spite of the general constraint mentioned above, an immense prospect exists for the development of an apple industry in Nepal. Pocket areas suitable for commercial cultivation of apple have already been identified. These areas are becoming more and more accessible every year because of the construction of new transport infrastructure. For instance, the opening up of Pokhara-Baglung road and the construction of Baglung Beni dirt road have drawn Mustang apple area more closer to the market centre. Similarly the construction of Surkhet - Dailekh road and its extension to Kalikot will make Jumla and its surrounding apple areas quite accessible in near future. If ropeway lines were constructed between Kalikot and Nagma of Jumla, and between Tatopani and Jomsom of Mustang, potentials for commercilization of apple industry would soon be realized.

There is a large internal demand of apple which is growing every year in Nepal because of increasing population, increasing number of tourists and increasing awareness about the nutritive value of Apple. At present, this demand has been largely met by imports from India. So, market for commercial produce of apple within Nepal is no problem. Lack of proper post harvest handling, marketing system and marketing infrastructures such as collection centres, sheds, cellar storage and cold storage etc. are a big problem.

Since most of the apple growing areas in Nepal are food deficit areas, the present produce of fermenting or distilling alcohol out of food grains could be discouraged by making apple brandy and cider while the present practice of making dried apple slices should be encouraged.

Commercial cultivation of apple in pocket areas would generate additional employment opportunities through the promotion of apple based industries such as picking, grading, packaging, transportation, storage and processing. Plantation of apple orchards on sloppy land favourable to soil erosion would also contribute to environmental conservation.

RECOMMENDATIONS

1. Commercial apples orchards should be planted on more favourable agricultural lands than on marginal land. Selecting well drained sites on alluvial soils in valleys and location in the hills where irrigation can be supplied; would provide optimum soil water conditions for commercial orchards,
2. Scattered apple production should be consolidated by developing commercial orchards in pocket areas and providing both the production and post-harvest technologies to the apple grower.
3. Private nurseries should be encouraged to produce healthy and standard saplings of adaptable apple cultivars. For this , more adaptable varieties of scions and clonal

rootstocks should be introduced and evaluated. Nursery Act should be formulated and enacted to maintain the quality sapling production.

4. Improved post harvest technology should be developed and used for apple industry in Nepal.
5. Transportation, Marketing System and Marketing Infrastructure should be developed for apple industry in Nepal.
6. Apple research should be accorded a high priority. Significant research or specific production oriented problems should be undertaken by creating capable and highly trained manpower, allocating sufficient budget and building infrastructures such as good nursery, orchard, laboratories and library.
7. A good working relationship between research and development should be established. At present the mandate for apple research and budget are within NARC whereas that for extension and manpower are within the Department of Agriculture. Unless and until, these two institutions go hand in hand, no development of apple industry is possible in Nepal.
8. Since spur types of apple are more precocious than the normal cultivars they should also be introduced, evaluated and made popular in Nepal.
9. Research should be conducted on integrated pest management and integrated nutrition management of apple

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