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Apple Cultivation in India

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Introduction

Horticultural development in the mountains in India has been concentrated in the temperate zones for the most part. In fact, horticultural development in these areas is generally considered synonymous with the development of hill fruits, in general, and temperate fruits in particular. This paper, therefore, is primarily focused on temperate horticulture although the observations and recommendations may apply equally to all fruit crops in the region. The Himalayan hill region covers more than one-eighth of the total area of India and makes up the entire boundary of the country running from Jammu and Kashmir in the west to Arunachal Pradesh in the east. It is divided into two distinct sub-regions: the northwest hill region and the northeast hill region (NWHR and NEHR). The NWHR covers the states of Jammu and Kashmir and Himachal Pradesh and Uttar Pradesh hill districts.[1] The NWHR has an area of 324,000 hectares and a production of 948,000 tons. Apple is the most important fruit and the NWHR has 99 per cent of its area under apple cultivation. The basic information of this region is given in Table 2.1. The NEHR includes the states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Tripura, and Sikkim. However, most of the NEHR has sub-tropical and tropical fruits. The entire NEHR has only 7469 hectares under temperate and sub-temperate (hill) fruit cultivation and this is distributed as presented in Table 2.2.

In view of the facts explained above, the main focus of this presentation is on temperate fruits, which are primarily confined to the NWHR.

[1] Uttar Pradesh in this paper refers to the eight hill districts and not the plains areas.

TABLE 2.1
Basic statistics of NWHR

Area	Population (million)	Total area ('000 Kms)	Area under tree crop ('000 ha)	Area under apple ('000 ha)
Jammu and Kashmir	5.9	222	166	67
Himachal Pradesh	4.28	55	142	55
Uttar Pradesh	4.84	51	160	51
Total NWHR	15.10	328	468	173
NWHR as per cent total Himalayan hill region	62	56	76	99

TABLE 2.2
Fruit production in NWHR

State	Area (ha)	Production (tons)
Arunachal Pradesh	4,756	9,500
Manipur	1,750	24,700
Meghalaya	631	3,175
Nagaland	317	830

Source: National Horticultural Board, India, 1988.

However, the technology for development, observations, and recommendations made will apply to the entire mountain region.

Climatically, for the purpose of fruit growing, the NWHR can be divided into four distinct horticultural zones. These are given in Table 2.3.

The suitability of different tree crops to specific areas is governed primarily by climate. In the NWHR the climate can change within short distances because of the abrupt change in elevation or proximity to the plains or to snow-covered peaks. Although total rainfall in the NWHR is good, distribution is such that moisture stress is often experienced at critical stages of fruit growth. Almost all the orchards in Uttar Pradesh about 80 per cent of those in Himachal Pradesh, and 60 per cent in Jammu and Kashmir are rainfed. It is estimated that of the total area of 468,000 hectares under tree crops in the NWHR, about 80 per cent is subject to moisture stress at some time of the year.

The expansion of tree crops was rapid in this region and by 1985/86 they covered about 20 per cent of the cultivated area. The state-wise figures are presented in Table 2.4.

A part of the area under tree crop cultivation has been diverted from grasslands, wastelands, and even cultivable wastes. Therefore, the percentage figures for the cultivated areas are just a rough indicator. The exact figures for the cultivated areas that have been diverted to horticulture are not available.

TABLE 2.3
Annual rainfall and important fruits of different zones

Zone	Annual rainfall (mm)	Most significant fruit crops
Temperate zone: high hills with low winter temperatures, experiencing snowfall.	600–1000	Apple, pear, cherry, walnut, almond, and chestnut
Dry temperate: high elevations very cold in winter, very little rainfall.	130–300	Apple, grape, prune, and drying varieties of apricot. These can be grown if irrigation is available.
Sub-temperate: hills lower than in the temperate zone; winters are less cold (no snowfall).	800–1000	Stone fruits such as peach, plum, apricot, almond, pear, pecan, nuts and olive.
Sub-tropical: low hills and valleys adjoining plains.	800–1000	All sub-tropical fruits such as mango, citrus, guava, oriental pear, fig, and grape

TABLE 2.4
Area under tree crops in NWHR (1986/87)

	Jammu and Kashmir	Himachal Pradesh	Uttar Pradesh	Total NWHR
Cultivated area ('000 ha)	817	601	698	2116
Area of tree crops ('000 ha)	166	142	162	468
Per cent under tree crops	20	23	23	22

Source: National Horticultural Board.

In most of these areas there is severe degradation of land. Many hills are devoid of vegetation, others have no soil and still others have only a thin layer of soil, which is also in the process of being washed away. Therefore, the resources are shrinking. The implications for crop production (or productivity improvement) of this fragile ecological base have not been given serious thought. Many people believe that overexploitation of forests and vegetative cover has adversely affected the weather, that there is less rain and more hail and frost whereby the conditions for fruit growing are becoming more unstable.

Status of Horticulture in NWHR

The holdings are small and are being further fragmented. The per caput holding in Jammu and Kashmir is 0.15 hectare and in Himachal Pradesh and Uttar Pradesh it is 0.14 hectare. Such small parcels of land are

not productive enough to meet the cost of basic needs such as food and clothing. Therefore, the cultivation of high-value, labour-intensive tree crops has been encouraged in the region. Holdings that are very small require a different dimension of horticultural development.

The agroclimatic conditions of the NWHR are eminently suited to commercial cultivation of a large variety of temperate, sub-temperate, and sub-tropical crops. A tremendous expansion in area and production has taken place during last two decades. Apple is the predominant crop and accounts for 40 per cent of the total area and 80 per cent of the production. The area and production of different tree crops in the NWHR is given in Table 2.5.

TABLE 2.5

Area and production of fruits and nuts in the NWHR

Commodity	Area ('000 ha)				Production ('000 tons)				Yield T/ha
	J & K	HP	UP	NWHR	J & K	HP	UP	NWHR	
Apple	64	50	49	163	760	175	165	1100	6.5
Other temperate fruits	04	24	32	60	6	21	51	78	1.3
Nuts and dried fruits	50	10	13	73	16	2	8	26	0.35
Sub-tropical fruits	30	36	54	120	10	10	126	146	1.21
Total	148	120	148	416	792	208	350	1350	

Note: Figures relate to 1985/86 for J&K and UP and 1984/85 for HP.

Out of the total production of 1.34 million tons, apples alone account for 1.1 million tons, which is about 81 per cent of the total fruit production in the region. In the states, apples constitute 43 per cent of the area and 96 per cent of production in Jammu and Kashmir; 42 per cent of the area and 84 per cent of the production in Himachal Pradesh; 33 per cent of the area and 47 per cent of the production in Uttar Pradesh. Comparative figures of area and production of other fruits are presented in Table 2.6.

TABLE 2.6

Percentage of area and production of different fruits in each state in the NWHR

Commodity	Area ('000 ha)				Production ('000 tons)			
	J & K	HP	UP	NWHR	J & K	HP	UP	NWHR
Apple	43	42	33	39	96	84	47	81
Other temperate fruits	3	20	22	14	1	10	15	6
Nuts and dried fruits	34	8	9	18	2	1	2	2
Sub-tropical fruits	20	30	36	29	1	5	36	11

The major emphasis in the region has been on apples. The development of other fruits has been generally neglected. As a result, those areas suitable for growing other temperate fruits and sub-tropical fruits have not received the attention they deserve.

Apple Plantation

There has been a rapid expansion under apple cultivation in the NWHR. From 1975/76 to 1985/86, cultivated areas increased by about 50,000 hectares and the average annual rate for the decade was 5000 hectares. Himachal Pradesh increased the area by 19,988 hectares from 1965/66 to 1975/76. Uttar Pradesh increased its area by 19,240 hectares. The progress of apple plantation on the region is presented in Table 2.7.

TABLE 2.7

Progress of Apple Plantation in NWHR (area in ha)

Year	Jammu and Kashmir	Himachal Pradesh	Uttar Pradesh	NWHR
1950/51	NA	400	NA	
1955/56*	NA	1,023	NA	
1960/61**	NA	3,992	7,540	
1965/66	NA	15,088	12,260	
1970/71	NA	26,735	19,600	
1975/76	47,342	35,076	31,500	113,918
1980/81	60,286	43,331	40,000	143,617
1985/86	63,796	51,400	48,700	163,896
1986/87	67,031	52,399	49,924	169,154
1987/88	67,402	54,912	57,148	173,462

*relates to 1961/62
**relates to 1966/67
NA not available

Apple Production

In India apple production increased tenfold from 1966/67 to 1984/85. Production figures from 1966/67 to 1987/88 are given in Table 2.8.

Production, has, by and large, increased on account of expansion in the area. As is evident from the figures for Himachal Pradesh there have been considerable fluctuations. Production, in terms of yield increase, has not been impressive. Except for the last two years in Jammu and Kashmir, where the average yield has increased by 18 per cent to 30 per cent, there has not been much impact on yields. For instance, three years of moving averages (up to 1985/86) for the last 10 years in Himachal Pradesh were 7.7, 6.4, 5.4, 7.0, 6.6, 7.8, 5.9, and 6.0 tons/hectares. Yield per hectare is the real indicator of the efficiency of management in orchards. One of the most important aspects of tree crops in the region

TABLE 2.8
Apple production in the NWHR ('000 tons)

Year	Jammu and Kashmir	Himachal Pradesh	Uttar Pradesh	Total NWHR
1966/67	50	26	21	97
1970/71	157	76	40	273
1971/72	213	98	46	357
1972/73	230	30	53	313
1973/74	205	113	61	379
1974/75	362	43	70	475
1975/76	328	200	68	596
1976/77	311	119	NA	—
1977/78	348	131	NA	—
1978/79	450	121	NA	—
1979/80	463	135	NA	—
1980/81	562	118	95	795
1981/82	523	307	120	950
1982/83	471	139	130	740
1983/84	642	258	NA	—
1984/85	672	171	155	998
1985/86	760	175	165	1100
1986/87	724	259	165	1148
1987/88	427	179	165	771

Source: National Horticultural Board, Government of India.

should be stability of production along with increased yield per unit area. Apple yields in the three states of the NWHR are given in Table 2.9.

TABLE 2.9
Yield of apples in the NWHR

Year	Yield (ton/ha)		
	Jammu and Kashmir	Himachal Pradesh*	Uttar Pradesh**
1975/76	7.35	15.73	2.70
1976/77	6.40	7.83	NA
1977/78	6.96	7.48	NA
1978/79	8.70	6.03	NA
1979/80	8.77	5.77	NA
1980/81	8.90	4.41	2.76
1981/82	8.13	10.84	3.57
1982/83	7.03	4.48	3.69
1984/85	10.12	5.07	4.04
1985/86	11.92	4.98	4.24
1986/87	10.80	9.20	4.26
1987/88	6.30	4.72	2.80

*Assuming the previous 10 years were without harvest.
**Assuming 25 per cent of the area is without harvest.

Source: National Horticulture Board, Government of India.

The yields presented in Table 2.9 are much below the international standard of 30 tons/hectare. There is, therefore, considerable scope for improvement. Yields in Uttar Pradesh are the lowest and range from 11 to 17 kg per tree (250 trees per hectare). The yields in Himachal Pradesh have failed to equal the level of 1975/76. Many factors are responsible for this, e.g., unfavourable weather conditions, rapid expansion, plantation in marginal areas, lack of proper orchard management and inadequate fertilizer. These factors apply to other states also. The yield per tree in Himachal Pradesh ranged from 63 kg in 1975/76 to 20 kg in 1985/86.

In Uttar Pradesh a substantial number of orchardists are absentees. There is great variation in yields among districts (450 kg to 7000 kg/hectare), indicating the difference in level of management and perhaps also agroclimatic conditions. This variation is presented in Table 2.10. It is essential to analyse the factors responsible for low productivity and to take remedial measures.

TABLE 2.10

Variation in production and yield in Uttar Pradesh hills

District	Area (ha)	Production (tons)	Average yield (ha/ton)
Nainital	11,622	71,500	6.15
Almora	7,300	26,500	3.60
Pauri	6,300	5,000	0.79
Tehri	6,450	11,500	1.78
Uttarkashi	5,808	11,500	1.98
Pithoragarh	4,420	31,000	7.00
Chamoli	3,500	6,500	1.97
Dehra Dun	3,300	1,500	0.45
Total	48,700	16,500	3.39

Source: Department of Horticulture, Uttar Pradesh Government.

The Agro-Economic Centre of Himachal Pradesh University has conducted several studies on yields. In one study it was found that the yield was only 4.23 tons/hectare under 10 years of age, 14.90 tons/hectare for those between 10 and 15 years. The average of all years was 14.23 tons/hectare (Plantations were only of seedling rootstocks). This shows that it takes about 15 years for the full development of a tree. Until then the planting space remains vacant. Therefore, efforts have to be made to attain full bearing area in the shortest possible time. High density plantations need to be given special attention. Local requirements must be kept in mind when selecting rootstocks and scions.

Potential

During these studies (NWHR horticultural review field trips), a number of orchards with yields ranging from 30 to 60 tons/hectare were

seen. These included both private and government stations. The Agro-Economic Centre's studies also show yields of up to 23 tons. Fertilizer (NPK) trials in Chaubattia in the UP hills showed a yield of 22.5 tons. This aptly demonstrates, that, given better management, there is a potential for improvement.

At the Regional Fruit Research Centre, Mashobra, Himachal Pradesh, a 15-year trial on the performance of 13 varieties of apple revealed that Red Delicious gave the highest average yield of 102 kg per tree and 25.5 tons/hectare. These results were achieved despite the fact that Mashobra is considered to be an unfavourable zone for tree crops because of the frequent occurrence of hail, frost, and strong winds. The results are presented in Table 2.11.

TABLE 2.11

Comparative performance of apple cultivars, Regional Fruit Research Centre, (Himachal Pradesh)

Name of Cultivar	15-year kg/tree	Average yield (tons/ha)
Red Delicious	102	25.5
Royal	102	25.5
Allington Pippin	100	25.0
Red Gold	82	20.5
Lord Lambourne	70	17.5
Tydeman's Lali Orange	68	17.0
McIntosh	65	16.25
James Grieve	62	15.4
Golden Delicious	60	15.0
Northern Snap	60	15.0
Tydeman's Worcester	41	10.25
Granny Smith	25	6.25
Rome Beauty	25	6.25

Role of Proper Management in Production and Returns

Trials conducted at the Horticultural Station, Chaubattia, Uttar Pradesh showed that balanced doses of fertilizer (300 g urea, 200 g DAP, and 500 g N and P per tree) increased the yield by 400 per cent and the colour by 100 per cent (The colour red attracts consumers and determines the price of the apple.) There was also improvement in T.S.S. and sugar. The results are given in Table 2.12.

The need for application of balanced doses of fertilizer cannot be overemphasized. Improper fertilization is one of the important contributing factors to low productivity in existing orchards.

Under the Indo-Australian Apple Project in Jammu and Kashmir, Australian experts used an area of 4 ha with 1257 apple trees to demon-

TABLE 2.12
Impact of fertilizer on yield (Uttar Pradesh)

Treatment	Year kg	Yield (full)	Colour (per cent)	Sugar (per cent)	T.S.S. (per cent)	Acidity (per cent)
Fertilizer application	I	96.3	79.5	11.58	13.0	0.248
	II	109.2	71.0	11.22	13.0	0.241
	III	62.2	85.3	12.79	13.0	0.268
	Average	89.4	78.6	11.86	13.0	0.250
Control	I	19.2	58.0	10.28	12.0	0.295
	II	30.5	30.5	9.82	11.0	0.268
	III	11.0	32.0	10.37	12.0	0.268
	Average	20.2	40.2	10.57	11.7	0.277

strate convincingly the impact of improved orchard management on the production and quality of fruits. The trees belonged to 13 farmers. Out of 1237 trees, 945 (67.4 per cent) were of large size, 183 (14.8 per cent) of medium size and 109 (8.8 per cent) of small size. The following treatment was given for three years:

- Two doses of fertilizer in March-April and after the harvest.
- Winter pruning.
- Ethrel spray for thinning.
- Scab spray (6–7) at 10- to 14-day intervals, commencing from the time the green shoots appear and continuing until the end of June.

The results obtained from this treatment are given in Table 2.13. Results have been analysed for the years from 1983 to 1985. The figures for 1982 have not been included because production during this year related to bud formation in 1981, prior to the commencement of imported husbandry practices. Gross income varied from Rs. 44,000 in 1981 to Rs. 141,000 in 1984, with an average gross return for 1983–1985 of Rs. 108,500 for the whole block (Rs. 27,167/hectare). The average net return per hectare comes to Rs. 11,667. There has been a slight increase in yield from 625 to 744 boxes per hectare. The average increase in gross income is 146 per cent (from Rs. 11,000 per hectare in 1981 to the 1983–1985 average of Rs. 27,167), compared to an increase in yield of only 19 per cent. Thus the major benefit has come from improvement in the quality of fruit. However, there is still considerable scope for increasing production when we compare the apple yields in areas with similar natural resources. Whereas the response to quality improvement techniques in disease-affected fruit (e.g. scab) is rapid and can be achieved

in one year, the yield response to improved husbandry takes longer for tree crops.

TABLE 2.13

Indo-Australian apple technology and extension project orchard management field demonstration

Year	Cost	Total production (20 kg boxes)	Total gross return (Rs.)	Total net return (Rs.)	Production per ha (20 kg boxes)	Hectare gross return (Rs./ha)	Hectare net production
1981		2,510	44,000	625	11,000		
1982	14,800	1,761	44,000	29,200	440	11,000	7,300
1983	34,000	3,358	79,000	45,000	840	19,750	11,250
1984	79,000	3,650	141,000	62,000	912	35,250	15,500
1985	73,000	3,127	106,000	33,000	782	26,500	8,250
Total: 1983–1985	186,000	10,135	326,000	140,000	2,534	82,500	35,000
Annual Average 1983–1985	62,000	3,378	108,667	46,667	844	27,187	11,667
Increase throughout 1981 (base yr.)	NA	878	64,667	NA	219	16,167	NA

The average yield for the three years from the other demonstration plots is approximately 17 tons/hectare. The maximum average annual yield from the plots was for 18 tons/hectare in 1984, compared to the state average of almost 12 ton/hectare (an increase of 50 per cent). Studies conducted on the plots of 42 different farmers in different areas throughout Himachal Pradesh have revealed that yield increase with modern technology can be as high as 225 per cent more than the yield procurement from traditional management techniques. The results have shown that modern technology improved yields by 50 per cent (more than traditional management) in 33 per cent of the plots, 20–50 per cent in 36 per cent of the plots, and less than 20 per cent in 32 per cent of the plots.

Production per unit area of the existing plantations can be doubled if orchard management is improved. During the next five years Jammu and Kashmir should aim for a yield of 18 tons/hectare; Himachal Pradesh should attempt to achieve at least the 1981/82 level; Uttar Pradesh should make efforts to achieve 6 tons/hectare, which is the present level of the Nainital District (6.15) and Pithoragarh (7.00). All three states should review their targets in 2000 A.D. Some indication of the projected targets has already been given. They are 3.61 tons/hectare for Uttar Pradesh, 7.5 tons/hectare for Jammu and Kashmir. The actual

position as projected in Table 2.14 needs improvement in production and yield. This will be the major factor in improving the returns of the farmers as there will be limited scope to decrease the cost of marketing and to increase gross sales.

TABLE 2.14

Apple production and productivity 1985/86–2000

State	Area ('000 ha)		Production ('000 tons)		Yield (tons/ha)	
	1985/86	2000	1985/86	2000	1985/86	2000
J & K	63.8	77.8*	760	1000	11.9	12.8
HP	51.4	73.8	175	557	4.3	7.5
UP	48.7	67.4	165	244	3.4	3.6
NWHR	163.9	219.0	1100	1801	6.7	8.2

* The figures for Jammu and Kashmir for 2000 are a rough estimate based on the increase from 1984/85 to 1989/90. The projections for yields and production need to be upgraded as suggested in the text.

Improvement of Quality

It has been seen that balanced nutrition and scientific orchard management improves the quality of the fruit and the return on it. The impact of these two factors and disease control is illustrated below:

	Quality grades (per cent)		
Particulars	*A*	*B*	*C*
Good weather (J & K)	10	25	65
Good weather (HP, UP)	20	30	50
Bad weather, no disease (scab) control	2	2	96

These figures are based on general observations and discussions during field visits. In Uttar Pradesh about 50 per cent of the fruit is packed in boxes and the rest is marketed in gunny bags. Among a variety of reasons given for this practice is that of poor quality. These estimates may be somewhat high but the proportion of poor quality fruit is indeed large. The quality can be substantially improved and gross sales can be increased connsiderably.

Improvement in Size Grades

By and large about 10 per cent of the fruit on an average tree (at present) is super and extra large, 65 per cent large and medium, and 25 per cent small and below. Average proportions of different grades, as calculated in Himachal Pradesh, are given in Table 2.15.

TABLE 2.15
Average production of size grades (Himachal Pradesh)

Size grade	Size (mm diameter)	Percentage	
Super large	85	2	10 (I)
Extra large	80	8	
Large	75	22	65 (II)
Medium	70	43	
Small	65	18	25 (III)
Extra small	60	3	
Pitto (very small)	55 and below	4	

The maximum income comes from group II (large and medium, 65 per cent). The upper group I (extra large and super large), though attractive, gets damaged in handling. However, its percentage is likely to remain stable. It is the third group (25 per cent) which should receive special attention as far as reductions in percentage are concerned. This can be done with better orchard management, canopy management, thinning, and application of fertilizer related to load of crop. At least 50 per cent of this group could be upgraded to group II bringing the total yield of group II from 65 to 77 per cent.

Apple Varieties

At present the Delicious group of apples dominates production. These account for about 45 per cent of the yield in Jammu and Kashmir, 83 per cent in Himachal Pradesh, and 30 per cent in Uttar Pradesh. The status of different cultivars in NWHR is as indicated in Table 2.16. The distribution by variety in Jammu and Kashmir, Himachal Pradesh, and Uttar Pradesh is given in Tables 2.17, 2.18, and 2.19.

The region as a whole has to look for a strategy for future plantations, so that the harvesting and marketing operations overlap to the minimum extent possible. At present only 10 per cent of the total production of the NWHR is early (June and July), 75–80 per cent is mid-season (August, September and part of October), 10–15 per cent is late (latter half of October and November). There is scope for increasing harvest in the early and late seasons so that there is the minimum possible pressure during mid-season, or main harvest seasons, when gluts are the order of the day. The possibility of diversification of varieties, by harvesting 25 per cent in early season, about 55 per cent in mid-season, and about 20 per cent in late season, should be explored for the region as a whole. The marketing period can be extended by means of cold storage facilities.

TABLE 2.16
NWHR share of apple varieties

Variety	Area (ha)	Percentage
1. Delicious group (J&K, HP, UP)	87,178	54
2. Maharaji (J&K, 22 per cent)	13,443	8
3. American (J&K, 8 per cent)	5,000	3
4. Early Shanberry Banoni Fancy (UP, 30 per cent)	14,160	8
5. Rymer/Buckingham (UP, 40 per cent)	19,480	12
6. Golden Delicious (HP, 11 per cent)	5,654	3.5
Total	145,015	89
NWHR	163,000	100

TABLE 2.17
Estimated varieties, area, and percentage of apples in Jammu and Kashmir (1985/86)

Variety	Area (ha)	Percentage area
Ambri	837	1.3
W.D. Red	13,443	22
American	4,953	8.2
Red Delicious	26,906	44.6
Golden Delicious	321	0.5
Cox's Orange	3,630	6.0
Pippen Benoni	1,259	2.1
Irish Peach	335	0.6
Others	8,631	14.3
Total	60,315	100

Source: Department of Horticulture, Jammu and Kashmir Government.

Improvement in Varieties

Most of the present strains are outdated and have also degenerated. This is also one of the factors contributing to low productivity and low quality production. New strains have to be introduced from abroad and local trees of outstanding merit should be earmarked. It is time for the establishment of a national variety foundation as a repository for all commercially grown varieties/stocks.

Moisture Stress

About 80 per cent of the NWHR is rainfed. Generally, in most areas, the bulk of the precipitation takes place during three or four months (mostly

TABLE 2.18
Varietal distribution in Himachal Pradesh

Variety	Percentage area
Red Delicious	25
Star King Delicious	44
Rich-a-Red	14
Total Red Delicious	83
Golden Delicious	11
Other varieties	6
Total	100

Source: Department of Horticulture, Himachal Pradesh Government.

TABLE 2.19
Varietal distribution in Uttar Pradesh

Variety	Percentage area
Early: Fanny, Shanberry, Banoni	30
Mid season: Delicious	30
Late: Rymer, Buckingham	40
	100

Source: Department of Horticulture, Uttar Pradesh Government.

the monsoon period). The remaining periods are more or less dry. The trees suffer from serious moisture stress during those periods. This is one of the important contributing factors to low productivity. Because of the concentration of rainfall within a short period, and the hill gradients, two of the most important natural resources, i.e. soil and water, go to waste for want of appropriate conservation measures. The rain water travels down the hill slopes at high velocity, erodes the soil, makes gullies, and has very little chance of being absorbed by the soil because of its speed. This causes floods during the rainy season and drought or moisture stress afterwards. The technology for the conservation of moisture in soil is now available and consists of (1) planting behind vegetation contour lines and (2) establishment of vegetation hedges or fences (with species having crowns below ground level), so that they develop into dense barriers for filtering soil out of the water and reducing the velocity of the rain. These hedges are established at suitable intervals depending upon the slope.

The distance or space between two lines of a plantation (1 above)

serves as a catchment area for water and soil. Reduced water velocity encourages more infiltration to the soil. Even a minor amount of rainfall can be collected. Consequently, this helps to overcome the stress. The species already identified for sub-tropical and temperate regions are listed below:

Sub-tropical region	Temperate region
Vetivera zizanioides	*Idigofera hetrantha*
Dodonaea viscosa	*Plectranthus ruqosus*
Adhatoda vasica	*Viburnum foetens*
Agave sislana	*Parrothi jacquemontiana*
A. americana	*Onobrycus vicifolia*
Carissa spinaeum	*Cotoneaster baccilaris*
Woodfordia fruticosa	*Crataeva varia*
Vitex nigundo	*Coronella varia*
Desmodium	*Rhus pur viflora*
	Rubus ellipticus
	Bareris spp.

Two sketches showing the contour layout and hedges in new orchards and the contour hedges in existing orchards are shown in Annexes 1 and 2.

Contour layouts in the hills have been recommended for a long time. However, planting of contour vegetation hedges is a new technique. Its impact has yet to be effectively demonstrated before the system is adopted on a large scale.

In addition to overcoming the problem of moisture stress in orchards, contour layouts have many other advantages:

- prevention of soil erosion
- regenerate vegetation on hill slopes
- prevention of floods in lower areas
- accumulation of water in the soil profile and improvement of the water level in wells
- availability of fuelwood from some shrub species thus reducing the pressure on forests
- additional production of grass or grass legume mixtures in the spaces between hedge or tree lines

Adoption of this technology means that tree crops will improve the environment and ecology of the region as a whole.

Summary of the Present Situation

The present situation of apple cultivation in the NWHR is characterized by:

- low production per unit area,
- fluctuations in production from year to year,
- low quality produce, and
- low and discouraging returns, giving no incentive to the farmer to improve the production finality by investment.

This situation is the result of many factors. Some of these are:

- poor quality plants,
- low-density plantations (waste of space),
- long gestation periods,
- gaps in plantations, waste of valuable land resources,
- moisture stress at critical phases of tree and fruit development,
- poor orchard soil management,
- inadequate nutrition, in fact, malnutrition in many cases,
- inadequate control of pests and diseases, and
- lack of coordination among producing states, growers, and marketing agencies.

The problems referred to above relate to management of existing orchards and the plantation of new orchards. While the former needs immediate attention and improvement, the latter needs medium-range planning and strategy.

Post-harvest Management

The post-harvest management of horticultural crops has not kept pace with the expansion of production. This has led to lopsided development and imbalances in the industry. However, some efforts have been made to create a modern infrastructure for post-harvest handling of apples in Himachal Pradesh and Jammu and Kashmir through World Bank-assisted projects for apple marketing and processing. Although the projects have been created, and a network of packing houses, cold storage plants and other facilities along with juice concentrate plants have been established, the real benefits have fallen short of expectations. Himachal Pradesh and Jammu and Kashmir corporates (HPMC) were expected to handle about 25 per cent and 12 per cent of the production respectively but they have handled only 2 per cent. Recently the North Eastern Region Agriculture Marketing Corporation has been created in the northeastern region for processing and marketing horticultural produce.

Notwithstanding the creation of such an infrastructure, post-harvest management of fruits has remained grossly inefficient. Added to its inadequacies is the mismanagement which results in its being advantageous to middlemen at the cost of the grower and the customer. There is a long chain of handling for perishables during the process of marketing. Each step in the chain adversely affects the quality of the fruit resulting in low net returns and high marketing costs. Horticulturalists have no control over consignments once they have left their premises. The negligible care taken in handling the fruit at various stages demonstrates that no one has the interests of the produce in mind. The stages through which the fruit passes for marketing are:

- picking,
- assembly in the packing shed,
- sorting and grading,
- packing,
- transport (mainly head loads) to the forwarding areas,
- loading (in lorries),
- transport,
- unloading in the wholesale market,
- storage[2] or
- sale in the market to retailers or bulk purchasers,
- In case of bulk purchasers, unpacking, regrading, packing, loading, transport, unloading in other markets, and sale to retailer,
- transport by retailer to his retail shop,
- consumer.

Because of the lack of post-harvest quality control, a substantial part of the produce is damaged and is much below its optimum consistency, flavour, and taste. Many factors are responsible for this. Examples of these are:

- lack of understanding of maturity standards (picking as against eating),
- use of poor quality packing material,
- lack of proper grading,
- packing of fruits of different maturity in the same lot,
- packing too tight or loose,
- protracted transport, transhipment, and delays in sale or disposal,
- frequent transhipments, loading, and unloading that involves rough handling,

[2] The stored fruit again passes through loading, transport, and unloading. It could also be stored in production areas.

- exposure to variations in temperature, sunshine, rain and
- lack of proper temperature and humidity control in cold stores.

As a result of the lack of proper handling, the produce is sold at low prices. In the majority of cases, the farmer is disappointed and is not inclined to invest in more and improved produce.

Post-harvest technology has received very little attention as a result of which its deleterious factors have not been accurately identified. The ultimate goal of an efficient post-harvest management system (or marketing in its entirety) is that the fruit reaches the consumer (after passing through so many stages) at its optimum consistency, taste, and flavour, at minimum cost and optimum returns. The present system of marketing simply consists of putting the consignments in the market. It cannot be described as scientific marketing.

Post-harvest management can be divided into on-farm and off-farm operations. The on-farm post-harvest operations include picking, grading, packing, and on-farm storage, if required. Sufficient information on improvement of these operations is available. Extension workers and farmers should be given intensive training in it and it should become an integral part of their expertise.

Maturity Standards

The picking maturity standards should be fixed and widely disseminated amongst horticulturists. The storage (long and short period), distant or nearby markets, and other aspects have to be kept in mind. Unripe fruit shrivels and does not develop the requisite flavour. On the other hand, fruit picked at optimum eating maturity will be overripe by the time it reaches the consumer. Either situation should be avoided.

Grade Standards

Grade standards, both quality and size grades, despite the fact that they have been fixed in consultation with the involved states and the central government, are not being followed. Proper grading should be introduced, first on a voluntary basis and subsequently through legislation if need be.

Packing Cases

Packing cases have been causing serious problems. So far, the entire apple industry has been dependent on wooden packing cases. Whereas in Jammu and Kashmir one ton of fruit is packed in about 0.7 cu m of wood, in Himachal Pradesh and Uttar Pradesh about 1 cu m and 1.25 cu m are used, respectively. At this rate the NWHR will require about 800,000 cu m of wood annually. This wood will be supplied by

130,000 hectares of natural pines, or 80,000 hectares of planted pines, eucalyptus, and poplar, or 40,000 hectares of irrigated eucalyptus and poplars, annually. These are colossal requirements and have direct impact on the environment. It is gratifying that steps for the use of substitute packing cases have been taken. The Government of India has waived the duty on cartons. Himachal Pradesh will supply these cartons in bulk (approximate total of 2 million in 1989) on a subsidized bases. Himachal Pradesh is also establishing a modern plant for the manufacture of cartons of the latest quality. Other states should follow suit as quickly as possible.

Distribution

Unfortunately, the distribution of apples in the market is unbalanced. The Delhi market receives about 60–70 per cent of the apples from Himachal Pradesh and Jammu and Kashmir but it consumes only 16 per cent, regrades the remainder, repacks them, and sends them to other markets. This involves additional expenditure, more middlemen, more handling, more damage, and more deterioration. The distribution is such that, whereas there is a glut in Delhi and the surrounding areas, in other places there may be a scarcity. Unless consignments are sent to the markets and towns directly, in accordance with their requirements, there will be very little change in the pricing structure for apples.

New Markets

There is a case for starting new markets in the production areas themselves. However, it must be understood that almost the entire crop should be sent outside the production areas. The new markets, as in the case of Haldwani in Uttar Pradesh, should not become satellite markets for Delhi, because this will mean another set of middlemen and additional infrastructure. What needs to be ensured is the direct despatch of consignments in accordance with the requirements of towns and markets. This may require market studies.

Bulk Handling

In view of the scarcity and high cost of packing material, an alternative approach in the form of bulk handling may entail truck loads of loose fruit or assorted packs in returnable master containers. The results of a trial in Jammu and Kashmir under IAATP showed that mixed sizes and grades of fruits, when carried loose in trucks, had the same amount of bruises as apples packed in wooden boxes. Another alternative is to take the shipments to markets and towns and sell them in returnable

wooden or plastic boxes, or in cartons which need not be as solid nor cost as much as those required for long-term use. Storage accommodation will be required for this purpose in these places.

Transport

Transport remains a major problem throughout the NWHR. On average (1985 figures), the present production of marketable apples needs 100,000 truck journeys. Most of these journeys take place in the months of August, September, and October. The transport system has been built or is suitable for hardware; it has not been designed for perishables. There is a great deal of pressure during the peak harvest periods, and often transport is not available in accordance with requirements. There is at least one transhipment in most cases, if not more. The situation becomes untenable. The share of railway transportation is insignificant. The following measures need attention:

- Designing of trucks and rail wagons specially suited for perishables.
- Substantial increase in the share of railways.
- Quick transport and delivery. Railways should not take more time than road transport.
- Extended period of marketing through varietal diversification and storage in producing areas.
- Careful handling during loading, unloading and other such operations.
- Covered sheds at transhipment centres.
- Avoiding congestion in main distribution markets, such as Delhi, by direct dispatch to other markets.

Cold Storage

Cold storage (including pre-cooling) has become an integral part of the production, planning and post-harvest management system. Increase in cold storage capacity has become imperative under Indian conditions, where production is already creating temporary gluts. Transport and marketing problems have increased considerably and the fruit available in the Indian market is in poor condition.

The technology to supply garden-fresh apples almost throughout the year is now available and has been tried successfully within the country. Ordinarily, apples are harvested at between 55°F (mean minimum) and 70°F (mean maximum). At the same time temperatures in the main market of the country (Delhi) vary from 79° to 93°F. There is, therefore, a difference of 23°F. Fruits continue to respire after harvest. The higher the temperature, the higher the respiration rate, and the quicker the

TABLE 2.20
Normal storage life expectancy of delicious apples

Temperature	(°F)	Storage life (days)
Held at	70	20
	60	30
	50	50
	40	90
	36	130
	32	220
	30	280
Cooled to	30 in 7 days and held	250
	32 in 7 days and held	200
	36 in 7 days and then to 32 in 4 weeks	180
	40 in 7 days held at 40 for 21 days, then cooled to 32 for 28 days	137
	36 in 7 days and held at 36	110
	36 in 6 weeks and held at 30	90

Source: Harbans Singh, Cold Storage of Apples in the Pacific North West by Sainbury.

deterioration in quality and eventual breakdown. The storage life for apples has been worked out as given in Table 2.20 in the United States.

The pre-cooling of apples before storage and even for immediate marketing is essential, as is evident from Table 2.20. Pre-cooling for fresh markets will prolong shelf life. This is in fact a key factor in marketing. Should cooling facilities not have been established, the fruit should be picked early in the morning when the temperature is at its lowest. Cooling can also be done by picking in the evening and leaving the fruit outside in the open and/or by sprinkling with cold water if available. This, though not ideal, will help to some extent.

The storage of fruits, apart from extending the period of marketing and the availability of high quality fruit, will also reduce the pressure on transport and markets. A strategy for short and long duration storage should be developed. Short-duration storage will be required for marketing in December, January, and February, and long-duration storage from March to May, or even early June. It may be appropriate to plan for the storage of about 25 per cent of the crop, which is approximately 275,000 tons at the current production level.

An ideal system may also require refrigerated vans in general and railway wagons in particular. This may be necessary for the export of quality fruit in the beginning.

Marketing Cost and Returns

The marketing costs and returns vary considerably with the cost of packing, transport area, and other factors. However, it would be appropriate to refer to some studies as models. The Agro-Economic Centre, Shimla, gives the figures presented in Tables 2.21 and 2.22 for good quality apples sold on the Delhi market.

TABLE 2.21

Share of growers in consumer rupees (Delhi, 1984)

Particulars Total	Percentage share Rs.	Rs.	Progressive Rs.
Farm gate price	48.20	57.94	57.94
Marketing expenses by farmers	23.31	28.02	85.96
Expenses by commission agent	4.28	5.16	91.12
Retailers expenses Expenses 1.50 + Losses 10% 9.11	8.83	10.61	101.73
Retailer's margin	15.38	18.50	120.00
Consumer's price	100.00	120.00	120.00

Source: AEC, Shimla, 1984.

TABLE 2.22

Price of different varieties: five-year average, AEC, Shimla (per 18q kg case)

Starking Delicious	Rs. 46
Rich-a-Red	Rs. 41
Red Delicious	Rs. 34
Golden Delicious	Rs. 28

It appears that the farmer's share in the consumer's rupee is only 48 per cent (farm gate price). The marketing expenses of farmers average 23 per cent, the expenses of commission agents 4 per cent and that of retailers 15 per cent. In addition, retailers charge about 9–10 per cent against losses. In all, the retailer receives 25 per cent. This shows that 52 per cent of the price paid by the consumer is spent in the market. Out of this, the margins of the middlemen account for 30 per cent. Reduction in prices results in a decrease in the percentage received by farmers, wholesalers, and retailers. This is because the cost of packing, transport and other items will remain the same irrespective of the price of the fruit. The margin retained by the retailer against losses is an indication of the absence of post-harvest quality control. This could be reduced

by 75 per cent at least in a comparatively stable commodity such as apples.

Other studies undertaken in 1974, 1979, and 1984, in Himachal Pradesh by AEC produced the data given in Table 2.23.

TABLE 2.23
Marketing cost and returns, Himachal Pradesh

	Rs./Box		
	1974	1979	1984
Wholesale price	37.83	46.63	85.96
Marketing expenses	17.17	21.70	33.18
Net returns (farm gate price)	20.66	24.93	52.78
Farm gate price/kg (@ 18 kg./case)	1.15	1.38	2.93

Impact of Grades on Prices

There is a difference in the prices of different grades of apple. As far as quality is concerned, better coloured and better quality fruit get higher prices. Apples that are marked by hail, scab, or other diseases cannot be sold at A grade price. They will be sold at B or C grade prices which are about 15 per cent or 30 per cent less than that of A grade. A firm, ripe consignment gets a better price than soft or overripe fruit. The impact of colour and size grades on the sale prices is evident from Table 2.24.

TABLE 2.24
Sale rates of different grades

Rs./Box

Variety	Size grades		
	Large	Medium	Small
Starking Delicious	46.16	41.28	33.65
Rich-a-Red	41.23	35.20	29.39
Red Delicious	33.70	30.70	27.70
Golden Delicious	28.06	22.83	18.64

Source: AEC, Shimla, 1975/76

The Starking Delicious is a deep red strain. It is followed in quality by Rich-a-Red Delicious, and Red Delicious in descending order. Golden Delicious is golden in colour. The first two keep better than Red Delicious. The difference in sales shows the market value of each and the importance of colour.

Recommendations

The following are broad recommendations for modernizing the horticultural industry in the hill areas. They are not a substitute for detailed project proposals, which should be independent exercises governed by local conditions.

Production Aspects

The wide gap between the technology now available and actual application by the farmers should be bridged by reorganizing and strengthening the Department of Horticulture so that competent, professional horticultural extension services can be provided.

For easy adaptation of horticultural technology at the farm level, demonstrations should take place at the site. These should include: (1) orchard management, (2) tree canopy management, (3) density of plantation, (4) moisture conservation *in situ*, (5) tree nutrition, (6) integrated pest and disease management, and various aspects of these in accordance with the requirements of specific localities.

The quality of saplings should be improved so that future plantations are established with trees of outstanding merit. To achieve this, the following procedures should be undertaken:

- introduction and testing of new varieties and rootstocks.
- establishment of a national variety foundation as a repository for commercially grown varieties in India.
- encouragement of private sector nurseries which should use plants made available by the national variety foundation.

A horticultural development plan, along with a strategy for implementation, should be prepared. The plan should incorporate appropriate crop diversification and the requirements of the industry in respect of planting stock, inputs, management, pest control, packing, storage, transport, marketing, and research needs and other aspects up to the year 2000 must be taken into account.

The problems and constraints that are being faced in each area, district, and block, should be identified in order of importance so as to initiate remedial measures. This should be done after appropriate in-depth studies.

Provision of essential production support services, such as laboratories, for plant tissue analysis and plant protection must be made.

Creation of data banks at national and state level to provide information on area, production, and yield of each crop, budgets, and other allied aspects should be undertaken.

Inter-state coordination with the active support of the central government and the National Horticultural Board must come into play.

Simplified credit procedures for farmers should be provided.

Post-harvest Management

The gap between actual requirements and the facilities available should be bridged as soon as possible. Post-harvest quality control must be given top priority.

The established grading standard for size and quality should be introduced immediately. It should be uniform throughout the states concerned. A start can be made by encouraging people to adopt them on a voluntary basis and this can be followed by legislative measures if necessary.

Wooden packing cases used should be replaced by corrugated fibre board cartons and similar packing materials to conserve resources and present better quality fruits.

Bulk handling of apples should be encouraged in order to reduce the per unit cost.

In order to avoid gluts and to regulate supplies throughout the year the marketing period for apples should be extended by establishing cold storage network.

The transport system should be improved. Cableways and roads should be constructed where necessary in the areas of concentrated production.

Imbalances in the distribution of apples in the market should be reduced. Efforts should be made to consign them directly to the market in accordance with requirements. Market studies should be conducted for this purpose.

States which propose to develop new markets should ensure that they do not become satellites of already existing terminal markets.

Distribution markets should be set up in production areas.

There should be effective and meaningful cooperation and coordination among the three states. The National Horticultural Board must play a leading role in bringing about such cooperation.

A long-term strategy and development plan for the creation of post-harvest handling and marketing facilities should be drawn up and the existing infrastructure strengthened.

The HPMC in Jammu and Kashmir and Himachal Pradesh and NERAMAC in the northeastern region should play the role of horticultural development corporations. They should encourage the promotion of facilities and infrastructure required for post-harvest handling.

A compilation of problems faced in the post-harvest handling and marketing of apples should be undertaken and financial incentives

required by the growers or private trade should be made available.

Transfer of technology in respect of on-farm post-harvest operations (including pre-harvest picking, maturity standards, handling operations such as picking, grading, packing and storage) should become the responsibility of horticultural extension workers.

An efficient market information service should be provided.