Visit us - www.researchjournal.co.in ■ DOI : 10.15740/HAS/IRJAES/11.2/217-225
International Research Journal of Agricultural Economics and Statistics
Volume 11 | Issue 2 | September, 2020 | 217-225 ■ ISSN-2229-7278

Research Paper

Post-harvest losses in the mango supply channel in Tamil Nadu state, India

■ C. Sekar

Correspondence to :
C. Sekar
Department of Agricultural Economics, Centre for Students' Welfare, Tamil Nadu Agricultural University, **Coimbatore (T.N.) India**
Email: csekar2000@gmail.com

ABSTRACT : A study was conducted to identify mango value chains and analyse the post-harvest losses along them in the major mango-growing areas of Tamil Nadu state in India. The post-harvest losses were estimated using survey data collected during 2016-17 from 400 farmers; 60 households; and 100 traders consisting of wholesalers, commission agents, exporters, processors and retailers and 60 consumers in Tamil Nadu. Six major mango value chains were found in the production catchments through which the mango fruits reached consumers in different forms. Overall, the post-harvest losses at the farm level were estimated at 7.08 per cent. At the primary wholesaler level the losses were estimated at 7.30 per cent and at the processing level at 8.70 per cent. At the secondary wholesaler level the losses were estimated at 10 per cent. Maximum losses were observed at the retail level (14.97%), most likely as a result of improper post-harvest handling, lack of proper storage facilities, and rough handling of fruits by consumers who check fruit quality by squeezing. It is recommended that establishing procurement yards near farms, minimizing transaction points in the mango value chain, establishing value added and processing units near production catchments, initiating farmer cooperatives similar to Anand Milk Union Limited (AMUL) in India model, involving collection of fruits directly from the farmers by cooperatives, initiating Farmer Producer Company (FPC) and establishing a refrigerated transport system for well graded fruits right from farm to consumption centres would minimize post-production losses of mango.

KEY WORDS : Economic analysis, Post-harvest losses, Mango supply channel, Value chain, Market intermediaries, Market actors

***Paper History* :**
Received : *19.06.2020;*
Revised : *20.07.2020;*
Accepted : *21.08.2020*

How To Cite This Paper: Sekar, C. (2020). Post-harvest losses in the mango supply channel in Tamil Nadu state, India. *Internat. Res. J. Agric. Eco. & Stat.,* **11** (2) : 217-225, **DOI : 10.15740/HAS/IRJAES/11.2/217-225.**

INTRODUCTION :

Mango, "the king of fruits," is believed to have had its origin in India. Total production of mango in the world was 46.51 million tonnes from an area of 4.95 million hectares (Horticultural Statistics at a Glance, 2017).Out of this massive global harvest, India accounted for about 40 per cent of mango production, making it the largest producer of mango in the world (APEDA, 2017). It is reported that in India, the area under mango production was 2.26 million hectares and production was 19.68 million tonnes during 2016-17(Horticultural Statistics at a Glance, 2017). The other major mango producing countries are China, Thailand and Pakistan.

Mango production trends :

According to the Horticultural Statistical Year Book of India (Ministry of Statistics and Programme Implementation 2016), the major mango producing states in India (in decreasing order) are Uttar Pradesh, Andhra Pradesh, Telangana, Karnataka, Bihar, Gujarat and Tamil Nadu. Even though India is the highest producer of mangoes globally, the availability of mangoes in India is low due to intensive population pressure and large quantities of post-harvest losses that occur at various stages in the mango value chain, starting from production and continuing on through to consumption. Affecting both producers and consumers, post-harvest losses not only reduce the availability of mangoes but also increase the transport and marketing costs of saleable mangoes due to the bulk transporting of unsorted, decayed, bruised, pest-infested and diseased fruits alongside marketable fruits (Murthy *et al.,* 2002).

The area and production of mango continuously increases over the years. The area under mango was 1077.6 thousand ha during 1991-92 which reached to 2262.8 thousand ha in 2016-17. However, the production has been fluctuating drastically. During 1991-92, the total production was 8715.6 thousand MT which increased to 13997 thousand MT in 2007-08. During 2008-09 the production declined to 12750 thousand MT. From 2009-10 there is a continuous increase in the mango production. A total about 110 per cent increase in area under mango cultivation has been recorded from 1991-92 to 2014-15 while 126 per cent increase in production was recorded during the same period. However, productivity has been fluctuating drastically. The productivity of 8.1 MT/ha was recorded during 1991-12 whereas, it declined upto 5.5 MT/ha in 2008-09 and again increased to 8.5 MT/ha in 2014-15 and reached a maximum of 8.7 MT/ha in 2016-17. There was overall increase of 7.41 per cent in productivity of mango from 1991-92 to 2014-15 (Indian Horticulture Database).

Production status of mango in Tamil Nadu :

During the 2015–2016 production year, the area under cultivation and production of mango in Tamil Nadu were 1.63 x 10^5 hectares and 11.67 x 10^5 tonnes, respectively (Ministry of Agriculture and Farmers' Welfare 2016). In an earlier report, Murthy *et al.* (2009) stated that mango comprised 28.2 per cent of total fruit production in Tamil Nadu in 2009. The major districts growing mango in the state of Tamil Nadu (in decreasing order) are Krishnagiri, Tiruvallur, Dindigul, Vellore, Dharmapuri, Salem and Theni (Ministry of Agriculture and Farmers' Welfare, 2016).

Post-harvest losses in India :

Various authors have reported post-harvest losses for several mango cultivars in India for various years. According to the Kitinoja *et al.* (2010), the post-harvest losses of mango were between 18 per cent and 31 per cent in Uttar Pradesh during 2009. Physical losses due to sorting were 6.5 per cent at the farm level, 7.9 per cent at the wholesale level and 8.0 per cent at the retail level. Mechanical damage due to the use of improper harvesting tools accounted for losses of 6.5 per cent at the farm level, 6 per cent at the wholesale level and 9.5 per cent at the retail level.

Study objectives:

The overall objective of our study was to assess the post-harvest losses of mango in the mango value chain of Tamil Nadu state in India. The specific objectives were: to identify the existing mango value chains in the major mango producing domains of Tamil Nadu state, to estimate the post-production losses of mango at various transaction points in the mango value chain and to advocate changes and recommendations to reduce post-harvest losses of mango in the mango value chain.

MATERIALS AND METHODS :

Study region :

The farmer surveys were administered in Tamil Nadu in Krishnagiri, Dharmapuri, Theni and Dindigul districts (all major mango-producing areas) and in Kanyakumari district (a minor mango-producing area). Study areas were selected based on highly concentrated areas of mango production. The two locations for the consumer study, Coimbatore and Chennai, were purposively selected as they are major markets for and consumption centres of mango.

Surveys and sampling framework :

For the study, 400 farmers, 60 households and 100 mango traders in Tamil Nadu during the agricultural year 2016–2017 were surveyed to estimate the post-harvest losses. Multi-stage, purposive sampling was adopted for selecting the respondents to estimate post-harvest losses at different stages of the value chain. In the first stage,

districts were selected based on their importance and contribution in terms of area utilized for the production of mango. In the second stage, blocks were chosen based on the acreage under mango cultivation. In the third stage, villages predominantly cultivating mango were selected with farmers selected randomly from the list of mango farmers provided by the Mango Growers' Association of the respective districts. Data on post-harvest losses at the field level were collected from farmers of 400 mango orchards in the study areas. The major factors contributing to post-harvest losses and quality deterioration of mango were assessed at the farm level.

The losses were estimated by the author from the sample analysis as well as based on the farmers' input. For the market-related survey, 100 mango traders consisting of 40 wholesalers, 15 commission agents, 15 exporters, 5 processors, 15 retailers and 10 secondary wholesalers operating in the production and consumption catchments in the districts were identified randomly. The author surveyed 60 consumers representing 60 households (30 households each in Coimbatore and Chennai cities) randomly selected for the assessment of losses at the household level. Cross sectional data were collected on the causes of post-production losses and the extent of damage of mango in the value chain. Information was collected using both open-ended and closed-ended questions, and focus group discussions (FGD). Data from FGDs with the mango growers' associations, experts, and state-level institutions dealing with mango crops were cross-checked and validated with field-level information. The losses at transaction points from production to consumption were estimated as the difference between the quantities purchased and sold. Information was also collected on the qualitative parameters of mango - like colour, size, gloss, firmness, bruising, fungal infestation, shrinkage and appearance- to help assess losses.

Data analysis :

Post-harvest losses were calculated and described in kg/tonne. The percentage of losses was computed between stages within the value chains and overall. Descriptive statistics (*i.e.* averages and percentages) were computed using SPSS software (version 16) and the percentage of losses and quality deterioration were computed using the procedure adopted by Debele *et al.* (2007) and Kasso and Bekele (2016).

RESULTS AND DATA ANALYSIS :

The collected information was analysed in accordance with the three objectives of the study and the results are presented below. The following six supply channels are in operation in the Tamil Nadu study areas:

– Producer → Processor→ Wholesaler (Distant market) → Retailer → Consumer

– Producer → Commission agent (Pre-harvest contractor) →Processor →Retailer →Consumer

– Producer →Wholesaler/Pre-harvest contractor → Retailer → Consumer

– Producer→ Primary Wholesaler/Pre-harvest contractor→Secondary Wholesaler→Retailer→Consumer

– Producer →Retailer → Consumer

– Producer →Exporter/Pre-harvest contractor → Wholesaler → Retailer (Distant market) → Consumer.

The marketing practices for mango were distinctly

Table 1: Post-harvest losses in supply channel I (producer→ processor→ wholesaler* → retailer* → consumer)

Sr. No.	Nature of losses	Losses (kg/tonne)	Losses (%)
Farm level			
1.	Harvest injury	24	14.72
2.	Pest-infested and diseased fruits	27	16.57
3.	Presence of small, immature and un ripened fruits	25	15.34
	Farm-level total	76	46.63
Processing unit level			
1.	Pest-infested and diseased fruits	30	18.40
2.	Presence of small, immature and un ripened fruits	11	6.75
3.	Transit injury	46	28.22
	Processing unit-level total	87	53.37
	Overall losses	163	100.00

Note: * Collected data upto processor level only because after processing, the product goes as pulp to consumers located elsewhere

different in each mango value chain. Pre-harvest contractors and commission agents were the most common market actors in the mango value chains. Pre-harvest contractors directly purchase mangoes from farmers, transport the fruit by truck, and make advance payments to the sellers (*i.e.* the farmers) before the onset of the season or at the time of flowering. Commission agents provide space and charge commission for this service. Of the six mango value chains, I, II, III and IV accounted for more than 80 per cent of the mango trade in Tamil Nadu state.

Mango supply channel I:

The post-harvest losses in Mango Supply Channel I (producer →processor → wholesaler (distant market) → retailer → consumer) are presented in Table 1. Due to rough handling, uneven roads, inappropriate packaging and staking and bruising, the post-harvest losses were 52.8 per cent. At the farm level, the major causative factors for losses were the adoption of improper harvesting methods such as shaking trees, using sticks to harvest fruits, injury from pests and diseases and immature and un-ripened fruits. At the field level, the total losses were estimated at 76 kg/tonne. At the processing level (*i.e.* in the pulp industry), the total losses were 87kg/tonne of fruits. Among the various factors, improper handling alone contributed to 52.8 per cent of losses. In some situations, traders resorted to direct loading of fruits on to trucks which also resulted in post-harvest losses. The combined total post-harvest losses at the farm level and at processing units were 163 kg/ tonne of fruits. At the processing yard, about 53 per cent of losses were due to improper handling practices during loading and unloading of fruits and 34.48 per cent losses were contributed by pest and disease infested fruits. The major pest that affected fruits was fruit fly (*Bacterocera* sp). The most common diseases which occurred in mango were anthracnose (*Collectotricum gloeosporioides*) and stem end rot caused by *Botryodiplodia theobromae.*

A study conducted in Uganda during 2014 by Acema *et al.* (2016) involving 90 mango farmers also reported the similar outcome. The study further revealed that 88 per cent of respondents identified fruit fly as the most common pest causing significant damage to mango fruits resulting in losses and 89.8 per cent of respondents indicated that anthracnose caused severe post-production losses of fruits, followed by bacterial leaf spot and powdery mildew, which resulted in premature flower and fruit drops. Jha *et al*. (2016) also reported the losses of mango in the supply chain during 2014. Their survey was conducted in major mango growing zones of India. At the national level, the total farm-level losses were 60.9 per cent. Poor harvesting, transporting, sorting and grading were the main contributors to losses at the farm level.

Mango supply channel II:

The post-harvest losses in mango supply channel II (producer → commission agents (pre-harvest contractor) → processor → retailer → consumer) are similar to that of value chain I. In this value chain, commission agents

Table 2 : Post-harvest losses in supply channel II
(producer → commission agent (pre-harvest contractor)-processor → wholesaler* → retailer* → consumer)

Sr. No.	Nature of losses	Losses (kg/tonne)	Losses (%)
Farm level			
1.	Harvest injury	25	14.89
2.	Pest-infested and diseased fruits	28	16.67
3.	Presence of small, immature and un ripened fruits	24	14.28
	Farm-level total	77	45.84
Commission agent level - Commission agents act as intermediaries between producers and processors and they do not take title of the goods and just forward the goods from farmer to processor without handling the fruits physically and hence no losses were reported.			
Processing unit level			
1.	Pest-infested and diseased fruits	32	19.04
2.	Presence of small, immature and un ripened fruits	12	7.15
3.	Transit injury	47	27.97
	Processing unit-level total	91	54.16
	Overall losses	163	100.00

Note: * Collected data upto processor level only because after processing, the product goes as pulp to consumers present elsewhere

simply act as intermediaries between producers and processors and do not take title of goods, hence, there were no losses at the commission agent level (Table 2).

The farm level and processor level losses did not show any significant difference and it was almost the same as that of mango supply channel I. The farm level and processor level losses were 77 kg and 91 kg per tonne of fruits, respectively, as reported in value chain II.

Mango supply channel III:

The post-harvest losses in mango supply channel III (producer →wholesaler/pre-harvest contractor → retailer →consumer) are furnished in Table 3. At the field level, 33 kg/tonne or 44 per cent of total farm level losses were due to harvest injury. At the wholesale level, total losses were 85 kg/tonne due to pest and disease injury, transit injury and improper packaging and storage techniques.

Traders stack the lots one above the other resulting in huge losses due to the crushing of fruit, which can increase the incidence of pests and diseases and hasten ripening of fruits due to ethylene production. These practices accounted for 38 kg/tonne or 44 per cent of losses at the wholesale level. At the retail level, the total losses were reported to be 161 kg/tonne. Pest infestations and disease incidences resulted in major losses (82kg/tonne). Diseases, such as anthracnose (*Collectotricum gloeosporioides*) and stem end rot (*Botryodiplodia theobromae*) and pests such as nut weevil, also contributed to the post-production losses. Consumers crushing and rough handling of fruits, amounted to 45 per cent to 55 per cent of losses at the retail level. In the mango value chain, the major losses occurred at the retail level. At the consumer level, the losses were minimal (19 kg/tonne) because consumers prefer to buy only what they need and store fruits for no more than two or three days. On many occasions, fruits fall directly on the ground and neither farmers and nor traders use tarpaulin for collecting fruits, which result in bruising of fruits. Farm level losses were attributed to improper harvesting methods and presence of unmarketable fruits, which accounted for 33 kg/tonne and 21 kg/tonne, respectively.

An FAO (2017) study indicated that due to wide variation between day and night temperatures, the majority of the flowers were unable to withstand heat,

Table 3 : Post-harvest losses in supply channel III (producer → wholesaler/pre-harvest contractor → retailer → consumer)

Sr. No.	Nature of losses	Losses (kg/tonne)	Losses (%)
Farm level			
1.	Harvest injury	33	9.73
2.	Pest-infested and diseased fruits	20	5.92
3.	Presence of small, immature and unripened fruits	21	6.22
	Farm-level total	74	21.87
Wholesale level			
1.	Transit injury	19	5.60
2.	Pest-infested and diseased fruits	28	8.25
3.	Storage and over ripening losses	38	11.20
	Wholesale-level total	85	25.05
Retail level			
1.	Transit injury	9	2.65
2.	Immature and overripened fruits	47	13.86
3.	Pressing of fruits by consumers	23	6.78
4.	Pest-infested and diseased fruits	82	24.18
	Retail-level total	161	47.47
Consumer/Household level			
1.	Improper storage	4	1.18
2.	Pest-infested and diseased fruits	15	4.43
	Consumer/household-level total	19	5.61
	Overall losses	339	100.00

which led to the premature dropping of mangoes resulting in losses of between one and five per cent at the field level. Lack of irrigation also compounded the problem and resulted in significant crop losses. At the wholesale level, traders store fruit under insanitary conditions in dark rooms using gunny bags made of jute fibres; bags are lightweight and not durable. Through these unscientific practices, 38 kg of fruits per tonne were discarded due to over ripening and 19 kg were lost due to splitting of fruits, bruising and so on during transportation. At the retail level, among the various elements, pest infestation and disease resulted in major losses of around 82 kg per tonne. Retailers normally prefer partially ripened fruits for extended storage and prolonged sale to consumers. The outcomes of this study are comparable to the data reported in the state of Andhra Pradesh during 2015–2016 (FAO, 2017).

Mango supply channel IV:

Mango supply channel IV (producer →primary wholesaler/pre-harvest contractor→secondary wholesaler →retailer →consumer) is presented in Table 4. Farm-level losses were estimated at 64 kg/tonne. At the primary wholesaler level, the major losses were due to rejection of small and immature fruits during cleaning, grading and sorting, which amounted to 33kg/tonne. The total losses at the wholesale level were 73 kg/tonne. The losses at the secondary wholesaler level were 100 kg/tonne in places like Chennai, Mumbai, Ahmadabad and Cochin. Poor ventilation within trucks during transportation

Table 4 : Post-harvest losses in supply channel IV
(producer → primary wholesaler/pre-harvest contractor → secondary wholesaler → retailer → consumer)

Sr. No.	Nature of losses	Losses (kg/tonne)	Percentage
Farm level			
1.	Harvest injury	20	5.43
2.	Pest-infested and diseased fruits	23	6.25
3.	Presence of small, immature, and unripened fruits	21	5.70
	Farm-level total	64	17.38
Primary wholesale level			
1.	Pest-infested and diseased fruits	23	6.26
2.	Rejection of small and immature fruits during cleaning, grading and sorting	33	8.96
3.	Transit injury	17	4.63
	Primary wholesale-level total	73	19.85
Secondary wholesale level			
1.	Transit injury	30	8.15
2.	Decay due to excess ripening	35	9.53
3.	Pest-infested and diseased fruits	24	6.52
4.	Pressing of fruits by traders and retailers	11	2.98
	Secondary wholesale-level total	100	27.18
Retail level			
1.	Transit injury	8	2.17
2.	Immature and overripened fruits	40	10.86
3.	Pressing of fruits by consumers	11	2.98
4.	Pest-infested and diseased fruits	50	13.58
	Retail-level total	109	29.59
Consumer/Household level			
1.	Improper storage	5	1.36
2.	Pest-infested and diseased fruits	17	4.64
	Consumer/household-level total	22	6.00
	Overall losses	368	100.00

resulted in a loss of 35 kg/tonne. At the retail level, 109 kg/tonne were estimated to be lost. We noticed that major losses were due to the incidence of pests and diseases because of two to three weeks of storage. At the consumer level, 22 kg/tonne of fruit were lost due to pest infestations, diseases and improper storage.

In mango supply channel IV, post-harvest losses were 36.8 per cent that is 368 kg per tonne of fruits. Fruits are wasted due to too many intermediates and improper methods of handling of fruits at various transaction points. In this value chain, major losses occurred at the secondary wholesale level and retail level. The post-harvest losses of mango at the secondary wholesaler's level were mostly attributed to improper transportation and rough handling during transportation, adoption of unsuitable transport containers and stacking of crates or large bags one above the other. Sachan *et al.* (2013) reported that the typical shelf-life of mango was 5-7 days and it was estimated that 30-40 per cent of mangoes produced were wasted every year due to improper harvesting techniques and poor infrastructural facilities. The study also indicated that mango farmers in Krishnagiri district used to grow Alphonso variety during as it fetches higher price in the export market.

Mango supply channel V :

In mango supply channel V (producer →retailer → consumer), the post-harvest losses at the farm level were estimated at 65 kg/tonne, which occurred due to harvest injury (27 kg/tonne) and the presence of small and immature fruits (21 kg/tonne).

Retailers procure mangoes directly from farms and sell the fruit in small stalls (vending yards) established temporarily during the mango season along the national highway of Bangalore–Salem. In this value chain, retail level losses were reported to be 179 kg/tonne (Table 5) due to pest infestations and disease levels (112 kg/tonne) followed by immature and over ripened fruits (33 kg/tonne). It is quite interesting to observe that in mango supply channel V, among all intermediaries, retail level losses were enormous due to long-term storage of fruits by the traders, which resulted in more incidences of pests and disease and repeated crushing of fruits by consumers. Primarily, retail level losses are man-made and occurred due to poor handling and storage practices. Moreover, the retailers earn more profit from selling small quantity fruits at higher prices. Hence, they seldom attach significant importance on the value of the losses of fruits.

Mango supply channel VI :

In mango supply channel VI (producer → exporter/ pre-harvest contractor → wholesaler → retailer (distant market) →consumer), farm-level losses amounted to 75 kg/tonne (Table 6).

Exporters prefer only grade I quality fruits for export. In some instances, 50 per cent of fruits are rejected at the farm to maintain a high level of fruit quality.

Table 5 : Post-harvest losses in supply channel V **(producer → retailer → consumer)**

Sr. No.	Nature of losses	Losses (kg/tonne)	Losses (%)
Farm level			
1.	Harvest injury	27	9.78
2.	Pest-infested and diseased fruits	17	6.15
3.	Presence of small, immature and unripened fruits	21	7.60
	Farm-level total	65	23.53
Retail level			
1.	Transit injury	7	2.58
2.	Immature and over ripened fruits	33	11.95
3.	Pressing of fruits by consumers	27	9.78
4.	Pest-infested and diseased fruits	112	40.57
	Retail-level total	179	64.88
Consumer level			
1.	Improper storage	10	3.62
2.	Pest-infested and diseased fruits	22	7.97
3.	Consumer-level total	32	11.59
	Overall losses	276	100.00

At the exporter level, cleaning, grading and sorting practices were followed and through these practices combined, 75 kg/tonne of fruit were rejected. In this channel, 170 kg/tonne were the estimated losses of fruits since exporters follow strict quality parameters. There are wide arrays of post-harvest technologies that can be followed to reduce losses throughout the value chain, starting from pre-harvest and all the way through to market distribution. These losses need to be reduced significantly to increase the quality and quantity of fruits for consumers at affordable prices.

Conclusion:

Several of the value chains demonstrated common themes that contributed to losses of fruit. At the farm level, improper harvesting alone led to significant losses. Farmers would benefit from education regarding the use of appropriate harvesting devices like nets and hooks, tarpaulins for collecting fruits and stackable plastic crates for handling to minimize farm level losses. At the wholesaler and retailer levels, transit injury, rapid decay of fruits due to over ripening, immature fruits and over ripened fruits leads to significant losses. To reduce wholesale- and retail-level losses, it is important to eliminate over ripened and immature fruits, avoid injuries to the fruit during transportation and providing protection against pests and diseases. Post-harvest losses at different stages of handling of mango in the value chain varied between 15 per cent and 37 per cent, depending upon the route the fruit travelled to reach consumers.

The post-harvest losses were significantly high at each and every stage in the mango mango supply channel. Higher post-production losses were directly related to the number of steps in a value chain. Elimination of redundant market intermediaries in the value chain will help to reduce the losses. This study highlights that the largest losses occur at the retail level. In the mango value chain, multiple instances of the handling of fruit, such as frequent disturbances owing to, too many operations (like grading, sorting, packaging and repackaging) at each level of transaction, the presence of almost innumerable market actors, and improper transportation lead to damaged fruit resulting in enormous losses.

Recommendations:

Losses can be avoided or at least minimized by following better practices. Based on our findings, we recommend the following policy changes:

– The institutions, both central and state, should establish procurement yards near the production catchments so that farmers can sell their fruits directly without any losses to the government and get a profitable price by eliminating market actors (*i.e.* intermediaries). By doing so, the government can provide employment to local people, particularly women, for cleaning, grading, sorting, packaging and labelling.

– Establishing value addition and processing units near production centres to significantly minimize handling and transportation associated losses.

– Initiating farmers' cooperatives using Anand Milk Union Limited (AMUL) in India as a model; this may ensure competitive prices for farmers, better flow of fruits in the mango value chain and a more plentiful supply of quality fruits to the consumer at affordable prices.

As cities expand, farmer-producers (*i.e.* the first step in the supply chain) are getting further away from consumers and this leads to higher wastage and hence, creating a refrigerated transport system would help to

Table 6 : Post-harvest losses in supply channel VI (producer → exporter → wholesaler/retailer* → consumer)

Sr. No.	Nature of losses	Losses (kg/tonne)	Losses (%)
Farm level			
1.	Harvest injury	38	22.35
2.	Pest-infested and diseased fruits	16	9.41
3.	Presence of small, immature and unripened fruits	21	12.35
	Farm-level total	75	44.11
Export level			
1.	Transit injury	12	7.06
2.	Cleaning, grading and sorting	76	44.70
3.	Packaging	7	4.13
	Export-level total	95	55.89
	Overall losses	170	100.00

ensure that good-quality fruits reach consumers at affordable price.

Strengthening the activities of the Farmer Producer Company in the mango growing regions will considerably reduce the post production losses of mango.

LITERATURE CITED :

Arivazhagan, R., Geetha, P. and Ravilochanan, P. (2012). Analysis of sources of fruit wastages in retail outlets in Chennai, Tamil Nadu, India. *Internat. J. Trade, Econ. & Finance*, **3**(3) : 199-204.

Bung, P. (2012). Indian fruit processing industry: Import and export analysis. *J. M P Birla Institute of Management, Associate Bharatiya Vidya Bhavan*, **6**(2) : 72-86.

CIPHET (2016). Assessment of quantitative harvest and post-harvest losses of major crop commodities in India. Ludhiana, India: Indian Council of Agricultural Research - Central Institute of Post-Harvest Engineering and Technology.

Dan, A., Baron, A., Emmanuel, O. and Dickson, E. (2016). Assessment of mango pests, diseases and orchard management practices in West Nile Zone of Uganda, *Agriculture, Forestry & Fisheries,* **5**(3): 57-63.

Debele, D., Fekada, L. and Ravishankar, H. (2007). Development and performance evaluation of indigenously made cooling chambers for extending the shelf-life of mangoes and sweet oranges. *East African J. Sci.,* **1** : 127-135.

FAO (2017). *Mango value chain food losses analysis -causes and solutions in the state of Andhra Pradesh – India,* United Nations of the Food and Agriculture Organization, Rome, Italy.

Government of India (2016). *Horticultural Statistics at a Glance,* Ministry of Agriculture and Farmers' Welfare, New Delhi, India.

Gustavsson, J., Cederberg,C., Sonesson U., Van Otterdijk, R. and Meybeck, A. (2011). *Global food losses and food waste - extent, causes and prevention.* Food and Agriculture Organization of the United Nations, Rome, Italy.

Jha, S.N., Vishwakarma, R. K., Tauqueer, A., Anil, R. and Dixit, A.K. (2016). Assessment of quantitative harvest and post-harvest losses of major crops and commodities in India. ICAR- All India Coordinated Research Project on Post-Harvest Technology, ICAR-CIPHET, Punjab Agricultural University, Ludhiana (Punjab) India.

Kasso, M. and Bekele, A. (2016). Post-harvest loss and quality deterioration of horticultural crops in Dire Dawa Region, Ethiopia. *J. Saudi Society of Agric. Sci.,***30** : 30 http://dx.doi.org/10.1016/j.jssas.2016.01.005.

Kitinoja, L. H., AlHassan, A., Saran, S. and Roy, S. K. (2010). Identification of appropriate postharvest technologies for improving market access and incomes for small horticulturalfarmers in sub-Saharan Africa and South Asia. Invited paper in three parts for the IHC Postharvest Symposium Lisbon, August 23.Acta Hortic.

Murthy, S. D., Gajanana, T.M.,Sudha, M. and Subrahmanyam, K.V. (2002). Post- harvest loss estimation in mango at different stages of marketing – A methodological perspective. *Agric. Econ. Res. Rev.,* **15** (2) : 188-200.

Murthy, S. D., Gajanana, T.M. and Sudha, M. (2004). Post harvest losses and its impact on marketing cost, margin and efficiency: A study on grapes in Karnataka. *Indian J.Agric. Econ.,* **59** (4) : 773-786.

Murthy, S.D., Gajanana T.M., Sudha, M. and Dakshinamoorthy, V. (2009). Marketing and post-harvest losses in fruits: its implication on availability and economy. *Indian J. Agric. Econ.,* **64** (2) : 259-275.

Nita S.,Munagala, V., Chakravarty, S. and Sharma, N. (2013). *Innovation cluster in the food processing industry at Krishnagiri, Tamil Nadu.* Indian School of Business, National Innovation Council, Government of India.Telangana.

Sharma, G. and Singh, S.P. (2011). Economic analysis of post-harvest losses in vegetables in Uttarkhand. *Agricultural Economics Research Review*, **24** : 309-315.

Srinivas, R.N.,Venkatesha Reddy,T., Ravi, P.C., Achoth, L. and Chinnappa Reddy, B.V. (1997). Post-harvest losses assessment in Totapuri and Alphonso Mangoes. *J. Food Sci. &Technologies,* **34** (1) :70-71.

Wanjari V., Ladaniya, M.S. and Gajanana, T.M. (2002). Marketing and assessment of post-harvest losses of acid lime in Andhra Pradesh. *Indian J. Agric. Mktg.*, **16**(2) : 32-39.

WEBLIOGRAPHY

APEDA (2017). *Mango report of the Government of India organization* APEDA (Agricultural Processed Food Products Development Authority). Available at:*http:/* ***agriexchange.apeda.gov.in****/Market%20Profile/MOA/Product/MANGO.pdf.*

http://mangifera.res.in/indianstatus.php.