
ESTIMATING SUPPLY CHAIN LOSSES OF FRESH MANGO IN SOUTH GUJARAT

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ABSTRACT

There is no need to emphasize the significance of horticulture crops, particularly fruits and vegetables, in improving nutrition and the economy. South Gujarat's most important horticultural crop is mango. Mango is distributed via two supply chains: the traditional APMC Supply chain and the Mango Marketing Cooperatives of South Gujarat. Post-harvest loss in the Mango Supply Chain is one of the most significant concerns and obstacles in the Indian Fruits Supply Chain. A knowledge gap exists about post-harvest losses in Gujarat and South Gujarat. The extent of the overall loss and its causes at each actor level remain unknown. This study determines the supply chain loss in both chains and concludes that both the Conventional APMC Chain (38.44%) and the Co-operative Marketing chain (38.26%) experience losses. Given the size of the loss is approximately 38%, policymakers and the government must take immediate measures to reduce the overall loss in the mango supply chain in South Gujarat.

Key words: Mango Marketing, Mango Supply chain, Post-Harvest Loss, Supply chain Loss

I. INTRODUCTION

Mango is an important and profitable crop for farmers in South Gujarat. Mangoes are harvested in April, May, and June. Mango is primarily harvested and marketed in South Gujarat during May. According to conversations with the District Horticulture Officers of Surat, Navsari, Valsad, and Tapi, Kesar, Alphonso, Rajapuri, and Totapuri are the most widely cultivated varieties in Southern Gujarat. Other cultivars include Sabja, Sonpari, Nilphanso, Nilam, Sardaar, Dasheri, and Begam Palli, among others. Nonetheless, the Kesar, followed by the Alphonso, is the predominant cultivar in Southern Gujarat. As per Area and Production Reports 2019 published by the Director of Horticulture, Government of Gujarat, a total of 97,646 Hectares of land were under Mango cultivation and resulting in 7,48,219 Metric Tons of Mango Production in South Gujarat in the Year 2019-20.

Post-Harvest Loss is the primary issues in all fruits and Vegetables in India. According to (Negi & Anand, 2016) Indian fruits and vegetables supply chain is issues of post-harvest loss of ranging from 30-40 in supply chain. The Approximate loss across the chain is Rs. 1,00,000/- crore per annum. The Study is needed to identify the magnitude of Post-harvest loss across the Mango supply chain for necessary interventions from Government Institutions, Research Institutions and Extension Agencies. This study throws light on post-harvest loss at each actor level with factors and their contribution to overall loss in Mango Supply chain.

Need of Study

As Mango is a very important crop for south Gujarat, it was selected for Supply chain loss estimation. This study covers all critical aspects of managing the Supply Chain for Mango. Finally, this study provides insight into the Mango Supply Chain's current state, which can benefit policymakers, researchers, and private investment in agriculture marketing and Supply Chain.

As there is no past study conducted in Gujarat and South Gujarat for Supply chain loss estimation, this study is required. At present there exists a knowledge gap for supply chain loss estimation in Gujarat as well as south Gujarat for fruits crops including Mango. Due to that, there is an urgent need to study empirically estimate the supply chain loss of Mango in South Gujarat.

II. LITERATURE REVIEW

Proper postharvest processing of food is more important than intense and widespread farming in securing food for a nation. Losses waste food, people's time, farm inputs, ways to make a living, investments, and scarce resources like water. Postharvest losses of horticultural crops in general and fresh fruits and vegetables (perishables) in particular are very common problems (Hailu & Derbew, 2015).(Hodges et al., 2011),defines Post-harvest food loss as measurable qualitative and quantitative food loss that occurs along the supply chain, beginning at the moment of harvest and continuing until the food is consumed or used for some other end purpose.

According to (Negi & Anand, 2015),Post-harvest losses plague India's Fruits & Vegetables supply chain. Perishable food supply chain losses to major market,

processing units, etc. are substantial. India wastes 30-40% of its food. Fresh food losses from shipping and storage. Post-harvest losses in India are substantial due to a lack of cold chain facilities, insufficient logistics, etc. As per Prime study considered by Government of India (Jha S, Vishwakarma R, Ahmad Tauqueer, Rai Anil, 2015), In the fiscal year 2014, it was estimated that post-harvest losses in India totaled INR 926.51 billion, which is equivalent to USD 15.19 billion.

Government of India has made statement in Parliament for supply chain loss for various commodities and admitted that the cumulative waste in Fruits and Vegetables in Country is 4.58-15.88% based on the CIPHET & ICAR Study (Ministry of Food Processing, 2016). Similarly Government of India has admitted through Doubling Farmers' Income Committee Report (DFI Committee, 2018), that past studies in India on Post-Harvest loss of Horticulture Crops in India not easily comparable due to varying coverage. All the Previous studies are having wide margin in Loss Magnitude.

All these past studies lack for no Information in Supply chain for fruits and Vegetables. This Implies Knowledge gap for supply chain loss es for Selected Fruits and Vegetables in South Gujarat. In south Gujarat study needs to identify the supply chain loss at each actor level. The reasons for loss need to be identify the reasons for loss at each actor level. The study was conducted across the supply chain of selected fruits and vegetables across the chain.

III. RESEARCH METHODOLOGY

Research Design

Descriptive Research Design adopted for this study.

Primary Data

Farmer's Survey

150 Farmers from APMC Markets and 150 Farmers from Co-operative marketing chain total 300 were purposively selected.

APMC Commission Agent

120 APMC Commission Agents were purposively selected from APMC Valsad, APMC Navsari, APMC Bilimora, APMC Surat and APMC Vyara, APMC Bharuch.

APMC Whole Sellers

120 APMC Whole Sellers were purposively selected from APMC Valsad, APMC Navsari, APMC Bilimora, APMC Surat and APMC Vyara, APMC Bharuch.

Pre-Harvest Contractor Survey

The Pre-Harvest survey was conducted in Valsad and Navsari Districts. The Pre-harvest contractor were selected conveniently. Total 50 Pre-harvest contractor were selected and sampling was done with non-probabilistic convenient sampling method.

Retailer Survey

The Retailer survey was carried out across the South Gujarat from Surat, Vyara, Navsari, Valsad, Rajpipla and Bharuch city. The survey conducted convenient sampling method. For the study 30 retailers from each city were surveyed. Total 180 Retailers were surveyed in South Gujarat.

Secondary Data

The secondary data were collected from APMC Annual Reports, Co-operative Annual Reports, Government Reports, NSSO Reports, ICAR Reports, NAU Aggresco Reports and websites.

Pilot Study

The Pilot Study was carried out at Surat, Amalsad and Vyara location for 30 respondents for each stake holders. Necessary modifications were incorporated and survey was conducted.

Methodology Adopted

To identification of supply chain loss across the chain, The methodology adopted by (Jha S, Vishwakarma R, Ahmad Tauqueer, Rai Anil, 2015) was adopted for assessment of supply chain loss across the various chains. As per the methodology Primary survey was conducted to identify the loss factors at each actor level and overall post-harvest loss in the supply chain is estimated.

Objectives

- To Identify the Mango Marketing Channels in South Gujarat.

- To Identify Mango Supply chain in South Gujarat.
- To estimate losses in Mango Supply chain in South Gujarat.

IV. RESULTS and DISCUSSIONS

As per the Area and Production Report (Director of Horticulture, 2019), Valsad District, Navsari District, Surat District, and Tapi District are the major mango-producing districts in south Gujarat. A survey of farmers, APMCs, cooperatives, retailers, and pre-harvest contractors was conducted to identify supply chain losses using Schedule.

Mango Supply chain in South Gujarat

The South Gujarat Mango supply chain was identified based on the interactions of supply chain during study. The Following supply chain of Mango was found in South Gujarat. As per the Above seen figure, Farmer, APMC Commission Agent, APMC Whole Seller, Retailer and Mango Marketing Co-operative and Pre-Harvest Contractors are the Main Actors in Mango Supply chain. Each actor performs distinct operations based on the in Which Supply chain they are operating. In The Mango Supply chain Two Different Supply chains were observed i.e. Traditional APMC Supply Chain and Co-operative Supply chain.

Mango Marketing Channels in South Gujarat

In the Mango Supply Chain following marketing channels have been observed in south Gujarat.

- 1) Farmer→APMC Commission Agent→APMC Whole seller→Retailer→Consumer
- 2) Farmer→Pre-Harvest Contractor→APMC Whole seller→→Retailer→Consumer
- 3) Farmer→Pre-Harvest Contractor→Consumer (roadside sale)
- 4) Farmer→APMC Commission Agent→Organized Retailer→Consumer
- 5) Farmer→Marketing Co-operative→ Pulp Manufacturer→Consumer
- 6) Farmer→Marketing Co-operative→APMC Wholesalers→Consumer

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- 7) Farmer→Marketing Co-operative→ APMC Commission Agent→APMC
Whole seller→Retailer→Consumer (Towards Maharashtra and
Rajasthan)
 - 8) Farmer→Retailer

The Traditional APMC channel is the most dominant mango marketing channel. This route is followed by Channel 2 of pre-harvest contractors providing to the Commission Agent, as farmers find it convenient to hand over their mango orchards to the pre-harvest contractor due to labour shortages in the villages. Before the actual mango marketing season begins, the Pre-harvest contractor enters into an informal contract with farmers at a predetermined price. March and April are the active months for Pre-harvest contractors to make informal agreements with farmers. In particular instances, the Farmers to Consumers chain was witnessed in Surat and Tapi.

The Navsari District plays a significant role in the marketing cooperative channel for mangoes. Throughout the district, there are nine fruit marketing cooperatives. These cooperatives acquire sapota and mango at different times of the year. These co-operatives sell the procured mango to the co-operative Mango Pulp manufacturing facility in Gandevi, where "Amidhara" mango pulp is produced. According to the director's interactions, 80% of mango pulp is exported to destination nations, while the remaining 20% is sold on domestic markets. Due to mango value addition, co-operatives realise higher pricing than for fresh mango, resulting in a higher price for farmers.

Supply Chain Loss Estimation in Mango Supply Chain

The analysis was carried out as per the methodology adopted by (Jha S, Vishwakarma R, Ahmad Tauqueer, Rai Anil, 2015) for their prime study titled **"Assessment of Quantitative Harvest and Post-harvest Losses of Major Crops and Commodities in India"**. The Primary survey conducted for each actor level based on the Supply Chain identification in this study. The survey was conducted at different selected purposively at APMCs, Co-operatives and Selected cities for the survey in South Gujarat. The Supply Chain loss were estimated using Average and Percentages univariate statistics as per the methodology given by (Jha S, Vishwakarma R, Ahmad Tauqueer, Rai Anil, 2015). The outcome of the survey is given below.

Supply chain loss at Farmer's Level

In the Farmers' survey nine factors (variables) were used to identify the actual loss occurring at the Farmers' level. These Factors were prepared in consultation with Post-Harvest Academicians. The Outcome of the survey is given table 1.

The Post-harvest loss for loss at Mango Growing Farmer's level is calculated based on the primary survey. According to the table above, this factor causes Pest & Disease Attack (2.47%) loss, followed by Harvesting Injury (2.25%). while packaging injury (0.51%) and other factors (0.42%) of the total harvested mango crop before reaching the market for sale. The Total Loss occurring at Farmers' Level in the chain is 12.59%.

Supply chain loss at Commission Agent Level

In the APMC Commission Agent's survey nine factors (variables) were used to identify the actual loss occurring at the Commission Agent's level. These Factors were prepared in consultation with Post-Harvest Academicians. & Disease Attack, Lack of Storage Facility, Ripening Process, and Miscellaneous Factors. The Outcome of the survey is given table 2.

The Post-harvest loss for loss at APMC Commission Agent's level is calculated based on the primary survey. According to the table above, this factor causes Harvesting Injury loss (2.58%), followed by Grading (2.11%). while Lack of Storage Facility (0.25%) and Miscellaneous Factors (0.37%) of the total harvested mango crop before reaching the market for sale. The Total Loss occurring at APMC Commission Agent Level in the Mango Supply chain is 9.73%. Supply chain loss at APMC Commission Agent Level.

Supply Chain Loss at APMC Whole Seller Level

In the APMC Whole Seller Level survey nine factors (variables) were used to identify the actual loss occurring at the APMC Whole Seller level. These Factors were prepared in consultation with Post-Harvest Academicians. The Outcome of the survey is given table 3.

As per the table 3, it can be seen that environmental effects (2.04%) and grading (1.76%) incur maximum losses at APMC Whole Seller Level. The APMC Whole Seller Level Supply Chain in South Gujarat suffers minimal losses due to the ripening process (0.27%) and a lack of storage facilities (0.25%). The total

estimated loss in percentage terms is 7.39% at the APMC whole seller level in the mango supply chain in south Gujarat.

Supply chain loss at Retailer's Level

Retailers are the main points of ending supply chain as the Consumers are getting the supply in their hands from these points of supply chain. At Retailer's Level survey eight factors (variables) were used to identify the actual loss occurring at the Mango retailer's level. These Factors were prepared in consultation with Post-Harvest Academicians. The outcome of the Retailer's level supply chain loss is below 4.

As per the table 4, it can be seen that perishability (2.22%) and unsold quantity (1.74%) are the maximum loss-causing factors at the retailer's level in the mango supply chain. While excessive grading by customers (0.56%) and lack of storage facilities (0.44%) are the least loss-causing factors at the retailer's level in the mango supply chain, The total estimated loss at the retailer's level is 8.73 percent in the mango supply chain in south Gujarat.

Supply Chain Loss in Co-operative Chain

South Gujarat enjoys good presence of Fruit Marketing Co-operatives. They Trade dominantly in Selected fruits in south Gujarat. All the Mango Marketing co-operatives are situated in Navsari District of South Gujarat. Due to that census survey of Mango Marketing Co-operatives has been performed in south Gujarat. For the survey all the variables of Commission Agents have been selected for the survey as Marketing co-operatives' functions are similar to Commission Agents in the supply chain. The nine Variables are Harvesting Injury, Transportation Injury, Offloading Injury, Grading, Environmental Effect, Pest & Disease Attack, Lack of Storage Facility, Ripening Process, and Miscellaneous Factors. These Factors were prepared in consultation with Post-Harvest Academicians. The Outcome of the survey is table 5.

As per the table 5, it can be seen that grading (2.5%) is the highest loss-causing factor in terms of percentage loss, followed by pest and disease attack (1.7%) at the mango marketing cooperative level in the mango supply chain. Ripening loss (0.4%) and miscellaneous factors (0.4%) are the least loss-causing factors in

mango marketing cooperative loss in the mango supply chain. The overall loss estimated at the Mango Marketing Co-operative level is 9.55%.

Supply chain loss at Mango Pre-Harvest Contractor Level

Mango Pre-harvest Contractor are the one of the important intermediaries in Mango Supply chain in South Gujarat. Many Farmers have turned towards informal contractual arrangements with mango pre-harvest contractors in the chain.

Total 50 Mango Pre-Harvest working in Navsari, Valsad and Surat Districts are surveyed using snow boll approach and conveniently in the south Gujarat. The Supply chain loss estimates has been also performed. The survey was conducted with factors (variables) similar to Commission Agents as both have similar kind of functions. These Factors were prepared in consultation with Post-Harvest Academicians.

As per the table 6, it can be seen that pest and disease attack (2.13%), followed by harvesting injury (1.97%), are the major loss-causing factors at the mango pre-harvest contractor level in the mango supply chain. While ripening loss (0.29%) and lack of storage facilities are the least loss-causing factors at the pre-harvest contractor level in the mango supply chain in south Gujarat, the total estimated loss is 8.71%.

Overall Supply Chain Loss in Mango Supply Chain

Post-Harvest Loss in in Traditional APMC Supply Chain

The Total Post-harvest loss in Traditional APMC Chain is as per given below. For estimating Overall supply chain loss Farmer-APMC Commission Agent-APMC Whole Seller-Retailer chain was considered.

As per the table 7, it can be seen that the post-harvest loss in Traditional APMC Chain was found 38.44%.

Post-Harvest Loss in Co-operative Supply Chain

The Total Post-harvest loss in Co-operative Supply Chain is as per given below. For estimating Overall supply chain loss Farmer-Mango Marketing Co-operative- Agent-APMC Whole Seller-Retailer chain was considered.

As per the table 8, it can be seen that the post-harvest loss in Traditional APMC Chain was found 38.26%.

V. CONCLUSION

Mango is most produced and mostly traded fruit crop in South Gujarat. Mango is traded through one of the most complex Supply chain of fruits in India. The Mango is traded through two supply chains (1) Traditional APMC Chain and (2) Co-operative chain. The Highest loss is observed at Farmers' Level 12.59% and Least Loss is observed at Retailer's Level in Mango Supply chain in South Gujarat. The Overall loss estimated in Traditional Chain is 38.44% and in Co-operative chain is 38.26%. The Difference between these two chains is minor. The average overall loss in Mango supply chain is 38% is very high and it needs urgent attentions from Government, Research Institutes and Extension Agencies.

VI. LIMITATIONS

The Mango Supply chain is studied with keeping "Kesar" Mango variety as it is the highest growing Mango Variety across the South Gujarat. The Study results may be or may not be applicable to other parts of states and regions as area and variety changes there may be always change in results. This study does not include Organized Retailer in the Supply Chain Analysis from different angles and perspectives as they were reluctant to share their operational data.

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List of Tables

Table 1 Estimated Supply Chain Loss at Farmer's Level in Mango Supply Chain

Estimated Supply Chain Loss at Farmers' Level in Mango Supply Chain										
Factors	Harvesting Injury (in %)	Grading (in %)	Sorting (in %)	Immature Fruits (in %)	Pest & Disease Attack (in %)	Environment Effect (in %)	Transportation Injury (in %)	Packaging Injury (in %)	Miscellaneous Factors (in %)	Total Loss (in %)
Average	2.25%	1.67%	1.20%	0.74%	2.47%	2.17%	1.16%	0.51%	0.42%	12.59%
Standard Deviation	0.75	0.98	0.63	0.65	1.06	0.87	0.56	0.30	0.26	1.79

The Percentage value represents Total loss in percentages out of total marketable surplus Mango.

Source: Calculated from Primary Survey

Table 3Estimated Supply chain loss at Mango Whole Seller Level in Mango Supply chain

Estimated Supply chain losses at APMC Commission Agent Level in Mango Supply Chain										
Facto rs for Loss	Harvest ing Injury	Transport ation Injury	Offloadi ng Injury	Gradin g	Environ mental Effects	Pest & Diseas e Attack	Lack of Storag e Facilit y	Ripeni ng Proces s	Miscella neous Factors	Total Loss
Avera ge	0.36%	0.43%	0.43%	1.76%	2.04%	1.54%	0.25%	0.27%	0.30%	7.39%
S.D	0.37	0.41	0.46	1.00	0.82	1.09	0.29	0.36	0.81	2.15
The Percentage Loss indicates percentage loss in terms of Total Mango Traded at their Level in Supply chain										

Source: Calculated from Primary Survey

Table 4 Estimated Supply chain Loss at Retailer's Level in Mango Supply Chain

Supply chain loss at Mango Retailer's level in South Gujarat									
Factor s for Loss	Pest & Diseas e Spoila ge	Environme ntal Effects	Lack of Storage Facility	Ripeni ng Proces s	Unsold Quanti ty	Perisha bility	Excessiv e Grading by Custom ers	Miscellane ous Factors	Total Loss
Avera ge	0.57%	1.63%	0.44%	1.15%	1.74%	2.22%	0.56%	1.00%	8.73%
SD	0.48	0.69	0.34	0.65	0.79	0.68	0.50	0.62	1.25
The Percentage Loss indicates percentage loss in terms of Total Mango Traded at Retailer's Level in Supply chain									

Source: Calculated from Primary Survey

Table 5 Estimated Supply chain loss at Mango Marketing Co-operative level in south Gujarat

Estimated Supply chain losses at Mango Marketing Co-operative Level in Mango Supply Chain in South Gujarat										
Factors for Loss	Harvesting Injury	Transportation Injury	Offloading Injury	Grading	Environmental Effects	Pest & Disease Attack	Lack of Storage Facility	Ripening loss	Miscellaneous Factors	Total Loss
Average	1.35%	0.9%	0.45%	2.5%	1.4%	1.7%	0.45%	0.4%	0.4%	9.55%
S.D	0.24	0.61	0.50	0.53	0.52	0.26	0.16	0.21	0.52	1.50
The Percentage Loss indicates percentage loss in terms of Total Mango Traded at their Level in Supply chain										

Source: Calculated from Primary survey

Table 6 Estimated Supply chain losses at Pre-harvest Contractor Level in Mango Supply chain level in South Gujarat

Estimated Supply chain losses at Mango Pre-harvest contractor Level in Mango Supply Chain in South Gujarat										
Factors for Loss	Harvesting Injury	Transportation Injury	Offloading Injury	Grading	Environmental Effects	Pest & Disease Attack	Lack of Storage Facility	Ripening loss	Miscellaneous Factors	Total Loss
Average	1.97%	0.71%	0.63%	1.72%	0.73%	2.13%	0.23%	0.29%	0.3%	8.71
S.D	0.90	0.59	0.44	0.89	0.52	0.92	0.25	0.27	0.61	2.02
The Percentage Loss indicates percentage loss in terms of Total Mango Traded at their Level in Supply chain										

Source: Calculated from Primary survey

Table 7 Estimated Post-Harvest loss in Traditional APMC Supply Chain

Estimated Post-Harvest Loss in Traditional APMC Supply Chain	
Supply Chain Actors	Loss in Percentages
At Farmer's Level	12.59
At APMC Commission Agent Level	9.73
At APMC Whole Seller Level	7.39
At Retailer's Level	8.73
Total Overall Loss (in Percentages)	38.44

Source: Calculated from Primary Survey

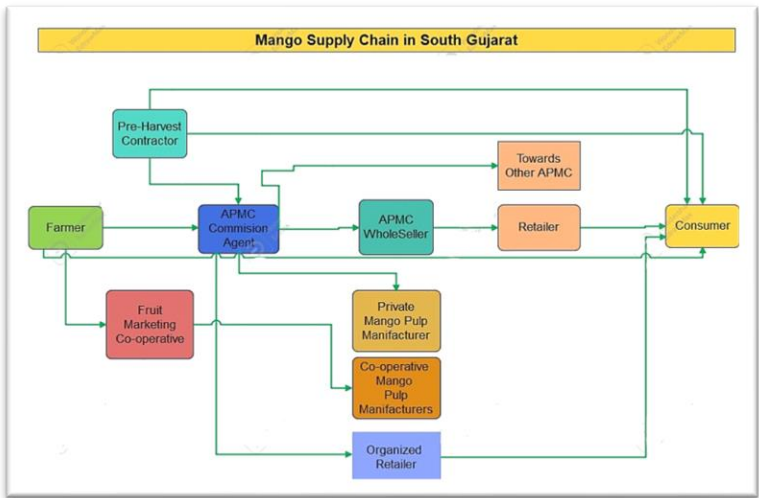
Table 8 Estimated Post-Harvest loss in Co-operative APMC Supply Chain

Estimated Post-Harvest Loss in Co-operative Supply Chain	
Supply Chain Actors	Loss in Percentages
At Farmer’s Level	12.59
At Mango Marketing Co-operative Level	9.55
At APMC Whole Seller Level	7.39
At Retailer’s Level	8.73
Total Overall Loss (in Percentages)	38.26

Source: Calculated from Primary Survey

List of Charts

Figure 1 Mango Supply chain in South Gujarat



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