Ind. Jn. of Agri. Econ.
Vol. 64, No. 2, April-June 2009

Marketing and Post-Harvest Losses in Fruits: Its Implications on Availability and Economy

D. Sreenivasa Murthy*, T.M. Gajanana*, M. Sudha* and V. Dakshinamoorthy**

I

INTRODUCTION

Fruits are important sources of vitamins and minerals and their role in improving nutritional status needs no emphasis. Fruit production in India, which is the second largest in the world (9 per cent), is growing at a significant growth of 3.74 per cent per annum from 28.63 million tonnes in 1991-92 to 63.50 million tonnes in 2007-08. The per capita availability of fruits even with this increase is lower at 107 g/day than the recommended level of 120 g. One of the main reasons attributed to lower availability is the large quantity of post-harvest losses that occurs at various stages of marketing, which ranged from 15 to 50 per cent (FAO, 1981; Roy, 1989). There have been very few systematic attempts to estimate the losses at each stage of handling and its causal factors. Many studies have been conducted on post-harvest losses of fruits and vegetables based on small-scale experiments but do not reflect the real situations (Ratnam and Nema, 1967; Biswas, 1969; FAO, 1981; Waheed *et al*., 1986; Government of India, 1985; Madan and Ullasa, 1993). A few studies also estimated losses at each stage of marketing but had not estimated the total value of losses at the macro level which could have provided a scientific basis for valuation (Krishna, 1976; Senthilinathan and Srinivasan, 1994; Srinivas *et al*., 1997; Gajanana *et al.,* 2002; Sreenivasa Murthy *et al*., 2004).

The post-harvest losses not only reduce the availability of fruits but also result in increase in per unit cost of transport and marketing (Subrahmanyam, 1986). This affects both the producers (reduction in share in consumers' price) and the consumers (reduced availability and higher prices). At the macro level, rough estimate indicates that India annually loses fruits worth about Rs.13,569 crores (based on 30 per cent loss). The reduction in post-harvest losses is a complementary means for increasing the production, i.e., the cost of preventing losses is less than producing the same

*Senior Scientists and **Technical Officer, Section of Economics and Statistics, Indian Institute of Horticultural Research (IIHR), Bangalore – 560 089 (Karnataka).

The authors are grateful to Division of Horticulture, Indian Council of Agricultural Research (ICAR) for providing the financial assistance for conducting this study under the ICAR Network Project on 'Marketing and Assessment of Post-Harvest Losses in Fruits and Vegetables in India' and to Director, IIHR, Bangalore for providing the necessary facilities to carry out this research work. The guidance of K.V. Subrahmanyam, as a Principal Investigator during the initial stages of the project is gratefully acknowledged. The help of Roopa and Govinda Raju, Research Fellows in data collection is also gratefully acknowledged.

additional quantity of fruits. The assessment of post-harvest losses of fruits at various stages of handling would help in identifying the factors responsible for losses. This in turn would help in developing proper measures required at different stages to prevent/reduce such losses and to increase the availability of fruits for domestic consumption and for export purposes. Thus, the overall objective of the present paper is to assess the post-harvest losses in major fruits both in physical and economic terms at different stages of handling and to develop strategies to reduce these losses. The specific objectives are: (i) to identify the major channels and practices of packing and transport in marketing of selected fruits, (ii) to estimate post-harvest losses at various stages of handling and to compute costs, margins, and efficiency of marketing in selected fruits, and (iii) to quantify the magnitude of losses at the national level, and to recommend suitable measures to reduce the post-harvest losses.

II

METHODOLOGY

2.1 *Crops and Study Regions*

The selection of crops and area to assess the marketing and post-harvest losses (PHL) in fruits was done based on the importance of crops and area of production and marketing. Mango, banana, grape and pomegranate were selected based on their importance both from the domestic and the export point of view. Mango and banana were the two major fruits with a share of 28.2 and 29.4 per cent, respectively in the total fruit production. Grape and pomegranate are the two important export-oriented crops. Andhra Pradesh for mango and Karnataka for banana, grape and pomegranate were selected for estimation of PHL based on importance in terms of area and production as well as keeping in view the time, resources and mandate under the ICAR network project on marketing and assessment of post-harvest losses in fruits and vegetables in India.

2.2 *Stages of Estimation of Post-Harvest Losses and Sampling Design*

The different stages of post-harvest losses during handling in selected crops were identified as farm level, wholesale level and retail level. Data from the different agencies involved in these stages were collected during 2000 and 2002 depending on the crops and seasonality. The sampling procedure is given below.

Farm Level: Multi-stage purposive and random sampling techniques were used for estimation of PHL at farm level for all crops. The details are presented in Table 1. In the first stage, the state was selected purposively based on the importance and contribution in terms of area and production. From the selected states/districts, mandals/villages were selected purposively based on area and production. Then the

data on PHL at field level was collected from 30 farm fields for each crop. Three fruit lots from each farm were drawn to obtain representative of the whole farm and the average was taken as one sampling unit. The PHL was estimated from each farm on weight basis by personally drawing the sample from the harvesting field.

TABLE 1. SAMPLING STRUCTURE FOR ESTIMATION OF POST-HARVEST LOSSES DURING MARKETING OF SELECTED FRUITS

Sr. No. (1)	Crop (2)	Study area (3)	Villages/Taluks (4)	Sample size and group (5)
1.	Mango Banganapalli			
	Field level	Krishna district, Andhra Pradesh	Vissanampet,Agiripalli Nuzividu, Myalavaram G.Konduru	30 farmers/pre-harvest contractors
	Assembly market	Krishna district, Andhra Pradesh	Nunna, Vijayawada,	5 wholesalers/commission agents
	Wholesale market	Krishna district, Andhra Pradesh	Kedaranatheswara, wholesale market, Vijayawada	5 wholesalers
	Retail market	Krishna district, Andhra Pradesh	Vijayawada city	15 retailers
2.	Grape,Thomson Seedless			
	Field level	Bijapur district, Karnataka	Babanagar, Bijargi, Rathanapura Somadevanahatti, Kanmadi Thindagurdhi, Tikota, Kotligi,	30 farmers
	Wholesale market	Bijapur district, Karnataka	Bijapur city	5 wholesalers
		Bangalore urban district	K.R. Market Bangalore	5 wholesalers
	Retail market	Bijapur district, Karnataka	Bijapur city	15 wholesalers
		Bangalore urban district	Bangalore city	10 retailers
			Bangalore city HOPCOMS	5 retail outlets
3.	Banana variety Ney Poovan			
	Field level	Bangalore rural district, Karnataka	Kanakapura, Ramanagaram Channapatna	30 farmers
	Assembly	Karnataka	HOPCOMS centres at Bangalore, Channapatna and Kanakapura	3 centres
	Wholesalers	Bangalore urban district	Banana wholesale market Bangalore city	5 wholesalers
	Retail market	Bangalore urban district	Bangalore city	15 retailers
			HOPCOMS centres Bangalore city	5 retail outlets
4.	Pomegranate variety Ganesh			
	Field level	Bijapur district, Karnataka	Bijapur, Tikota, Kanmodi, Kotligi, Babanagar	30 farmers
	Wholesale market	Bangalore urban district	Bangalore	10 wholesalers
	Retail market	Bangalore urban district	Bangalore city	15 retailers

Market Level: For selection of markets, the major assembly market/wholesale market in the production and consumption centres for each crop were identified. The practices of marketing and the PHL were analysed by using data collected from the wholesalers, commission agents, retailers and other market participants. The details on sampling structure for selection of market intermediaries are given in Table 1.

2.3 *Techniques for Data Analysis*

Simple averages and percentages were used for estimation of PHL at different stages of marketing. For estimation of efficiency of marketing, the following ratio as suggested by Acharya and Agarwal (2001) was used.

$$ME = \frac{FP}{MC + MM}$$

Where,

ME - Marketing efficiency,

FP - Net price received by the farmers (Rs./kg),

MC - Total marketing cost (Rs./kg),

MM- Net marketing margin (Rs./kg).

An increase in the ratio represents improved efficiency and vice versa. The technical and pricing efficiency were also examined.

III

RESULTS AND DISCUSSION

3.1 *Marketing Practices and Channels*

The marketing practices of selected fruits were found distinctly different from each other. The practice of hedging was dominant in marketing of mango and to some extent in pomegranate and banana. The crop-wise detailed marketing practices are discussed below.

Mango: Pre-harvest contract was the most common marketing practice followed by the farmers. Farmers/pre-harvest contractors (PHC) transported mango to assembly market mostly by tractor. Auctioning of fruits was by open type and the payment to the seller was made immediate by the next day. The commission agents provided space and charged 10 per cent commission. Out of eight channels of marketing observed, four major channels, which together accounted for more than 85 per cent of the trade, are depicted below.

Channel-1 Farmers ⟶ PHC ⟶ Wholesaler (Distant) ⟶ Retailer ⟶ Consumer

Channel-2 Farmers → PHC→ Wholesaler (Local) → Wholesaler (Distant)→ Consumer

Channel-3 Farmers ⟶ PHC ⟶ Wholesaler (Local) ⟶ Retailer ⟶ Consumer

Channel-4 Farmers ⟶ Wholesaler (Distant) ⟶ Retailer ⟶ Consumer

Mangoes were later sorted based on size and transported to different places such as New Delhi, Hyderabad, Gujarat, Rajasthan and other North Indian cities. About 60 per cent of the total arrivals was Banganapalli, Totapuri (30 per cent), Rasam, Swarnarekha and other local types were the other varieties marketed.

Banana: In Karnataka, the conventional practice of marketing was selling banana in the wholesale market, though the co-operative marketing also exists on limited scale in certain areas. The major marketing channels were as follows:

Channel-1 : Farmers ⟶ Wholesalers ⟶ Retailers ⟶ Consumers

Channel-2 : Farmers ⟶ Farmers Co-operative Society ⟶ Consumers (Wholesale and Retail)

Channel-3 : Farmers → Pre-harvest contractors → Wholesalers → Retailers → Consumers

Channel-4 : Farmers ⟶ Wholesalers ⟶ Consumers

More than 70 per cent of banana was marketed through Channel-1 and Channel-2. In channel-1, the farmers from different parts of Karnataka, Tamil Nadu and Andhra Pradesh brought their produce mostly by trucks to an exclusive banana wholesale market at Binny Mills area, Bangalore. Banana was disposed of through an open auction and the major varieties traded were Dwarf Cavendish and Ney Poovan. In Channel-2, the Horticultural Producers Cooperative Marketing and Processing Society Ltd. (HOPCOMS) played a role of single window agency of procurement and distribution. The society procures banana from farmers through its collection centres located at production areas, viz., Channapatna, Ramanagaram and Kanakapura and distributes the same to the consumers through its 256 retail outlets in major cities like Bangalore, Mysore and Mangalore. In Channel-3, the PHCs play an important role. They enter into a contract with the farmers and sell banana in the nearby wholesale markets. The marketing system for banana is reasonably well networked in Karnataka.

Grape: Among several varieties cultivated in India, Thomson Seedless is mostly used for both table purpose and raisin making and hence, the marketing practices pertaining to this variety has only been discussed. The critical factor, which

influenced the decision of the farmers to sell fresh grapes or make raisins, was the price. The farmers were willing to sell fresh grape at Rs.14-15/kg (price during study period). Other wise they converted fresh grapes into raisins on the farm itself. About 4 kg of fresh grape is required to make one kilogram of raisins. Normally raisins were packed in 12 or 15 kg boxes and almost all the farmers marketed it in the auction centre at Bijapur. The farmers preferred to keep it in the cold storage during glut. About 15 per cent of the total production in the region goes for fresh grape market in Bijapur unlike in Maharashtra where the trend is reverse. The major marketing channels for fresh grape in Bijapur are as follows.

Channel-1: Farmers→ Commission agents (Local) → Wholesalers (Local) → Retailers (Local) → Consumers (Local)

Channel-2 : Farmers→ Wholesalers (Local) → Retailers (Local) → Consumers (distant)

Channel-3 : Farmers→ Commission agents (Local) → Wholesalers (local/distant) → Retailers (distant) → Consumers (Local)

Field sale was the major practice of marketing (channel–1). Wholesalers, both from local and distant markets enter into agreement with farmers through commission agents by paying commission charges of Re. 0.25- 0.50 per kg. The major distant markets were Bangalore, Mysore, Sangli, Mangalore and Chitradurga. More than 75 per cent of grape was transacted through this channel. The extent of farmers selling directly in wholesale market either at Bijapur or at Bangalore was less.

Pomegranate: Three main channels were observed in marketing of pomegranate in Bijapur as given below.

Channel-1 : Producer ⟶ Contractor ⟶ Wholesaler/CA ⟶ Retailer ⟶ Consumer

Channel-2 : Producer ⟶ Wholesaler/CA (distant market) ⟶ Retailer ⟶ Consumer

Channel-3 : Producer ⟶ PHC → Wholesaler/CA (distant market) → Retailer → Consumer

Field sale was the most prominent marketing channel in Bijapur (Karnataka), which accounted for about 50 per cent of the trade. Growers sell it in the field itself to the agents of the wholesalers of the distant market. Selling of fruits by the growers themselves in the distant markets like Bangalore was the next important marketing channel, which accounted for nearly 40 per cent of trade. The earlier practice of PHCs was less prevalent and now hardly 10 per cent was sold to PHCs. Thus, a significant shift from selling through PHCs to distant marketing, directly or through agents was observed.

3.2 *Post-Harvest Losses*

Mango: The total PHL in variety Banganapalli (mango) was 29.73 per cent comprising 15.59 per cent at the farm, 8.89 per cent at ripening/storage and 5.25 per cent at retail levels (Table 2). At the farm level, small and immature fruits (66 per cent) and fungal diseases in fruits (23 per cent) resulted into losses. The harvesting injury accounted for about 8 per cent of field losses. Transit injury from field to assembly market was almost negligible. The major causes for losses during storage and ripening were bruising injury and fungal disease. At the retail level, the major causal factor for loss was pressing injury to the fruits (51 per cent) and fungal disease (31 per cent). Thus, the fungal disease, which was observed at every stage of marketing, accounted for 38 per cent of the total post-harvest losses. The discarding of fruits as immature and small fruits immediately after harvest was the next major factor, accounting for 35 per cent loss. Damage to fruits during harvesting, which was carried forward till the ripening stage, accounted for 14 per cent. The damage caused to the fruits due to improper placing of fruits during ripening resulted in about nine per cent loss.

Grapes: Aggregate PHL in Thompson Seedless variety ranged from 14.40 per cent when marketed in the production centre at Bijapur to 21.33 per cent when marketed at distant consumption centre at Bangalore (Table 2). The loss at Bijapur comprises 7.31 per cent at field level, 4.24 per cent during transit and wholesale level and 2.85 per cent at retail level. The corresponding losses at distant market, Bangalore were 7.31, 10.80 and 3.22 per cent, respectively. Thus, the total losses increased by 48 per cent when grape were marketed in Bangalore instead of local market at Bijapur. The major portion of losses in local market sales was accounted for by losses at field level (51 per cent) where the transit distance was less. In distant marketing, losses during transit and wholesaling accounted for the highest loss (51 per cent). The losses during retail marketing were 2.85 and 3.27 per cent, respectively in Bijapur and Bangalore. The major causes for the losses were damage to berries due to pressing injury (73 per cent in local market and 63 per cent in distant market), rotting and infection of berries at the point of attachment (15 per cent in local market and 20 per cent in distant market). All the discards were treated as total losses as these were not marketed further unlike in case of mango and banana.

Regarding the causes of losses, water berry or mummy was the major contributing factor for losses accounting for 43.20 per cent followed by insects/pests damage to berries (24.8 per cent) and loose berries/berry drops during harvesting (25 per cent). The transit losses in short distance marketing at Bijapur was 4.24 per cent, mostly due to injury to berries and detachment of berries (loose berries). Of this, the physical injury to berries accounted for 38 per cent and loose berries, 59 per cent. The transit loss in longer distance marketing at Bangalore was 10.80 per cent and injury to berries accounted for 30 per cent loss and loose berries for 68 per cent. The loss was

higher by 150 per cent during distant marketing, mostly in the form of loose berries due to jerks/shaking during transportation.

In raisin making, the whole produce is used without sorting it. This signifies the importance of processing of perishable grape in reducing the post-harvest losses. Further, it is heartening to note that 85 per cent of the production in the area was used for raisin making and virtually the total PHL is confined to about 15 per cent of the produce.

Banana: The losses at different stages of handling were estimated for both wholesale and co-operative channels as a major portion was marketed through these channels (Table 2). The PHL was higher in the wholesale channel (28.84 per cent) than co-operative channel (18.31 per cent). In wholesale channel, the total losses comprised 5.53 per cent at field and assembly market, 6.65 per cent at wholesale market and 16.66 per cent at retail marketing levels. In co-operative channel, these figures were 7.82, 1.77 and 8.72 per cent, respectively. The losses in co-operative channel were higher at the initial stages of handling, i.e., assembly market level and lower in the later stages. The losses at field and assembly market level accounted for 42 per cent of the total losses in co-operative channel compared to about 19 per cent in wholesale channel. The strict quality ensured by the society during procurement was the major reason. Losses at wholesale and retail stages in the wholesale channel accounted for 23 and 58 per cent, respectively, compared to 10 and 48 per cent in co-operative channel. Careful loading, better transportation, less number of handling and acceptance of the good quality produce at the time of procurement restricted the losses at the later stages of marketing in co-operative channel. Further, market-wise analysis revealed that the losses were higher during retailing compared to other stages of marketing. In the co-operative channel, PHL at the retail level accounted for 48 per cent losses while it was 58 per cent in the wholesale channel.

TABLE 2. POST-HARVEST LOSSES IN SELECTED FRUITS IN INDIA

(per cent)

Sr. No. (1)	Crops ⇒ / Markets ⇒ / Stages of Marketing ⇓ (2)	Mango	Grapes		Banana		Pomegranate
		Local marketing (3)	Local marketing (4)	Distant marketing (5)	Wholesale marketing (6)	Co-operative marketing (7)	Distant marketing (8)
1.	Field and assembly marketing	15.59	7.31	7.31	5.53	7.82	9.86
		(52.44)	(50.76)	(34.27)	(19.17)	(42.71)	(27.82)
2.	Wholesale marketing	8.89	4.24	10.80	6.65	1.77	10.10
		(29.90)	(29.44)	(50.63)	(23.06)	(9.67)	(28.50)
3.	Retail marketing	5.25	2.85	3.22	16.66	8.72	15.48
		(17.66)	(19.80)	(15.10)	(57.77)	(47.63)	(43.68)
	Total losses	29.73	14.40	21.33	28.84	18.31	35.44
		(100)	(100)	(100)	(100)	(100)	(100)

Note: Figures in parentheses indicate percentage to the total in the column.

Pomegranate: The total losses at different levels of handling was 35.44 per cent consisting of 9.86 per cent at field, 10.10 per cent at wholesale and 15.48 per cent at the retail levels (Table 2). The damage due to borer and anthracnose were the two major causes of losses at the field level (4 per cent). Scorching due to extreme heat (1.28 per cent) and cracking of fruits (1.22 per cent) due to the irregular irrigation/fertigation also contributed to losses. The labourers and the producer mostly consumed the damaged fruits. The transit and wholesale losses, estimated in the major distant market at Bangalore in the absence of assembly market, was 10.10 per cent and the major causes were press injury (3.57 per cent), injury due to friction (2.26 per cent), rotting (1.91 per cent), secondary infection due to moth/borer attack (0.87 per cent), overripe/date barred fruits (0.52 per cent), black spot (0.44 per cent), scorching (0.35 per cent) and cracks and broken (0.17 per cent). The losses at the retailers level at Bangalore were 15.48 per cent and the major causes were drying of skin (12.5 per cent) and over ripening (2.98 per cent).

3.3 *Packing and Transportation*

The details of packing and transportation practices followed in the marketing of selected fruits are given in Table 3. In pomegranate, the fruits were packed in cartons of different sizes, viz., 5 and 7 kg and cut paper waste from printing press provided cushioning to absorb the shocks during the transportation. In grapes, packing in bamboo baskets of size 5,10 and 15 kg capacity with newspaper cushioning to absorb shocks was in practice for local and surrounding markets. In recent times, fruits were packed in carton of 2 or 4 kg in the field itself to meet the growing demand for

TABLE 3. PACKING AND TRANSPORTATION PRACTICES IN SELECTED FRUITS IN INDIA

Crops (1)	Packing (2)	Transportation (3)
Mango		
Field to assembly markets	No packing. Directly heaped into the trucks with news paper cushioning	Tractors, Trucks
Assembly market to distant markets	No packing in most of the cases. Some times packed in the carton boxes.	Trucks
Grapes		
Field to wholesale markets	Baskets with news paper cushioning	Mini trucks
Field/Wholesale markets to distant markets	Baskets with news paper cushioning and also in carton boxes	Buses, trucks
Banana		
Field to procurement centres/wholesale markets	Packing with leaves	Mini trucks/ Trucks
Procurement centres/wholesale markets to distant markets	Packing with leaves	Trucks
Pomegranate		
Field to wholesale markets	Cartons with paper (pieces) cushioning	Tempos, Trucks
Field/wholesale markets to distant market	Cartons with paper (pieces) cushioning	Tempos, Trucks

quality fruits in the urban markets. However, no such systematic packing was practiced either in mango or banana. The mango fruits were heaped into the lorries/trucks/tractors during transportation either to assembly market or to the distant markets. Only newspaper cushioning was provided at the bottom as well as the middle layers of the fruits during transportation to assembly markets to absorb saps of fruits. In some instances, the wholesalers pack the mango fruits in the carton of 4-5 kg at the assembly market itself for direct sale in the retail marketing at a later date. In the case of banana, bunches were heaped and arranged one over the other. In some cases banana leaves were used to cover bunches.

Mostly minitrucks/tempos were used to transport to the local market. Trucks and buses were used for distant markets. No specialised transport vehicles exclusively for fruits transportation were used in any of the fruits. However, trucks were exclusively hired for the purpose of transportation to distant markets. Public service buses, both private and government, were also used for transportation to the distant markets.

3.4 *Marketing Costs, Margins and Efficiency*

The costs, margins and efficiency of marketing depend primarily on the channels of marketing. The channel selected for mango was Channel –3, while Channel –2, Channel –1 and Channel –2 were selected for grape, banana and pomegranate, respectively as these represent the major channels of marketing. The descriptions of different efficiency parameters are given below.

Costs: The marketing costs ranged from Rs. 2944/tonne in mango to Rs. 5664/tonne in pomegranate (Table 4). The cost of marketing in banana and grape worked out to Rs. 4360/tonne and Rs. 4630/tonne, respectively. The farmers/pre-harvest contractors incurred highest marketing costs, which constitute more than 50 per cent of the total marketing costs. One of the reasons for higher marketing costs by farmers was 10 per cent commission charged by the market intermediaries. The marketing cost in mango, grapes, banana and pomegranate accounted for nearly 16.82, 23.15, 27.52 and 20.98 per cent, cent, respectively of the consumers' price indicating that a substantial amount is spent on marketing.

Margins: Farmers' net margin in the consumers' price was as low as 46 per cent in mango to as high as 68 per cent in grape (Table 4). In mango, the margin was low because of predominant role played by the wholesalers and retailers, who among themselves shared 37 per cent of the consumers' price. A few private individuals traditionally dominated the working of assembly markets in mango. More than this, the nature of crop, i.e., relatively hard ones during the early stage of marketing enables the market intermediaries to manipulate the price.

TABLE 4. MARKETING COSTS, MARGINS AND EFFICIENCY IN MAJOR FRUITS

Sr. No.	Particulars	Mango	Grapes	Banana	Pomegranate
(1)	(2)	(3)	(4)	(5)	(6)
1.	Farmers' share (Rs./tonne)	8060	13600	8360	13540
		(46.06)	(68.00)	(52.78)	(50.15)
2.	Marketing cost (Rs./tonne)				
2.1	Farmers/PHC	1640	2400	3640	-
2.2	Wholesaler (Assembly)	664	250	210	4664
2.3	Wholesaler (Ripening)	256	-	-	-
2.4	Retailer	384	1980	510	1000
	Sub-total	2944	4630	4360	5664
		(16.82)	(23.15)	(27.52)	(20.98)
3.	Intermediaries margin (Rs./tonne)				
3.1	Wholesaler- (Assembly/ Ripening)	4449	750	1790	5796
3.3	Retailer	2047	1020	1330	2000
	Sub-total	6496	1770	3120	7796
		(37.12)	(8.85)	(19.70)	(28.87)
4.	Consumers price (Rs./tonne)	17500	20000	15840	27000
5.	Marketing efficiency (ratio)	0.85	2.13	1.12	1.01

Note: 1. The marketing channels for which the parameters are calculated are as follows:
1. Mango – Channel 3 2. Grape – Channel -2
3. Banana – Channel –1 4. Pomegranate – Channel –2
2. Figures in parentheses are percentage of consumers' price.

In grape, the share of market intermediaries in the consumers' price was nine per cent. One of the main reasons for lower margin was the better networking of markets and the opportunity for diversified product marketing, i.e., option to convert the fresh grape into raisins during glut. Knowledge and awareness of the farmers too contributed for efficient markets. All these resulted in higher share of farmers' net margin (68 per cent) when compared to other crops.

In banana, the farmers' net share in the consumers' price was 53 per cent while the market intermediaries' margin was nearly 20 per cent. Here, the share of market intermediaries margin was substantially higher than grape but lower than mango. The farmers had no option but to sell it in the market even if the price is not satisfactory (price takers). Banana markets were relatively better regulated than mango.

Price Spread: The price spread in mango was Rs. 9,440/tonne and the major share comes from market intermediaries (69 per cent) indicating their dominance (Table 4). In case of grape, the price spread was Rs. 6400/tonne and the major component was marketing costs (72 per cent) followed by the intermediaries' margins (28 per cent). In banana, the price spread was Rs. 7480/tonne with higher contribution from marketing cost (58 per cent) than intermediaries' margins (42 per cent). Among all fruits, the price spread was highest in pomegranate, i.e., Rs.13,460/tonne and the major contributory factor was the intermediaries' margin (58 per cent). The share of farmers' net price in the consumers' price was about 50 per cent. Thus, there is no uniform pattern in the price spread and different factors contributed to the spread among fruits.

Efficiency: It could be seen from Table 4 that the grape markets were found to be more efficient than mango, banana and pomegranate as reflected in the higher ratio (2.13) because of lower marketing costs and intermediaries' margins. In mango, markets were found inefficient as reflected by the ratio of less than one. The costs of facilitating marketing including the marketing costs and margins of market intermediaries were higher than the actual share of the farmers' net margin and this calls for an urgent need to address this issue. Better efficiency could be achieved by reducing the cost of marketing particularly the commission charges. At present, private individuals mostly manage the marketing of mango either individually or by group. By regulating the marketing or by providing viable alternate markets, the farmers' net share could be increased. This not only reduces the present margin of market intermediaries (37 per cent) but could also increase the efficiency of marketing. It appears that present banana marketing system was efficient but still there is scope to increase the efficiency by reducing the marketing costs, which includes at present 10 per cent of commission and 10 per cent weight loss. The question is whether or not to deduct weight loss as it is not in practice in other fruits, if yes how much, etc. This is in addition to strict enforcement of laws to restrict the amount of commission to specified amount.

3.5 *Estimates of Aggregate Losses at National Level*

Mango: It is the most important fruit crop in the country accounting for about 28.2 per cent total fruit production (Government of India, 2004). Except for about 0.8 per cent, which is used for processing, the entire production is subjected to PHL at various stages of marketing. At present level of production, the total PHL, based on variety Banganapalli, worked out to be 33.85 lakh tonnes (Table 5) comprising 19.45 lakh tonnes in the field itself after harvest, 9.36 lakh tonnes during wholesale marketing, both at assembly and wholesale markets and 5.04 lakh tonnes during retail marketing. It is assumed that the extent of losses in other varieties is the same as the marketing practices are by and large similar. It is not so difficult to extrapolate the quantity of losses at the macro level but the total losses in value is not easily quantifiable as price varies with varieties and stages of marketing. In the present study, an attempt is made by taking into account the actual prices prevailing at various stages of marketing but with the assumption of same price for other varieties. The total PHL in mango in India is likely to be about Rs. 3,892.36 crores comprising Rs. 1,887.01 crores in the field immediately after harvest (based on price of Rs. 9,700/tonne), Rs. 1,123.66 crores in the wholesale market (Rs. 12,000/tonne) and Rs. 881.69 crores in the retail market (Rs. 17,500/tonne). It was reported that the entire quantity of fruits treated as losses didn't go waste monetarily as some income was realised though at a lower price (Sreenivasa Murthy *et al*., 2002). The total loss is likely to come down to Rs. 2,963.48 crores comprising Rs. 1,416.17 crores in the field, Rs. 735.15 crores in the wholesale and Rs. 812.17 crores in the retail market levels by including such income.

TABLE 5. AGGREGATE VALUE OF POST-HARVEST LOSSES IN MAJOR FRUITS IN INDIA DURING 2002-03

Sr. No. (1)	Particulars (2)	Mango (3)	Banana (4)	Grapes (5)	Fruits (6)
1.	Total production (lakh tonnes)	127.33	133.04	12.48	272.85
2.	Total subjected to handling (lakh tonnes)	124.78	133.04	10.61	268.43
3.	Total quantity of post-harvest losses (lakh tonnes)				
3.1	Field level loss	19.45	7.36	0.78	27.59
3.2	Loss during wholesale marketing	9.36	8.36	1.06	18.78
3.3	Loss during retail marketing	5.04	19.55	0.28	24.87
3.4	Sub-total	33.85	35.26	2.12	71.24
4.	Total value of post-harvest losses (Rs. crores)				
4.1	Field level loss	1887.01 (1416.17)	540.75	89.02	2516.78 (2045.94)
4.2	Losses during wholesale marketing	1123.66 (735.15)	767.26	148.03	2038.94 (1650.43)
4.3	Losses during retail marketing	881.69 (812.17)	2135.05	46.32	3063.05 (2993.53)
4.4	Sub-total	3892.36 (2963.48)	3443.05	283.37	7618.77 (6689.90)

Note: Figures in parentheses indicate the value of post-harvest losses after taking into account income realised by selling the damaged fruits.

Banana: It is the second most important fruit crop in India, accounting for 29.43 per cent of the total fruit production during 2002-03. Almost the entire production is used as fresh and hence, the entire production is subjected to the post-harvest losses of 17.87 per cent as estimated in the present study. The aggregate PHL in the country is likely to be around 35.26 lakh tonnes (Table 5) comprising 7.36, 8.36 and 19.55 lakh tonnes respectively in the field after harvest, wholesale marketing and retail marketing. For estimation of the total value of losses, the procedure adopted is quite different from mango. Here loss is calculated for Ney Poovan variety in Karnataka and the price is relatively higher than other varieties like Dwarf Cavendish, Robusta and Poovan. Therefore, for more realistic approach, the average prices prevailing during the study period for these varieties were taken. Accordingly the price at farm gate, wholesale market and retail market were Rs. 7,350/tonne, Rs. 9,180/tonne and Rs.10,923/tonne, respectively. Thus, the total PHL in banana is likely to be Rs. 3443.05 crores comprising Rs. 540.75 crores at the field, Rs. 767.26 crore at wholesale market and Rs 2135.05 crores at retail market levels. Unlike in mango wherein the discards used to fetch a nominal income, in banana the discards are not marketed further. In Karnataka, the losses were reduced by 10.51 per cent by virtue of single window system of procurement and distribution practiced by HOPCOMS (Sreenivasa Murthy *et al.,* 2002). In absolute terms, 12.19 lakh tonnes of banana worth about Rs. 1781 crores could be saved annually in case the good practices are replicated everywhere in India.

Grape: Approximately 85 per cent of the total production of 12.48 lakh tonnes is consumed as fresh grape (Shikhamany, 2000). Based on the present estimates of losses, the total PHL in the country is likely to be about 2.12 lakh tonnes. The break up of losses at three stages of handling, viz., field level, wholesale market level and retail market level are 0.78, 1.06 and 0.28 lakh tonnes, respectively. For valuation of post-harvest losses, grape was grouped into seeded and seedless types, as there is a substantial difference in prices for these two types. Nearly 64 per cent of grape produced in India is seedless and Thompson Seedless is the major variety. The remaining is seeded and Bangalore Blue and Anab-e-Shahi are the major varieties (Shikhamany, 2000). Some portions in both types were used for processed products like raisins from seedless and wine from Bangalore blue. Therefore, it is assumed that nearly 85 per cent in both types is used for table purpose. Calculating the total losses in the same proportion valuing at actual prices at different stages of handling, the aggregate PHL in grape in India is valued at Rs 283.37 crores. The stage wise losses of grape are Rs 89.02 crores during and after harvest, Rs 148.03 crores during transit and wholesale marketing and Rs 46.32 crores during retail marketing.

Due to the non-availability of exact data on area and production of pomegranate at the national level, the extrapolation of total losses in pomegranate could not be done.

Thus, in India, about 7.12 million tonnes of mango, banana and grape are lost before reaching the consumers. In terms of value, the losses in these fruits together amount to Rs. 7,169 crores. In India, the horticulture sector comprising fruits, vegetables, spices, medicinal and aromatic plants, flowers, mushroom and plantation crops contributes about 28.5 per cent to agriculture gross domestic product (GDP) of Rs. 5,98,164 crores during 2004-05. The loss in terms of agriculture GDP is about 1.2 per cent, which is quite alarming. If we take other fruits into consideration, these figures will be still higher. Therefore, concrete efforts as detailed under policy implications should immediately be initiated to reduce the losses as it could save more than Rs. 7000 crores.

IV

SUMMARY AND POLICY IMPLICATIONS

Estimation of post-harvest losses is important as it helps in identifying the causal factors and provides ways and means to reduce the losses. In the present study the losses at various stages of handling were estimated for mango, banana, grape and pomegranate. The impact of PHL on availability and its implications on the economy has also been studied. The policy implications emerging from the results are given below.

1. Marketing practices for the selected fruits were found to be distinctly different. The practice of contracting on pre-agreed price was predominant in mango, while

field sale was the popular marketing practice in grape and pomegranate. Conventional wholesale marketing was prevalent in banana. Marketing of fruits in distant markets fetched higher returns to farmers. Therefore, strengthening of marketing infrastructure at distant consumption markets like Bangalore, Hyderabad, Bombay and Chennai away from the production zones would help to increase the income of the farmers.

2. Conversion of fresh grape into raisins also helped the farmers to realise higher returns. Similarly, possibilities of establishing processing units either in production centers or near the assembly markets in mango need to be explored. Many processing units are already established in Chittoor region, (Andhra Pradesh) and such success practices should be replicated. This also helps in reducing the PHL.
3. In mango, nearly 38 per cent of the total PHL was attributed to diseases at various stages of marketing and therefore, efforts should be made for proper pre-harvest and post-harvest management of diseases. Uniform ripening also seems to be of major concern as 35 per cent of fruits were rejected and thus, efforts should be made to educate the farmers regarding the optimum maturity index for harvest. Use of mechanical harvesters instead of present hand harvesting and proper placement of fruits during storage and ripening would help to reduce the losses to the extent of 23 per cent.
4. Distant marketing in grape increased the PHL by nearly 50 per cent mostly in the form of loose berries and injury to the berries. Standard harvesting methods and pre-harvest management are required to reduce the damages due to pests and diseases, water berries and harvest injury. Efforts should also be made to evolve better packaging and cushioning technologies to absorb shocks during transportation.
5. Acceptance of the good quality produce at the time of procurement, careful loadings, better transportation and lower number of handling and the good practices adopted by HOPCOMS in banana which not only reduced the losses but also fetched higher net price to farmers. Thus, the efforts by the concerned authorities to implement such good practices need to be initiated.
6. In pomegranate, proper pre-harvest management to reduce the losses due to borer and anthracnose and development of varieties, which could withstand long distance transport and long shelf life, is required.
7. No proper packing practices were followed in mango or banana but of-late packing in cartons was practiced in grape and pomegranate. In mango, packing in large crates and ripening process could substantially reduce the losses. Proper cushioning material should also be used in all cases. Specialised transport vehicles meant exclusively for fruit transportation need to be encouraged to reduce the transit losses.

8. Grape markets were found more efficient than mango, pomegranate and banana as indicated by lower marketing costs and intermediaries' margins. There is scope to increase the efficiency of banana marketing system by reducing the marketing cost. Mango markets were found inefficient due to high marketing costs and intermediaries' margin. This is also resulting in wider price spread. Therefore, efforts should be made to reduce the marketing charges particularly the commission charges by making suitable amendments in the existing regulated markets laws and thereafter strictly following the provisions.

9. About 1.2 per cent of agriculture GDP from 33.85 lakh tonnes in mango, 35.26 lakh tonnes in banana and 2.12 lakh tonnes in grape are discarded every year in India as PHL (Rs. 7,618.77 crores). There is an urgent need to initiate action as outlined above to reduce post-harvest losses.

Received September 2006. *Revision accepted April 2009.*

REFERENCES

Acharya, S.S. and N.L. Agarwal (2001), *Agricultural Marketing in India,* Third Edition, Oxford & IBH Publishing Co., New Delhi.

Biswas, M.K. (1969), "Wastage of Orange in Transit to Varanasi", *Agricultural Marketing*, Vol.12, No.4, pp. 11-16.

FAO (1981), *Food Loss Prevention in Perishable Crops*, Agricultural Service Bulletin, 43, Rome.

Gajanana, T.M., D. Sreenivasa Murthy and M. Sudha (2002), "Marketing Practices and Post-Harvest Loss Assessment of Banana var. Poovan in Tamil Nadu", *Agricultural Economics Research Review*, Vol.15, No.1 pp. 56-65.

Government of India (1985), *Marketing of Fruits and Vegetables*, Agricultural Marketing Series, DMI, Ministry of Food and Agriculture, New Delhi.

Government of India (2002), *Indian Horticultural Database-2002-03*, National Horticultural Board, Ministry of Agriculture, Gurgaon, India.

Krishna, P.V. (1976), "Marketing of Fruits through Co-operative Society- A Case Study", *Indian Journal of Agricultural Marketing,* Vol.7, No.1, pp. 27-32.

Madan, M.S. and B.A. Ullasa (1993), "Post-Harvest Losses in Fruits", in K.L. Chadha and O.P. Pareek (Eds.) (1993), *Advances in Horticulture – Fruit Crops Part-IV,* Malhotra Publishing House, New Delhi.

Ratnum, C.V. and K.G. Nema (1967), "Studies on Market Diseases of Fruits and Vegetables", *Andhra Agricultural Journal*, Vol.14, pp. 60-65.

Roy, S.K. (1989), "Role of PHT of Horticultural Crops in India - Trends in Food Science and Technology", Proceedings of the Second International Food Convention. Mysore, February 18-23, pp. 349-356.

Senthilinathan, S. and R. Srinivasan, (1994), "Production and Marketing of Poovan Banana in Trichirapalli District", *Indian Journal of Agricultural Marketing*, Vol. 8, No.1, pp. 46-53.

Shikhamany, S.D. (2000), "Grape Production in India", in Minas K. Papademetriou and Frank J. Dentfood (Eds.) (2000), *Grape Production in the Asia-Pacific Region*, United Nations Regional Office for Asia and the Pacific Bangkok, Food and Agricultural Organization of the United Nations, Thailand, 2001.

Sreenivasa Murthy, D., T.M. Gajanana and M. Sudha (2002), "Marketing Practices and Post-Harvest Loss Estimation in Mango var. Baganapalli at Different Stages of Marketing- A Methodological Perspective", *Agricultural Economics Research Review*, Vol.15, No.2, pp.188-200.

Sreenivasa Murthy, D., T.M. Gajanana and M. Sudha (2003), "Estimation of Post-Harvest Loss and Marketing Efficiency in Banana var. Yelakki in Karnataka", *Bihar Journal of Agricultural Marketing,* Vol.10, No.3, pp. 221-230.

Sreenivasa Murthy, D., T.M. Gajanana and M. Sudha **(**2004), "Post Loss Estimation and Its Impact on Marketing Cost, Margin and Efficiency: A Study in Grapes in Karnataka", *Indian Journal of Agricultural Economics,* Vol.59, No.4, October-December, pp. 772-786.

Srinivas, R.N., T. Venkatesha Reddy, P.C. Ravi, Lalith Achoth and B.V. Chinnappa Reddy (1997), "Post-Harvest Loss Assessment in Totapuri and Alphanso Mangoes", *Journal of Food Science and Technologies***,** Vol. 34, No.1, pp. 70-71.

Subrahmanyam, K.V. (1986), "Post-Harvest Losses in Horticultural Crops: An Appraisal", *Agricultural Situation in India,* Vol.41, August, pp. 339-343.

Waheed, A., M.Z. Iqbal and F.H. Shah (1986), "Post-Harvest Losses in Vegetables", *Pakistan Journal of Scientific and Industrial Research*, Vol.29, No.4, pp. 268-273.