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Post-harvest Practices as Affecting Marketing of Fruits and Vegetables in Himalayan Mountain Regions in India

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The Indian Himalayan mountain region, as considered in this paper, runs from Jammu and Kashmir in the west to Arunachal Pradesh and Mizoram in the east. This region covers more than one-eighth of the total land area of the country and makes up the entire northern boundary. The two important mountainous belts of the Himalaya in India include: the Northwest hill region (NWHR), comprising the states of Jammu and Kashmir, Himachal Pradesh, and hill districts of Uttar Pradesh and located between latitudes 28° and 37° N; and the Northeast hill region (NEHR), which consists of the states of Sikkim, Arunachal Pradesh, Assam, Manipur, Tripura, Meghalaya, Mizoram, and Nagaland and is located between 20° and 29° N. Due to higher latitudes and elevation the NWHR falls mostly in the temperate zone, whereas, the NEHR is mainly sub-tropical with a small temperate part. The entire area consists of high, medium, and low rugged mountains with valleys enjoying varying agroclimatic conditions. Rainfall is low to moderate in the west but heavy to very heavy in the east. Only a small area of these mountainous regions is under cultivation.

The importance of horticultural crops to the economic development of the hilly region cannot be overemphasized. It is only through more intensive horticultural production, improved orchard and land management techniques, and appropriate post-harvest marketing technologies

that we can increase farm income, generate employment, and conserve land resources.

Production Pattern of Fruits and Vegetables

The suitability of different tree crops to specific areas is governed primarily by the climate. In the NWHR, this can change within short distances, caused by abrupt changes in elevation or proximity to the plains or snow-clad peaks. These changes are not so marked in the NEHR where most of the area is located in the sub-tropics.

Apple is the dominant fruit grown in the NWHR. Other temperate fruits include plum, apricot, pear, cherry, peach, grape, and nuts such as walnut, almond, and chestnut. Sub-tropical fruits include mango, citrus, guava, fig, and grape. Among the vegetables, the important ones are potato, capsicum, cauliflower, cabbage, ginger, and chilli. The production of fruits and nuts in the NWHR is given in Table 16.1

TABLE 16.1
Approximate production of fruits and nuts in NWHR

Commodity	Production ('000 tons)			
	J&K	HP	UP	NWHR
Apple	760(96)	175(84)	165(47)	1100(81)
Other temperate fruits	4(1)	24(10)	32(15)	60(6)
Nuts and dried fruits	16(2)	2(1)	8(2)	26(2)
Sub-tropical fruits	10(1)	10(5)	126(36)	146(11)
Total	790	211	331	1332

Figures in parentheses are percentage of total.

Source: World Bank Review of Horticulture in North West Hill Region, January 1987.

In the NEHR, the major fruits grown include pineapple, citrus, banana, apple, pear, stone fruits, papaya, mango, guava, and coconut. The vegetable list includes potato, tapioca, sweet potato, cole crops, ginger, turmeric, and chillies. The approximate production of different fruits and vegetables in the region is given in Table 16.2.

Horticultural crops are extremely important and provide a useful avenue for the economic development of mountainous regions. This is especially so when the land holdings in these areas are small and becoming further fragmented with each generation. They are a rich source of vitamins and minerals and are essential for proper physical and mental growth. Fruits and vegetables are, further, a good source of income and employment for the farming community. Vegetables are extremely labour intensive in nature with high-pay-off crops.

TABLE 16.2
Approximate production of fruits and vegetables in NEHR

Fruits	Production ('000 tons)	Vegetables	Production ('000 tons)
Apple	6.7	Chilli	10.9
Banana	327.2	Ginger	23.2
Citrus	119.7	Potato	270.7
Coconut	32.1	Sweet potato	54.8
Guava	0.5	Tapioca	17.2
Mango	0.4	Turmeric	6.0
Papaya	47.3		
Pear	12.5		
Pineapple	167.5		
Stone fruits	7.4		
Total	721.3		382.8

Source: State Profile of Area and Production of Fruits and Vegetables in India, National Horticulture Board, Gurgaon (1988).

Besides production, related areas such as grading, packing, transport, marketing and processing are essential to proper management of horticultural crops and provide business and employment wherever these crops are marketed.

Increasing Importance of Post-harvest Handling

Deterioration in fruits and vegetables sets in soon after harvest, depending upon the nature of the fruits, their ambient conditions, and the mode of handling. The increased attention afforded to post-harvest horticulture has mainly been due to the realization that faulty handling practices after harvest can result in large loss of produce. There is increasing awareness now that more emphasis must be given to conservation after harvest, rather than in endeavouring only to increase crop production.

Various authorities have estimated that 50–80 per cent of fresh fruits and vegetables are lost after harvest, although a recent FAO survey serves only to indicate how vague and incomplete many of these estimates are. In tropical regions which include a large proportion of the developing countries, these losses can assume considerable economic and social importance. In India, out of an estimated production of 50 million tons of fruit and vegetables, 20 to 40 per cent, valued at Rs. 5000–7000 crores, is lost annually (Swaminathan, 1981). These losses further escalate when we include the cost of transportation from the farm to the retailer, including cost of preparation, packaging, transport, marketing, and control system. These overheads cost five to nine times the production cost (Greenhalgh, 1974).

Post-harvest loss of fruits and vegetables depends on whether the fruit is hard or soft, handling during picking, grading, packaging, mode of transport, the condition of roads, proximity to the terminal market, and above all, the temperature and humidity experienced between harvesting and final sale. Once harvested, each type of fruit and vegetable has its own post-harvest requirements and varying degrees of perishability, depending on a host of physical, physiological, and environmental parameters.

The basic parameters in the integrated distribution system depend upon:

- harvesting and preparation
- packaging
- transport
- marketing and storage
- retailing.

Great strides have been made in apple production in India, especially in the NWHR during the last 20 years. Production rose from less than 100,000 tons in 1966/67 to over 1 million tons in 1986/87 (Table 16.1). The basic parameters and their implications for the marketing process (mainly in terms of apples and other important perishables grown in the Indian Himalayan region) will be dealt with here. Solutions to overcome some of the constraints based on advances made in other countries have also been addressed where appropriate.

Harvesting and Preparation

The harvesting of fruits and vegetables and their sizing and grading form the first step in the marketing chain. Fruits and vegetables should be harvested when they are at their prime. Immature or overripe fruits and vegetables tend to deteriorate quickly in quality and bring depleted returns. Important criteria for harvesting and grading apples are discussed in the following paragraphs.

Harvest Maturity

Apples are picked by hand. The time to pick the fruit is judged on the basis of several physical, chemical, and physiological parameters, keeping in view the end use of the apples. It has to be seen whether the apple, once picked, is to be consumed locally, sent to near or distant markets, put in cold stores, or be processed (Table 16.3). Flesh, colour, firmness, total soluble solids, and days from full bloom can prove valuable guides. Mechanical gadgets such as a pressure tester and hand refractometer have been found very valuable because they provide immediate results.

TABLE 16.3
Firmness of apple indicating maturity vs. destinations/use

Destination/use	Firmness of flesh (pounds per square inch)
Nearby markets (Shimla, Chandigarh)	14.5–15.0
Distant markets (Bombay, Calcutta, Madras)	18.0–20.0
Export	18.0–22.0
Local market	13.0–14.0
Cold storage	18.0–20.0
Minimum for cold store fruits	12.0

Source: K.C. Azad, National Workshop on Temperate Horticulture in NWHR of India, p. 274, 1987.

Field Containers for Harvesting

Apples are usually picked and transported from farm to packaging sheds in conical containers called 'Kilta' made from bamboo, which can hold about 25 kg of fruits. Studies on replacing the Kilta with rigid plastic crates (55 × 35 × 30 cm) which can carry 30 kg revealed that bruising of Red Delicious could be cut by half due to the design and smooth inside surface of plastic crates. Labourers, however, still prefer to use Kilta because it can be carried easily on the back.

Grading

Standardization of size, grade, and packaging is important to post-harvest quality and the reduction of post-harvest loss. It also reduces marketing cost, establishes trade language, and brings increased returns. In apple, apart from size, colour and, freedom from blemishes or defects are also important criteria (Table 16.4).

Though the commercial grading practised in Himachal Pradesh is of a fairly high standard, buyers feel that grading is often subjective. There is not much difference between 'Agmark' and this form of grading. Agmark was introduced in 1970. The Market Planning and Design Centre, Directorate of Marketing and Inspection, in collaboration with Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh, took up an Apple Trade Development Project during 1980/81 to develop uniform

TABLE 16.4
Size grades of Himachal apples

Grade	Diameter of fruit at broadest point (mm)	No. of fingers placed between left hand thumb & middle finger
Super large	87 ± 3	4 and thumb
Extra large	81 ± 3	4 and some extra space
Large	75 ± 3	3–4
Medium	69 ± 3	2–3
Small	63 ± 3	1–2
Extra small	57	0–1
Pitto	Less than 51	None

This is mixed with C Grade apples and sold as culls for processing.

Quality Grades of Himachal Apples

A grade: Fruits must have more than 50 per cent of the colour characteristics of the variety, be of normal shape, clean, bright, and free from blemish or defects. The fruit should have reached that stage of maturity which will permit subsequent completion of ripening in the ordinary course of transport and marketing.

B grade: Fruits with less than 50 per cent colour characteristics of the variety, with slightly abnormal shape and two to three healed spots, say up to 0.5 cm.

C grade: Fruit with flesh bruising and spots which are likely to rot immediately in transit and fruit very irregular in shape. Fruits in this grade are not fit for the fresh market.

Source: Harbans Singh and H.L. Kochhar, *Grading and Packing of Apples*, Horticultural Bulletin No. 2, Shimla, 1974.

grade and size standards for the Delicious group, including Golden and Maharaji varieties. Unfortunately, the project could not be implemented. Efforts are now being made to do this and the National Horticultural Board of the Ministry of Agriculture, Department of Agriculture and Cooperation, convened a meeting of relevant agencies to work out standards for varieties from the three states. Use of the grading standards is voluntary, therefore, intensive extension efforts will have to be made to achieve these standards and to see that only A and B grade fruits reach the terminal market.

In the future, the marketing of NWHR fruits, especially apple, is to be size graded for better market returns. Currently, the only mechanical fruit sizing machines in NWHR belong to the two marketing corporations of HPMC and JK-HPMC, set up with World Bank assistance. The 11 HPMC and 17 JK-HPMC pack houses contain 45 sizing machines, each capable of grading 1000 cartons per day with a total capacity of 4.5 million cartons (90,000 tons) in 100 days. Besides, there is a very

large size grader installed by JK-HPMC at Sopore with assistance from the Australian Government. To date, there has been little demand from growers for these facilities because grade standards are not enforced. If these circumstances change in the future, the present grading capacity in the existing packing houses, which can handle only 10 per cent of the apple crop, can be considerably expanded by holding loose fruits in cold storage and expanding the existing capacity of grading centres in the production areas.

Packaging of Fruits and Vegetables

The whole aim of packaging fresh produce is to enable it to be moved from the producer to the consumer at the lowest cost, with minimum loss of quality. Several types of conventional packaging such as wooden boxes, bamboo and reed baskets, jute bags, and even earthen pitchers have been used depending upon the nature of the commodity, its intrinsic value and the ready availability of the packaging materials. More recently, corrugated fibreboard (CFB) cartons and rigid plastic crates have also been used. Due to the shortage of timber and alternative packing materials and their high cost, fruits such as raw mango, banana, and pineapple are marketed without any protective packaging. Increasing the production of fruit and vegetables in the country in general and in the mountains in particular depends to a large extent on the supply of wood for making wooden boxes from forest resources in the hills.

Wood Requirements

Fortunately, in the Himalayan mountain region there is an abundant supply of silver fir and pine-chir and, till recently, the Forest Department in Himachal Pradesh was committed to supply wood at subsidized rates for packaging of hill produce. The estimated supply of wood required in 1990 for packaging of apples has been drawn up (Table 16.5). These calculations are based on the assumption that nearly one-third of the standing volume of wood is wasted, only two-thirds of it being used for cases. Further, 60 packing cases of 18 kg capacity are made from each cubic metre of standing volume.

As may be observed the demand for wood for the manufacture of packing cases for Himachal apples alone would be about 2,00,000 (Negi, 1989). The considerably larger production of apples in Jammu and Kashmir and the demand of Uttar Pradesh will require much more wood. This figure can multiply if we take into consideration housing, furniture, and other uses of timbers. Massive deforestation of the Himalaya has become a source of great anxiety to environmentalists, causing as it does imbalance in the ecology, erratic rainfall, increased soil erosion, and faster

TABLE 16.5

Projected quantity of apple requiring packing and wood required for the purpose in Himachal Pradesh

Year	Production ('000 tons)	Net quantity to be boxed (84 per cent, of production) ('000 tons)	No. of boxes needed ('000 boxes)	Wood required for packing cases ('000 m^3)
1985	174.6	145.7	8069	134.5
1986	191.0	160.4	8822	147.0
1987	209.0	175.6	9658	161.0
1988	228.7	192.1	10566	176.1
1989	250.3	210.3	11567	192.8
1990	273.9	230.1	12656	210.9

Source: R. Swaroop, Director, Agro-Economic Research Centre, Shimla (Himachal Pradesh).

silting of dams and riverbeds. Restrictions have now been imposed on the indiscriminate felling of forest and alternative sources of wood for the packaging of fruits and vegetables are being looked into.

Wooden Packing Cases

Unlike in the advanced countries, in India wooden packing cases have not been properly standardized for the same or different commodities. In the case of apple, the standard size of packing case is 18 kg in Himachal Pradesh as against about 20 kg in Kashmir. There are also half standard cases in Himachal Pradesh, Jammu and Kashmir, and Uttar Pradesh (Table 16.6)

To pack and market stone fruits (plum, apricot, peach, and almond) and for vegetables such as tomato and capsicum, the capacity of the box is less than that used for apples (Table 16.7).

Substitutes for Wooden Boxes

With the timber crisis, its rising cost, and the recognition of the forests' role in preserving the ecological balance, every effort is being made to minimize the felling of trees. Efforts are therefore being made to develop substitute containers which consume less wood but are comparable in performance. Great success has been achieved in developing CFB cartons, alternative packing using little or no wood, and rigid plastic containers.

Corrugated fibreboard cartons with paper pulp trays have long been used for packing and transport of fruits and vegetables in many developed countries. They offer several advantages over wooden boxes:

- A CFB carton consumes only 30 to 40 per cent of the wood used for a

TABLE 16.6

Details of wooden boxes in use for packing and marketing of apple in Himachal Pradesh

Size grade	Fruit size (+ 2.5 mm)	Fruit count	Box size (inner dimensions, cm)	Capacity (kg)
Super large	85	54–57	45.72 x 30.48 x 27.94	18–20
Extra large	80	60–63	45.72 x 30.48 x 25.45	18–20
Large	75	96	45.72 x 30.48 x 30.48	18–20
Medium	70	112	45.72 x 30.48 x 27.94	18–20
Small	65	128–132	45.72 x 30.48 x 25.45	18–20
Extra small	60	160	45.72 x 30.48 x 25.45	18–20
Pitto	55	—	45.72 x 30.48 x 24.45	18–20
Kullu dabba (for different sizes)	—	—	48.70 x 20.50 x 22.50	10

The price for an empty box is Rs. 12–13 for all sizes except Kullu dabba, which costs Rs. 8

Source: B.B. Lal, Horticulture Technologist, Y.S. Parmar University of Horticulture and Forestry, Nauni, Himachal Pradesh (personal communication), 1989.

TABLE 16.7

Details of wooden boxes in use for packing of stone fruits and vegetables in Himachal Pradesh

Fruit	Inner dimensions (cm)		Capacity Height	Wood (kg)	Box (Cost Rs.)
	Length	Width			
Plum, apricot, fresh almond	37.5	20.5	15.5	5–6	5
Peach	42.5	27.5	19.5	12	8
Tomato small	43.2	25.4	20.3	13	8–10
Tomato large	45.7	27.9	20.3	15	8–11
Capsicum small	50.8	33.0	20.3	12–13	12
Capsicum large	55.9	38.1	27.9	15–16	14

Source: B.B. Lal, Horticulture Technologist, Y.S. Parmar University of Horticulture and Forestry, Nauni, Himachal Pradesh (personal communication), 1989.

wooden box of the same capacity. The change over to CFB cartons will thus considerably increase the total output of cartons from the same timber resources. These cartons can also be made from other materials like biomass, bamboo, bagasse, and wheat and rice straw.

- Their corrugation helps to minimize the bruising of fruits.
- They are easier to handle and stack, their weight being only one-fifth that of wooden boxes.
- They can be punched and ventilated.

- They are internationally acceptable.
- They are pilfer-proof and any tampering is seen at a glance.
- They can be printed artistically at low cost.
- Their telescopic form imparts a high degree of stacking strength.
- They can be fabricated and turned out quickly in highly precise and accurate sizes.
- They are totally recyclable into pulp, unlike wooden boxes which are invariably used as fuel.

The only disadvantage of the CFB carton is that, together with its paper tray, it costs more at present than the wooden box. This could be partially overcome by increasing production and bringing in better technology for production. The price difference could also be neutralized by higher prices fetched by apples packed in CFB cartons than in wooden boxes.

To promote the use of CFB cartons in India, the Market Planning and Design Centre of Marketing and Inspection took up an apple trade development project in 1980/81 under the auspices of UNDP/FAO, using the services of foreign consultants. Telescopic cartons and pulp trays were imported from New Zealand and distributed to apple-growing states for experimental purposes.

From 1983 onwards, the Himachal Pradesh Government took up promotional efforts for the extensive use of corrugated telescopic tray-pack cartons by appropriately subsidizing them to keep their price lower than that of standard wooden cartons. In 1986, these were sold at the rate of Rs. 9 per carton including pulp trays, straps, and gum tape, as against the prevailing price of Rs. 10 for standard wooden boxes. There is an increasing use of CFB cartons for packing apples in Himachal Pradesh:

Year	*No. of CFB cartons used*
1983	21,000
1984	16,000
1985	179,000
1986	1,665,000
1987	6,000,000

A company under the name of Agro Industrial Packaging India Ltd. has been incorporated by the Himachal Pradesh government at a cost of Rs. 240 million to manufacture 45 million sq.m of corrugated liner board and 30 million cartons for the packaging of fruits and vegetables in the first phase. The plant will have the most modern heavy duty technology and use high strength, water-resistant craft paper with a burst factor above 30. At present, the country is short of soft wood with long fibre and will have to develop long fibre resources in order to manufacture a liner and fluting medium with the necessary physical properties.

The CFB cartons used in apple packaging have the inner dimension of 50.8 × 30.8 × 28.0 cm and are assembled by fitting two standard telescopic pieces of five ply into each other, thus giving 10-ply thickness to the carton on the sides and five ply on the top and bottom. Fruits are packed in paper pulp-moulded trays with appropriate size cavities. Altogether, six trays, five trays carrying fruit and the sixth one as the topper, are stacked one above the other, carrying 120 fruits altogether. Each tray is arranged in the opposite direction to hold the weight of the fruit on the projections of tray cavities rather than on the fruit.

Details of CFB cartons used for packaging of different fruits like apple, plum, apricot and almond are given in Table 16.8.

So far, only Himachal Pradesh has been able to promote the use of CFB cartons for apple packing. This has been made possible because government subsidies on these cartons keep their price slightly lower than that of wooden boxes. In Jammu and Kashmir and Uttar Pradesh, apples are still being packed in wooden boxes. A part of the plum, apricot, and almond crop in Himachal Pradesh is packed in CFB cartons. The change-over to CFB cartons is complete in Jammu and Kashmir, where cherries are packed in these cartons. This is because of the lighter weight of these cartons for transporting cherries by air from Srinagar to Delhi and Bombay.

TABLE 16.8

Details of CFB carton used for apple, plum, apricot, and almond packaging

Type	Size	Approx. capacity (kg)	Subsidized price (Rs.)
Telescopic CFB carton with 6 trays for apple	50.8 × 30.8 × 28.0	20	11.50
Universal CFB carton	45.0 × 30.0 × 27.5	18	8.00
Universal Kullu dabba	48.7 × 20.5 × 22.5	10	6.00
Universal CFB carton for plum, apricot, and almond	37.0 × 18.0 × 15.0	5–6	4.5

Source: B.B. Lal, Horticulture Technologist, Y.S. Parmar University of Horticulture and Forestry, Himachal Pradesh (personal communication), 1989.

ALTERNATIVE PACKAGING USING LITTLE OR NO WOOD

In the Himalayan region, jute bags are extensively used to pack cabbage, beans, radish, turmeric, carrot, eggplant and cucurbits. Bamboo and wooden baskets are used to pack tomato, peas, capsicum, and cauliflower. Jute bags and bamboo baskets have extremely poor holding

capacity and stacking strength. They offer no physical support or protection to the product, resulting in unusually heavy losses and damage.

The Himachal Pradesh State Forest Corporation has set up a plant to manufacture pine-needle hardboard with a capacity to turn out 400,000 standard size boxes. Trials conducted with pine-needle packs reveal that the boxes absorb moisture and tend to loosen up during transit. Also, the printing of stencils on its body and its handling was difficult. These cartons may prove useful to pack apples in the interior areas not linked by roads.

Other innovations in alternative packaging, using cheaper and less wood, have also been tried. The Forest Research Institute, Dehra Dun, has devised five types of 18 kg standard size (30 × 30 × 45 cm) boxes: plywood boxes, fir veneer box, toon veneer box, chir box, and poplar box. Some of these boxes have proved as good as the conventional wooden Shimla box as far as bruising damage was concerned during the transit of fruit from the production centre near Shimla to Delhi in trucks (Table 16.9).

TABLE 16.9

Bruising damage in Royal Delicious apple during transit

Type of packaging	Bruising percentage
Shimla box	36.0
Chir Box	35.2
Toon veneer	26.2
Fir veneer	20.0
Thin plywood	39.0
Poplar	23.3

Source: Maini et al. *Trials on Substitute Boxes for Packing of Apples,* National Workshop on Apple Industry, New Delhi, 1983

USE OF PLASTIC CONTAINERS

Substitution of CFB cartons for wooden boxes for the packing of apple has been encouraged and large-scale production of these cartons is in hand. During the rainy season, however, the handling of CFB cartons becomes problematic as they are not totally moisture-proof. The Indian petrochemical industry has introduced two types of plastic containers: corrugated polypropylene co-polymer (PPCP) boxes; and moulded PPCP crates. The former is a prototype of the CFB carton made with plastic sheeting instead of craft paper and is being manufactured by Caprihans at Bombay. These cartons proved useful in rainy weather but are still not commercially used. The latter is the rigid plastic container. As they are made from petrochemical-based polymers, these containers are pro-

hibitive by PPCP box costs 2.5 times and a PPCP rigid plastic crate costs about 7 times the cost of a CFB carton. Compared with the wooden box, however, the rigid plastic crate offers the following advantages:

- It is 1/5th to 1/10th lighter.
- It does not absorb moisture.
- It is easy to handle and stack.
- Bruising damage is minimal.
- It provides better aeration.
- It can be easily washed and does not attract fungus or bacteria.
- It is excellent in removing field-heat from packed fruits and more economical to maintain at low temperature in cool storage.

Initial tests carried out on these PPCP cartons by IPCL show that they can be used 18 times, while other containers are used once. The economy of these cartons lies in recycling them through a close network of distribution and in standardizing their design. The material required for making crates is now indigenously available at the IPCL plant at Vadodara.

TABLE 16.10
Crate introduction plan

Year	No. of crates (M.T.)	Equivalent boxes replaced	Equivalent wooden
1987	100,000	220	18
1988	200,000	440	38
1989	600,000	1320	108
1990	2,400,000	5280	432
2000	2,400,000	5280	432

Source: Plastic in Packaging of Horticultural Produce, Proceedings of National Seminar on Use of Plastics in Agriculture, Vigyan Bhavan, New Delhi, p. 39, 1987.

With a view to introducing standardization, a compromise has been made in the common dimension of 60 × 40 cm. These rigid plastic crates have replaced the conventional wooden box for carrying apples from the orchard to the grading and packing house or nearby market. At present, HPMC uses about 50,000 plastic crates as field boxes. Mother Dairy of the National Dairy Development Board has used these crates successfully for the last two years for transportation and storage of fruits and vegetables in Delhi. Other user organizations include the Horticultural Producers' Cooperative Marketing and Processing Society Ltd., Bangalore. Both in economy and in performance, these crates were found satisfactory.

For plastic crates to become the generally used container for transportation and marketing of fruits and vegetables to distant markets, cer-

tain information besides size standardization and distribution mechanism is desirable:

- size and type of crate and capacity, advantage of collapsible crates
- technical specifications
- capacity for faster transportation and recycling
- price factor and economic feasibility
- mode of investment in crates, guaranteed security
- alternative use of these crates in cold stores and institutional supply
- overhaul and repair for maximum utility.

A scheme has been jointly launched by IPCL and HPMC using 20,000 crates on a trial basis to generate data on their performance. The HPMC is to be supplied 20,000 crates free of cost by IPCL for use by the apple trade. It is to generate all the data on these crates and to ensure lending and retrieval of them. It is to charge Rs. 5 and Rs. 8 per crate trip to apple growers. It is to meet total expenses on fruit, packaging, transportation, and washing and storage of crates.

Bulk Bins

The increased cost of apple packaging in India seems inevitable, but mid- to long-term bulk movement of fruits may have good potential. This can be done by the use of bulk bins. Initially, the concept may apply only to B grade apples which invariably bring lower prices in the market and thus not warrant the additional cost of a tray pack or carton operation.

Truck-loads of apples have also been moved by some orchardists using wooden planks as tiers, supported on the sides of the truck by hooks. Three tiers are used and the planks are padded with paddy straw to avoid bruising. On arrival at Delhi, these apples are graded again and stored in boxes in cold storage. This operation has shown promise and, if proved profitable, will gain momentum in future.

Packing Houses

After harvest, most horticulture crops are cleaned, sorted, graded, and usually packed if they are to be sold in the fresh produce markets. All these procedures usually take place in packing houses of different types, a small thatched shelter on the edge of a field or a more permanent packing house with various facilities. The packing house design and the facilities needed depend very much on the local infrastructure, quantity of the produce, the markets being served, and budgetary provisions. The operation carried out by a packing house may include: receipt, checking,

loading and unloading; packaging, including washing, waxing, grading; despatch, checking, and loading; and storage, ripening, and cooling.

Packing houses should be near production areas and have easy access to the market through good highways or railways or other transit facilities. Services such as water, electricity, and labour should be easily available. In the mountainous regions of the Himalaya, the grading and packing operation was usually done by individual farmers, while private contractors who buy the produce at pre-harvest stage from the individual grower arranged their own sheds to sort, grade, and pack the produce.

The HPMC was created in 1975 to set up an efficient marketing and processing organization with infrastructure to market horticultural produce (mainly apples), under a Rs. 160 million World Bank-assisted project. It was to set up packing houses with a capacity of 14,000 tons. Similarly, JK-MPMC, established in 1979 with Rs. 240 million as part of a World Bank-assisted project on marketing and processing horticultural produce, was asked to set up 17 packing houses with 34,000 tons capacity. All 17 packing houses have not yet been fully commissioned due to lack of response from the growers.

Storage of Fruits and Vegetables

Fruits and vegetables remain alive even after harvest, inhaling oxygen and exhaling carbon dioxide, water, and heat. If not managed properly, they tend to wither and may soon start rotting. Their shelf life can be considerably extended from a few days to several months if stored properly at low temperatures with high humidity. Cold storage of fruits and vegetables is helpful to avoid gluts in the market and to regulate the supply of these perishables over longer periods, to the advantage of both the producer and the consumer.

The Himalayan regions produce all types of temperate and subtropical fruits and vegetable. Their maximum storage life depends upon their maturity, variety, quality, and other factors. Currently, two of the important crops grown in this region, apple and potato, are stored at low temperature in cold stores for up to 12 months, thus being available throughout the year. It is not worthwhile to store all types of fresh produce if the ultimate price realized for them is not enough to cover the cost of storage. Low temperature management of post-harvest fruits and vegetables during grading, packing, transport, and marketing is of great advantage to retain their freshness and bring better economic returns to the growers. The recommended environmental conditions and approximate storage life of important fruits and vegetables is given in Table 16.11.

TABLE 16.11

Recommended temperature for storage of Himalayan region fruits and vegetables

Fruits	Temp °F (°C)	Life (weeks)	Vegetables	Temp °F (°C)	Life (weeks)
Extremely perishable (0–4 weeks)	RH 90–95			RH 90–95	
Apricot	31 (–0.5)	2	Asparagus	32 (0)	2–4
Banana (green)	55 (12.5)	2–3	Brussels sprouts	32 (0)	2–4
Cherry	32 (0)	2–4	Cauliflower	32 (0)	2–4
Guava	45–50 (7–10)		Green peas	31 (–0.5)	1–3
Mango	50–55 (10–12)	2–3	Melon	40–45 (5–7)	2–3
Papaya	45 (7)	7	Capsicum	45 (7)	2–3
			Radish	32 (0)	2–3
			Spinach	32 (0)	1–2
			Tomato (red)	45–50 (7–10)	1–2
			Mushroom	32 (0)	1–2
Perishable (4–8 weeks)					
Grape	31 (–0.5)	4–6	Cabbage	32 (0)	4–6
Mandarin	40–45 (5–7)	3–6	Tomato (green)	55 (12)	3–6
Peach	31 (–0.5)	2–6			
Pineapple	50 (10)	2–4			
Plum	31 (–0.5)	2–7			
Slightly perishable* (6–12 weeks)					
Grape	30 (–1)	7–12	Cabbage	32 (0)	6–12
Lime	50 (10)	6–8			
Orange	40–45 (5–7)	6–12			
Non-perishable (12 weeks)					
Apple	30–38 (–1–3)	8–28	Beetroot	32 (0)	12–20
Nuts	30 (–1)	up to 50	Carrot	32 (0)	12–20
Pear	30 (–1)	8–28	Potato	45 (7)	16–20
Quince	30 (0)	8–16	Sweet potato	55 (12)	16–24
			Turnip	32 (0)	10–24

*The longer-keeping produce which can be safely stored for correspondingly shorter periods at temperatures higher than the optimum temperature for best keeping are listed above.

Source: E.G. Hall, Mixed Storage of Food Stuffs, Cir. 9, CSIRO, Australia, 1973.

Cold Stores

In India there are 2522 cold stores with a storage capacity of 5.1 million tons, out of which 1588 stores with a capacity of 4.5 million tons (88.2 per cent) are used for storage of potato only (Directory of Cold Storage in India 1985, Directorate of Marketing and Inspection, Faridabad). With World Bank assistance, five cold stores with a capacity of 5000 tons were set up in Himachal Pradesh and seven cold stores with a capacity of

6400 tons, ultimately to increase to 12,000 tons, are to be constructed in the state of Jammu and Kashmir exclusively for apple storage.

With the increasing volume of apples coming into the market each year, the provision of adequate fruit storage facilities becomes increasingly imperative, if market gluts and reduced prices are to be prevented. In fact, to gain full benefits from the cold stores, a cold chain strategy in production, transshipment, and consumption areas has to be effectively adopted for the proper care of over 1 million tons of apple. The crop being harvested early in Uttar Pradesh, efforts should be made also to market it, avoiding investment in the establishment of cold stores. In Jammu and Kashmir and Himachal Pradesh, however, cold storage is inevitable for the Delicious variety, which does not have a long shelf life.

The scale of storage required is enormous when long-term management and the existing facilities are considered. Estimates drawn for Jammu and Kashmir by the Indo-Australia Apple Technology Extension Project proposed about 30 per cent of apples be cold stored in the Kashmir valley, 15 per cent in transshipment centres at Jammu, and 15 per cent at terminal markets, which would require a storage capacity in Jammu and Kashmir for 350,000 tons by 1990 (total production estimated 800,000 tons in 1990), compared with an existing facility for 12,000 tons. Similarly, additional cold storage capacity will have to be provided for Himachal Pradesh where the existing capcaity is only 6400 tons. Most of the cold stores were set up in India either in potato production areas or in large cities where potato is sold. Half of their capacity is used for potato seed. Some of the stores in terminal markets are also used to store apples during the off-season.

The construction and operation of cold stores for the NWHR's fruit crop is, therefore, likely to involve major investment in coming years. An addition of 4000 tons capacity will cost about Rs. 8 million. Keeping this in view, alongside the energy crisis and its rising cost, it becomes a matter needing serious and detailed planning to ensure that appropriately sized and equipped units are established at optimum locations in the hills, near production centres, or in terminal markets, in a phased manner matching the needs of growers, commission agents, and wholesalers.

Pre-cooling

Prompt cooling of apples in the production area, whether meant for direct marketing or destined for storage, is a key factor in retaining quality. Leaving Delicious apples outside at 70°F (21°C) for a week will reduce their storage life approximately nine weeks. The storage life of the apple is closely related to ambient temperature.

Pre-cooling can be achieved by picking fruit pre-chilled by night air and/or by watering down and forcing air over the stacked fruit (evapo-

rative cooling). Other methods like vacuum cooling and the more recent technique called ice-bank cooling are also used.

TABLE 16.12

Life of apple at various temperatures

Temperature (°F) °C	Storage Life
(30) −1	7 months
(32) 0	6 1/4 months
(36) 2	3 months
(40) 4	2 months
(50) 10	1 1/4 months
(60) 16	23 days
(70) 21	20 days

Source: US Department of Agriculture Bull. No. 1406 (1926)

Evaporative Cooling

Hot and dry weather prevails over much of India for a significant part of the year. Exposure to such weather causes rapid deterioration of perishables, particularly those more liable to water loss by evaporation. In hot and dry weather use of the evaporative cooling system can considerably reduce dry bulb temperatures and raise the humidity of the air, which is conducive to preservation of fresh fruit and vegetables after harvest.

With energy shortage and its rising cost, refrigerated cooling is becoming extremely expensive. Desert coolers are now fast replacing air conditioners to provide coolness in homes in the northern plains of the country. These coolers consume only one-fifth the energy per unit drop in temperature that air conditioners consume and create a desirable humidity of around 80 to 90 per cent which is difficult to obtain in the refrigerated system. If the air is drier, the evaporation is greater and so is the drop in temperature.

Several evaporative cooling models based on simple, natural convective ventilation without the use of energy and others using forced draft ventilation (FDV) with the use of energy have been tried and found useful. A simple fruit cooler using a draft of air forced by an exhaust fan through wet, porous walls has been used with success in Australia (Figure 16.1). This relatively cheaply constructed room has been found very suitable for the cooling and short-term holding of citrus fruits and grapes with negligible wilting and weight loss. It should be possible to maintain the room at a temperature of 65–70°F even on the hottest day.

Where electricity is **not available,** a thatched roof structure (Figure 16.2) can be kept cool by periodically flooding the gravel base. Maxi-

mum cooling is obtained by converting the wall facing the prevailing wind direction into a large evaporating surface. This can be done by packing porous material between supporting studs held together by wire netting. A drip system for water is also provided at the top. The structure has been used with great success in Kenya.

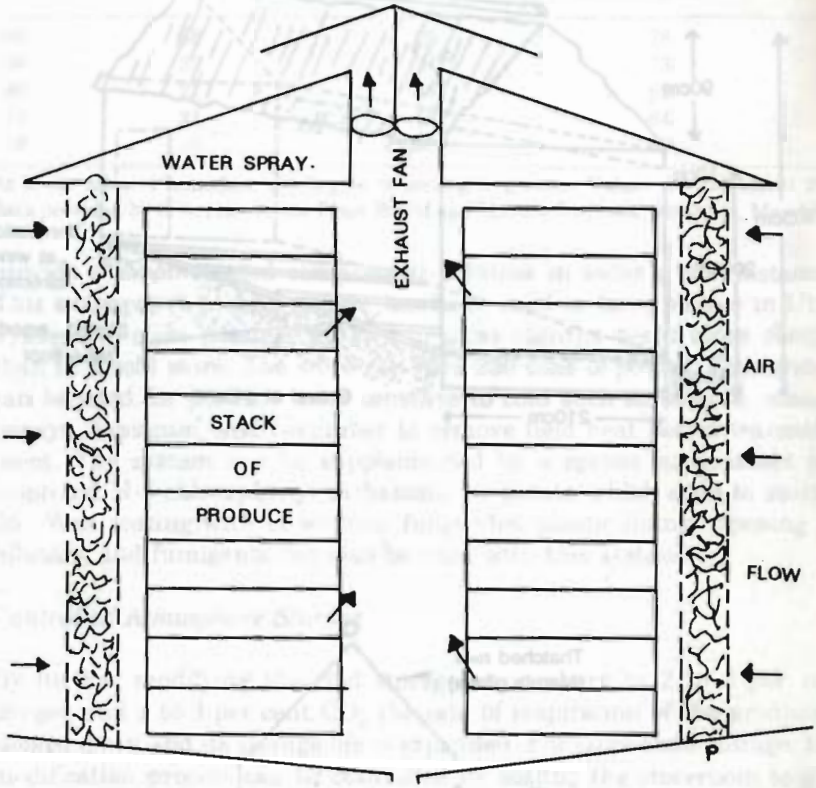
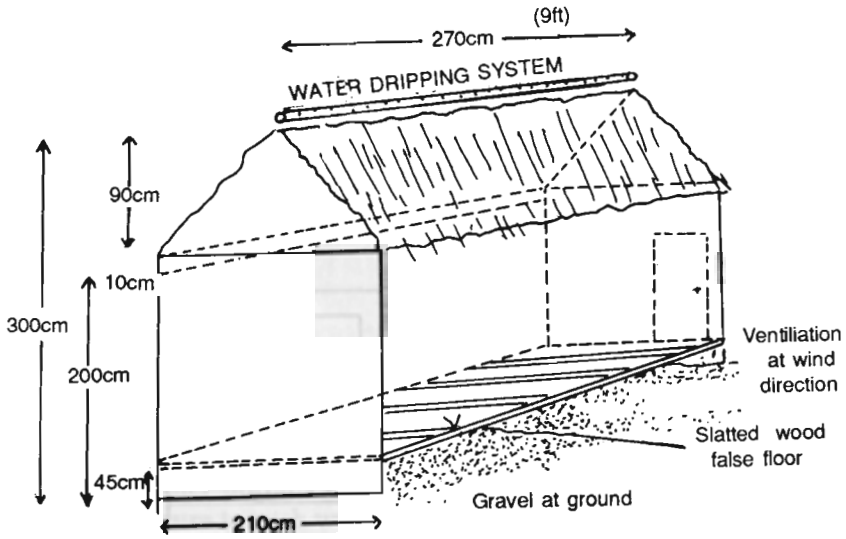


Figure 16.1: A simple evaporation-cooled fruit cooler (Australia)
P: Porous wall 15 cm thick on a timber frame with 1.25 cm wire netting, either side filled with 3–5 cm coke or charcoal pieces.
Source: E.G. Hall, *Evaporative Coolers* ASCA Seminar Proceedings, North Ryde, Australia.

Another cold godown working satisfactorily for the short-term storage of potatoes is made of mud wall with bamboo frame structure and thatched roof standing on a false bamboo bottom. The ground below is kept wet with sand and water. The thatched roof is also periodically sprinkled with water. This low-cost, energy-saving cooling system can be used with success on the farm in packing sheds and for pre-cooling purposes. It cannot be expected to do all that the cold store can but it can



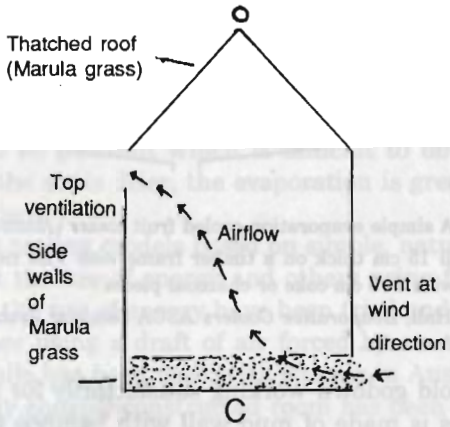


Figure 16.2: Low-cost ventilated store cooled by evaporation (Kenya)
Source: International Trade Forum UNCTAD/GATT, January-March 1981.

TABLE 16.13
Air temperature obtained by single-stage evaporative cooling

Ambient temperature		Ambient relative humidity (Percentage; 80 per cent RH)	Temperature of air ex-cooler at	
°F	°C		°F	°C
100	38	25	78	26
90	32	34	73	23
80	27	46	69	21
70	21	64	64	18
60	16	90	59	15

At lower relative humidity, the degree of cooling is greater. Values are calculated from data provided by E.G. Hall in the Fruit World and Market Growers, Australia, May 1972.

provide a much needed compromise solution in today's circumstances. This evaporative cooling system has been used in farm houses in Uttar Pradesh to store potatoes for two to three months much more cheaply than in a cold store. The store can hold 250 tons of potato. This system can be used for produce most sensitive to cold such as banana, mango, papaya, capsicum, and cucumber to remove field heat before transshipment. The system can be supplemented by a sprout suppressant like Isopropyl N-3-chlorophenyl carbamate for potato which adds to storage life. Wax coating with or without fungicides, plastic lining, ripening inhibitors, and fumigants can also be used with this system.

Controlled Atmosphere Storage

By further modifying the cold storage atmosphere to 2 to 3 per cent oxygen and 2 to 3 per cent CO_2 the rate of respiration of the produce is slowed down and its storage life is expanded. For large-scale storage, this modification process can be controlled by sealing the storeroom to gas-tightness and by incorporating equipment for the addition or removal of oxygen and carbon dioxide. The use of polythene bags of a specific thickness and gas permeability, combined with refrigeration, could be profitably used to extend post-harvest life because of the repressive effect on respiration and transpiration. This controlled atmosphere storage is in widespread use in many developed countries for the storage of apples and pears. Making a cold store gas-tight increases the capital cost by about 10 per cent and is thus not practicable in India. An experimental controlled atmosphere store has been used for the past three to four years for the storage of apples by JK-HPMC at Srinagar. Commercial controlled at atmosphere storage of apples should come into use only after normal air storage is widely practised to the greatest advantage.

Air-cooled Stores

In areas where night temperatures are low and the day temperature is high, air-cooled stores are used to house perishables on the farm. The temperature in an air-cooled storage room is reduced by opening air intakes and vents near the floor and the exhaust opening near the ceiling in the opposite wall to admit cool air at night. The vents and intakes are closed when the outside temperature rises above the storage-room temperature. The efficiency of these stores can be improved by using evaporative coolers in areas which experience high temperature and low humidity. Stacking of produce inside the store must allow for free movement of air. Humidification of incoming air can be done to restrict water loss from the produce. One such store with a capacity to stack 100 standard apple boxes is functioning satisfactorily at the Regional Fruit Research Station at Mashobra in Himachal Pradesh.

Transportation of Fresh Produce

Fruits are grown in the Himalaya on the slopes, ridges, and valleys of far-flung and remote areas. Improvised tracks and dirt roads provide the only linkages with roadheads. The fruit from these areas is first carried on human backs or heads or by mules to the roadhead. At these assembly points, fruit is stored, packed, and arranged to be transported by forwarding agencies to markets outside the states, mainly by truck. It is not usual for trucks to carry a load all the way to the terminal markets. In the case of apples in NWHR, local trucks are used to ply between the production centres and the transshipment centres established at Jammu and Kashmir, Parwanoo and Keratsahib (Himachal Pradesh), and Haldwani and Kathgodam (Uttar Pradesh). Local trucks carry about 400 boxes of 20 kg each but the truck from transshipment centres to the terminal markets carry an increased load of 500 to 550 boxes. Jammu, Parwanoo, and Haldwani are also connected by rail to different parts of the country, but railways are rarely used to transport fruit. Potato and some other vegetables are sometimes transported from these transshipment centres by rail.

Temperature is a major problem in the marketing of fruits, especially in the NWHR and NEHR. Fruits from both these areas have to travel long distances to reach the consuming markets. Srinagar is 800 km from Delhi and over 2000 km from Bombay and Calcutta. In the case of apples from Srinagar, the transport time in the hot humid plains may be about three days to Delhi and up to 10-days to distant markets. During this long haul at high ambient temperatures the fruit quality suffers. Pineapple, banana, and citrus grown in the NEHR has to reach the sale points by circuitous routes via Assam.

Road versus Rail Transport

For carrying fruits and vegetables there is a pronounced preference for road transport in this country. One of the basic reasons for preference is shorter transit time and the advantage of door-to-door service. Road transport, however, is two to three times more expensive. With the energy crisis there will undoubtedly be a switch back to the railway. It is estimated that rail transport is about 8 to 10 times more efficient in the use of energy than road transport to move a ton of produce. The railway system has thus to be improved and made more service-oriented to attract more traffic in perishables. Rail transport is handicapped in that fruit and vegetables have to be carried in general-purpose, all-steel, unventilated wagons which literally carry everything. In these wagons damage is bound to result because accumulated heat and solar radiation is unavoidable.

Temperature in Transit

Both refrigerated and insulated rail wagons and trucks are now in use in advanced countries to carry perishable produce from the production centres to the consuming markets. Although these would be ideal, understandably such specialized vehicles are not only costly to build, but also unreasonably expensive to operate in the Indian economy.

How best to maintain low temperatures in both trucks and wagons to preserve the quality of fruits and vegetables and to reduce loss during transit needs close attention. There is an urgent need to improve the design and ventilation of rail wagons. Fruits and vegetables need to be pre-cooled before loading. During movement by train, the fruit undergoes evaporative cooling and its temperature, instead of rising, remains close to the ambient temperature. Ventilation at night will help to cool the produce by cold air from outside. In the closed wagons, Dr. Swaminathan's committee (1981) recommended the use of dry ice inside the wagons to maintain low temperature. Dry ice can also be used in trucks for the local distribution of fruits. Painting the roofs of rail wagons white will further reduce the absorption of radiant heat to the advantage of the fruit.

There is a need to improvise small changes in the design of existing trucks to allow the passage of air through a wet surface connected by a drip system from an overhead tank. Water in the tank can be replenished during the journey.

Furthermore, trucks should travel at night to avoid the sun's heat and be made to park in the shade during halts. There is also suggestion to sprinkle powdered ice on the fruit boxes in the truck to keep them cool during transit. In the case of properly pre-cooled fruits, the use of insulated trucks would be an advantage. When grapes were cooled to 4°C

before loading in insulated trucks for transport from Bombay to Delhi in April, only 1°C rise in temperature per hour was observed.

Improvement in Transport Strategy

If India is to attain a marked improvement in the horticulture sector, a bold policy with massive financial inputs, as was done in the case of cereals and milk, has to be evolved to create a proper infrastructure for the post-harvest management of fruit and vegetables. Transportation forms the most important link in the distribution chain and is estimated to cost 30–35 per cent of the sale price. An action plan needs to be evolved and properly executed, based on the introduction of mechanical or gravity ropeways in difficult hilly terrain, designing of modified trucks and railway wagons, and subsidization of their rates to encourage their use. For long-distance NEHR export markets, links to the local airport should be developed. The cost of air transportation can be neutralized by appropriate subsidies to make the transported commodities competitive. Further, inland navigation needs to be developed through Bangladesh to market produce from the NEHR Calcutta. Priority clearance should be given to trucks carrying fruit and vegetables at sales tax barriers in the states.

Fruit and Vegetable Processing

Important fruits in the NWHR include apple, pear, plum, apricot, and cherry, and in the NEHR banana, pineapple, and citrus. The vegetables most common in both regions include potato, tomato, cabbage, cauliflower, pea, and capsicum. Jammu and Kashmir and Himachal Pradesh also grow nuts, (walnut, chestnut, pistachio, almond, pecan). The wild pomegranate is abundantly available in Himachal Pradesh and Jammu and Kashmir and wild mango in the NEHR.

Apple constitutes about 80 per cent of the total production of the NWHR amounting to over 1 million tons. Out of the total production of apples, about 200,000 tons are culls which are available for processing each year, 60 per cent of which comes from Jammu and Kashmir.

Several large-scale units for apple, pineapple, and orange juice concentrates have already been commissioned or are to be commissioned in the NWHR and NEHR (Table 16.14).

The apple juice concentrate unit at Sopore, Jammu and Kashmir, with a capacity of 12,000 tons was initially set up by Cadbury and sold later to JK-HPMC in 1985. The Parwanoo unit in Himachal Pradesh of 18,000 tons was built by HPMC while the second unit of 2000 tons at Jarol was built with German bilateral aid and is now run by HPMC. Thus, the total crushing capacity of apples in these units is 32,000 tons

TABLE 16.14
Units for concentrates in the NWHR and NEHR

State	Concentrates Produced	Location
Jammu and Kashmir	Apple	Sopore
Himachal Pradesh	Apple	Parwanoo and Jarol
Tripura	Pineapple	Kumarghat
Assam	Pineapple	Silchar
Arunachal	Orange	Tinsukhia*

*Unit to be commissioned shortly.

with several other small units crushing another 500 tons. The total number of units processing fruit and vegetables in the states of the Himalayan region are given in Table 16.15. Most of these units are very small when compared with fruit juice concentrate plants.

TABLE 16.15
Number of fruit and vegetable processing units in the Himalayan region (1988)

State	No. of units
Jammu and Kashmir	58
Himachal Pradesh	55
Uttar Pradesh	164
Assam	19
Arunachal Pradesh	02
Mizoram	03
Meghalaya	05
Manipur	04
Nagaland	03
Sikkim	01

Source: Ministry of Food Processing Industries, New Delhi.

Apple Juice

None of the apple juice concentrate plants have run to full capacity since their inception. In spite of great efforts made by HPMC for the promotion and sale of apple juice through juice vending machines set up at important centres, the sale of apple juice lags far behind mango, pineapple, and citrus juices. This is also reflected in the poor sale of apple juice compared with other juices packed in new packaging material like the tetra-pack. Public apathy to apple juice is said to be due to its lack of body and aroma. Blending apple juice with fruit pulp can give excellent

nectar (see Table 16.16). Blending with other fruits like mango, citrus, pineapple, and guava could also be tried.

TABLE 16.16
Recommended apple juice blends

Fruit blend	Other fruit (percentage)	Apple juice (percentage)	Added sugar (percentage)	PH malic	Acidity (acid gm/100 ml)	Brix 17.5°C
Plum-apple	63	37	1.5	3.40	0.98	18.50
Cherry-apple	55	45	3.0	3.22	1.14	17.75
Apple-raspberry	25	75	2.0	3.32	0.72	16.50
Apple-strawberry	53	47	5.0	—	—	—
Apple-grape	50	50	None	—	—	—
Apple-cranberry	22.6	77.4	2.5	3.10	—	13.00
Apple-elderberry	22.6	79.7	3.3	—	—	—

Source: Luh B.S. Nectars, Pulpy Juices and Fruit Juice Blends in Fruit and Vegetable Juice Processing Technology, 2nd ed. D.K. Tressler and M.A. Josylyn. AVU Publishing Company, INC, West Port, Connecticut, 1971.

Stone Fruit Pulp

Peach, plum, and apricot are rated very high on account of their attractive colour and flavour. Because they are highly perishable and because of the rising overheads on packaging, transport, and marketing them, growers are slowly becoming disenchanted. For better realization from these crops it may be more appropriate to preserve them as pulp at their optimum ripeness in the field, with simple technology like heat treatment or the addition of chemical additives. The pulp can be stored in plastic carboys or steel drums with plastic lining and used at convenience to convert into juice, nectar, or jam. These containers can be used again and again.

Appropriate Processing Technology for Hill Fruits

Large proportions of undersized, hail-damaged, and misshapen fruits which otherwise go to waste or are left in the field can be profitably used. Similarly, vegetables which grow abundantly during the summer months can be preserved for the lean winter months. Canning, freezing, freeze-drying, and vacuum concentration based on expensive equipment and cost by packaging have only a limited use in the techno-economic conditions in India. Alternative preservation technology based on sun-drying, pickling, chemical preservation, and fermentation, which are already being applied to some extent in the countryside, needs to be upgraded and supported. Technology in commercial use includes sun-dry of wild pomegranate seeds into 'Anar Dana' in Himachal Pradesh and Jammu and Kashmir; drying of ginger rhizomes into dry ginger 'sunthi'

in Arunachal Pradesh and Himachal Pradesh; drying of seedling varieties of mango into powder in Uttar Pradesh; preparation of wines and brandies from various fruits in some remote hilly areas; drying of wild apricots and the extraction of edible oil from their kernels in Kargil area of Jammu and Kashmir; and drying of *Morchella* mushroom (Guchhi) in Jammu and Kashmir. Upgrading the existing preservation techniques like the blanching of vegetables and sulphitation of fruits before drying can go a long way towards improving the quality of dried products and their shelf life. Further, the packing of dried products in plastic pouches for storage can help to improve their keeping quality. Some new areas in fruit processing which could be profitably exploited are:

(1) *Apple in cattle and poultry feeds*: Apple culls and windfalls can be cut into slices, dipped in sulphur dioxide solution or sulphur-fumigated, and sun-dried. Dried apple could be compressed into blocks of suitable size and finally coated outside with molten wax to prevent insect and microbial attack. During the winter months when cattle feed is scarce, these slices could be used as feed. The wax coating can be chipped off and used again and again.

(2) *Home preservation of fruit juices and pulps*: Fruit juices and pulp can be easily preserved in glass bottles with sulphur dioxide and the bottles tightly lidded.

(3) *Apple vinegar*: Vinegar making from apple has not yet been initiated. The setting up of home vinegar generators evolved at CFTRI, Mysore, could help to provide additional income to growers. Other fruits can also be used for this purpose.

(4) *Preservation of tomato concentrate*: Tomato as slices are sun-dried extensively on wooden planks or stones in the hilly areas for use in the off-season. Most of the juice from these tomatoes is dried away or absorbed by the wood. Tomatoes could be preserved by cutting them into slices, crushing these slices, and concentrating the mashed tomatoes three-fold on slow heat. A paste-like concentrate from tomatoes with seeds and skins can be preserved with acetic acid (vinegar), sulphur dioxide, and sodium benzoate in air-tight jars. The concentrate can be used during the off-season to add to vegetable curries.

(5) *Preservation of cabbage*: Cabbage shreds with the addition of 2.5 per cent salt and 0.5 per cent mustard powder are allowed to undergo lactic fermentation which helps to preserve them for the off-season. Other vegetables can also be preserved in glass or glazed jars in the same way.

The adoption of some of these simple, low cost, and practicable methods in the remote hill areas could go a long way towards the full use of hill produce and by making these fruit and vegetable products available in the lean season can upgrade the nutritional level of the rural popula-

tion. These techniques can also take on industrial overtones and develop into a fruit processing industry in the rural areas.

In order to achieve this, extension efforts along with preservation kits (glass jars, plastic pouches, chemical preservatives) need to be made freely available at reasonable cost as has been done in the case of fertilizers, pesticides, and other agricultural inputs.

Marketing of Horticultural Produce

Existing practices and infrastructural facilities in handling, packaging, transport, storage, and processing of horticulture produce grown in the NWHR and NEHR have already been highlighted. These are closely related to their efficient marketing. A well-organized marketing system is absolutely essential to help the producer to get remunerative prices for his produce and the consumer quality material for his money. Fruits and vegetables in India are primarily consumed by the urban population, especially in the metropolitan cities Delhi, Bombay, Calcutta, Madras, Bangalore, and Hyderabad. In recent years, this trade has also spread into smaller townships.

Role of Delhi Market

The Delhi wholesale fruit and vegetable market is located at Azadpur and has a unique role, being a major distribution centre, the biggest in Asia and the second biggest in the world. The total annual arrival of fresh fruit in this market is around 1,377,225 tons and of vegetables 1,135,777 tons; the total value is around Rs. 800 crores. Potatoes and onions account for 63 per cent of the total vegetables sold in Delhi. Among fruits, apple constitutes 37 per cent of the total sales.

According to a review of horticulture in the NWHR conducted by the World Bank, Delhi is the biggest apple distribution market in the country, receiving about 70 per cent from Jammu and Kashmir, 60 per cent from Himachal Pradesh, and a part of the apple produce from Uttar Pradesh. About 85 per cent of the fruit delivered at Delhi is sold, then repacked and shipped to other parts of India. It reaches the retailer and the consumer after passing through several intermediaries.

Delhi has always played a dynamic role in apple marketing not only because of its proximity to apple-growing areas, but also on account of its enterprising apple merchants who maintain a close link with the industry and retain their hold on the market by way of financing through pre-harvest contractors, as also supplying inputs such as packaging material through them. Market functionaries involved in the trade are forwarding agents, commission agents, wholesalers, and retailers. The forwarding agent arranges the transportation of consignments from the producing

areas to the terminal market mainly by road, prepares the forwarding note, and usually arranges for the payment of labour charges. All the expenses incurred along with forwarding commission charges are debited to the consignee from the gross sale proceeds of the commission agent in the terminal market. The commission agent then sells the produce to the wholesalers or sub-wholesalers who consign the fruits to other markets after regrading. Some commission agents also work as wholesalers.

Market Channels

Two types of marketing channels exist in apple marketing:

(1) Producer to forwarding agent to commission agent to wholesaler to retailer to consumer; and
(2) Producer to co-operative organization to forwarding agent to commission agent to wholesaler to retailer to consumer.

The usual market channels for fruit and vegetables are shown in Figure 16.3.

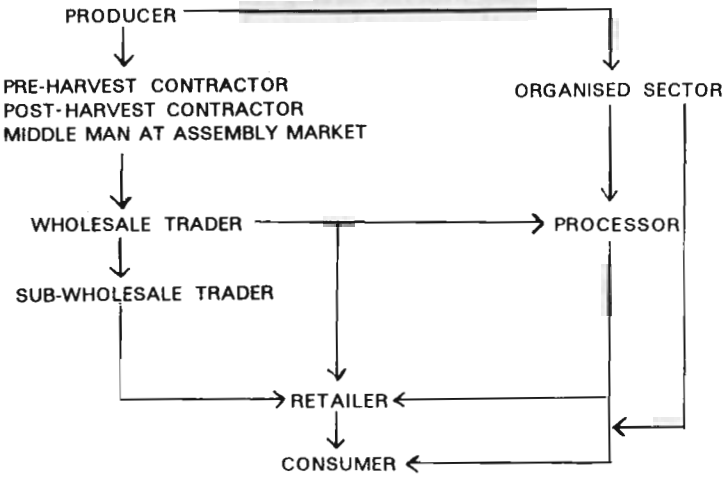
According to a Market Planning and Design Centre report (1987), the share of the producer in the two marketing channels amounted to 50 and 52 per cent respectively in Himachal Pradesh. Institutional channels in Jammu and Kashmir also bought 52 per cent from the producers as against 42 per cent through private channels. The packaging cost ranged from 7.3 to 9.4 per cent of the consumer price and transport charges ranged from 5.7 to 6.8 per cent in all cases. JK-HPMC charged lower commission at the rate of 4 per cent, as against 6 per cent charged by HPMC. Most of the existing sales of fruit and vegetables are regulated or being regulated to safeguard against the exploitation of producers.

Market Facilities

The marketing of fresh fruit and vegetables today faces a number of problems. The condition of the market, both wholesale and retail, is perhaps the most critical. The conditions under which markets operate and the facilities or services available in the markets are far from satisfactory, which is reflected the down-grading of produce. Most of the terminal markets are antiquated, improperly designed, and ill-equipped to handle the increasing load. Basic requirements for an up-to-date terminal market include:

- Appropriate location, well connected by road and rail.
- Appropriate design with wide platforms for auctions, loading and unloading, grading, packing of produce. These structures should be simple, functionally convenient, and cost-effective.
- Facilities for cold-storage.

Vegetable



Fruit

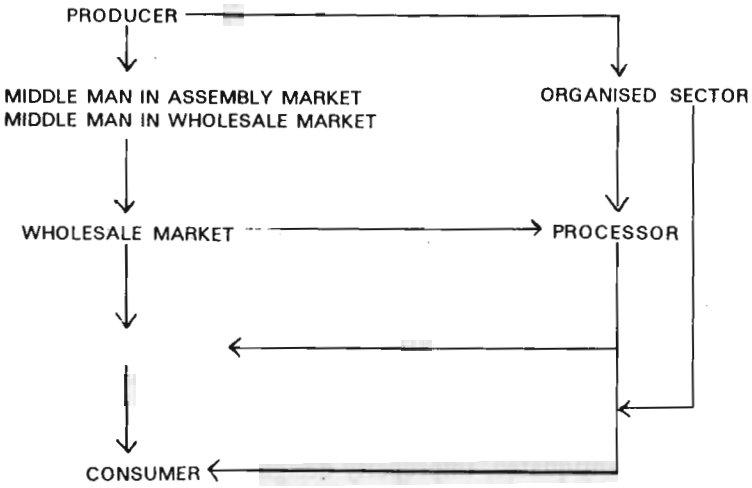


Figure 16.3: Marketing channels of fruits and vegetables at Delhi

- Amenities such as public conveniences, adequate water and power supply.
- Facilities such as banks, telecommunication system, canteen, dormitory, and rest rooms.
- Wide roads for free movement of traffic.

- Strict sanitation control through quick garbage disposal, proper drainage, and trained sanitarians.
- Effective monitoring of entry and exits.
- Provision of extra space for expansion.
- Development of an effective market information service for growers, traders, and consumers.

To increase the producer's share in the consumer price, government has encouraged growers' co-operatives and agro-industrial corporations to participate in the marketing of perishables. Karnataka was the first state to interlink producers directly with the consumers through the Horticultural Producers' Co-operative Marketing and Processing Society, which at present operates 150 outlets in four cities. The National Dairy Development Board in Delhi organizes marketing of fruit and vegetables through over 170 booths with modern grading, packing and storage infrastructure. The 'FRESH' Cooperative Society at Hyderabad has also adopted a similar approach in Andhra Pradesh under a project assigned by the National Co-operative Development Corporation.

The National Horticultural Board has also recently initiated a National Project on Post-harvest Management of Horticultural Crops, under which 50 per cent financial assistance is offered as a subsidy to strengthen the entire post-harvest infrastructure.

Marketing Information

Market information service is essential not only for the formulation of a proper price policy and its successful implementation at macro-level, but also for farmers to improve their marketing performance. The timely dissemination of market information, especially on prices, would help policy makers, administrators, traders, and farmers to take appropriate decisions regarding choice of time, place, and amount for the sale of perishable commodities.

Besides the data on price trends, data on market arrivals and despatches should be collected. Any surplus depresses the price critically. There should be regular dissemination of such data through the mass media for the benefit of relevant agencies.

The National Horticulture Board is in the process of setting up a national grid of market information centres at 21 important fruit and vegetable terminal markets in the country. All the market centres are to be provided with a computerized telex, interlinked to Delhi, where a central computer is interfaced with the main computer at the headquarters of the Board at Gurgaon. The rates in all markets are to be compiled and disseminated the very same day.

Post-harvest Loss Control Measures

The marketing of fruits and vegetables from the Himalayan mountain region in India results in huge quantitative and qualitative loss amounting approximately to one-third of the total production. Losses of this magnitude represent significant food wastage and a considerable economic loss to the producers.

In recent years, great concern has been shown by both state and central governments, as well as other organizations in the trade, about these losses. Sophisticated techniques adopted in the developed world like mechanical harvesting, appropriate packaging, efficient and fast-moving transport, proper storage and marketing, all operated under a cool chain umbrella, have paid rich dividends to minimize losses in perishables and to improve their quality. This is of no relevance to Indian conditions, where the climate is mostly tropical and humid, and where there is no infrastructure for proper management. To augment the basic infrastructure, the IDA World Bank is embarking on an Integrated Horticulture Development Project in the NWHR with an investment of around Rs. 300 crores containing a foreign component of 13 per cent in this investment. This project when initiated will help both producers and consumers.

Loss Assessment and Its Reduction

Most of the post-harvest loss is due to mismanagement in the field (pest attack, mechanical injury, temperature fluctuations, and respiratory disorders). Secondary causes like inadequate packaging, transportation, storage, and marketing also add to the loss. Because post-harvest losses occur throughout the marketing process, it is worthwhile to learn the origin and level of this loss, which in turn, will indicate the scope and means to overcome it.

Loss assessment is a major goal in the reduction of losses. Because of the complex diversity of fresh produce and the lack of handling and marketing operations of the appropriate type, much more attention needs to be given to determine an acceptable method for loss assessment. The steps include:

- identifying the stages in the marketing process where important losses occur
- further probing at identified spots to make detailed assessments of the magnitude of the loss
- devising strategy to reduce these losses
- implementation of remedial measures
- training manpower to execute programmes
- creation of research and development facilities

All the measures mentioned above need the preparation of a comprehensive proposal at national level.

Efforts at National Level

Several steps have been taken to reduce post-harvest losses in fruit and vegetables in India. These include:

- Formation of a national Horticulture Board as an apex agency under the Ministry of Agriculture to provide the needed coordination and monitoring of production and marketing of horticultural crops. The Board also provides financial, technical, and organizational assistance to organizations connected with the horticulture industry.
- A research infrastructure has been created under an All India Coordinated Research Project on Post-harvest Technology of Horticultural Crops at more than one dozen ICAR institutes and agricultural universities.
- A collaborative INDO-USAID project on post-harvest technology of fruit and vegetables has been in operation since 1985 at four centres in the country. This project is meant to strengthen the existing facilities by way of staff and additional infrastructure such as works, equipment, and advanced training.
- The Y.S. Parmar University of Horticulture and Forestry has been set up in Himachal Pradesh for research and training in temperate horticultural crops.
- A National Centre on Temperate Fruits and Vegetables has been proposed under the auspices of ICAR in the next Plan.

Besides the above, several national institutes, the Central Food Technological Research Institute at Mysore, the Indian Agricultural Research Institute, New Delhi, the Indian Institute of Horticulture Research at Bangalore, the Indian Institute of Packaging at Bombay, the Market Planning and Design Centre at Nagpur under the Directorate of Marketing and Inspection, the Indian Council of Agricultural Research's National Centres on citrus, mango, potato, tuber crops, etc, agricultural universities, and several state directorates of horticulture, are assisting in developing appropriate technology to reduce post-harvest loss, besides generating trained manpower to handle this stupendous task. The Bureau of Indian Standards has proposed several national standards on individual fruits as well as their containers. Processed fruit and vegetables are also covered under central laws, the Fruit Products Order, and the Prevention of Food Adulteration Act.

The limitations, such as the remoteness of fruit-growing areas, poor connecting roads, inadequate containers, insufficient systems, and ill-equipped transport, storage, and marketing, have been outlined along

with proposed remedial measures including improved handling and packaging practices, the use of an evaporative cooling system, and selection of appropriate varieties. Massive national efforts monetary and human resources are needed to increase the availability of fruit and vegetables, a valuable source of food, and to improve the present position of food shortages and malnutrition prevailing in the country.

Recommendations

The Indian Himalayan mountain region, west and east, offers great scope to diversify agriculture into horticulture in order to get an additional source of nutritious food supplies and to provide avenues of employment. For this purpose, an action plan has to be framed keeping the following guidelines in view:

- Surveying the area under individual horticultural crops and the actual potential for their extension.
- Screening existing plant material not only for quality, productivity, and disease resistance, but also for amenability to better packaging, transportation, storage, and marketing.
- Encouraging nuts and vegetable seed production in remote and inaccessible areas.
- Development of on-farm and refrigerated storage at production centres, assembly stations, and in the foothills to regulate supply.
- Making available appropriate packaging material like wooden boxes, rigid plastic containers, or CFB cartons at subsidized rates or in easy instalments.
- Development of a fleet of improvised trucks for cheap and efficient transport of perishables.
- Introduction of rigid grading of fruits so that only A and B grade fruits go into the market.
- Processing of fruit culls and undersized fruits into pulp at the production centres for subsequent use as fruit beverages and for fuller use of their by-products.
- Introduction of returnable steel and plastic containers for transport and the supply of fruit pulp to processing units in the plains.
- Subsidizing fruit and vegetable transport in the NEHR to make them more competitive with crops grown in the plains.
- Finding alternative outlets like defence establishments for the disposal of fresh and processed produce in these areas.
- Arranging a regular and reliable market information service.

- Arranging training programmes at different levels to acquaint farmers with scientific methods for grading, packaging, transport, and storage of perishable produce.
- Providing suitable outlets to farmers in the terminal markets for proper sale and better prices for their produce.

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