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Arun Kumar Savaria
MBA (ABM) Student,
Department of Agri-Business
and Rural Management, CoA,
IGKV, Raipur, Chhattisgarh,
India

Dr. Hulas Pathak
Professor, Department of Agri-
Business and Rural
Management, CoA, IGKV,
Raipur, Chhattisgarh, India

Siddharth Pisda
MBA (ABM) Student,
Department of Agri-Business
and Rural Management, CoA,
IGKV, Raipur, Chhattisgarh,
India

Sumit B Wasnik
M.Sc. (Agril. Econ.) Student,
Department of Agriculture
Economics and Statistics, PGI,
Dr. PDKV Akola, Maharashtra,
India

An economic analysis of cost and post harvest losses of mango in Durg district of Chhattisgarh

Arun Kumar Savaria, Dr. Hulas Pathak, Siddharth Pisda and Sumit B Wasnik

Abstract
The study was undertaken to fulfil the objectives to estimate the cost and physical post-harvest losses of mango at farm, wholesale and retail level and to identify the causes of these losses and to examine the impact of post-harvest losses on farmers' net price, marketing costs, margins and efficiency in Durg district of Chhattisgarh. The expense of development on a normal of mango Rs. 78029.69. Though, in natural products absolute post reap misfortunes in mango was 11.48 kg per quintal separately, most extreme misfortunes were found at rancher level as it were. The net cost got by ranchers of natural products was determined as Rs. 146508.9 for mango. In natural products, significant limitations in post-gather the board of mango developing ranchers was discovered to be deficient storerooms followed by unfavourable climate conditions and capital inaccessibility experienced by 90, 89 and 88 percent respondents individually. The average cost of cultivation of mango was Rs. 78029.69. total post-harvest losses in mango 11.48 kg per quintal maximum losses were found at farmer level only. The net price received by farmers for mango was calculated as Rs. 146508.90.

Keywords: Economic analysis, losses of mango, Chhattisgarh

Introduction

Agriculture, with its allied sectors, is unquestionably the largest livelihood provider in India, more so in the vast rural areas contributing a significant figure to the Gross Domestic Product (GDP). Sustainable agriculture, in terms of food security, rural employment, and environmentally sustainable technologies such as soil conservation, sustainable natural resource management and biodiversity protection, are essential for holistic rural development.

Mango (Mangifera indica) is the leading fruit crop of India and considered to be the king of fruits. Besides delicious taste, excellent flavour and attractive fragrance, it is rich in vitamin A&C. The fruit contains nearly 81 per cent moisture, 0.4 per cent fat, 0.6 per cent proteins, 0.8 per cent of fibers. It also contains nearly 17 per cent of carbohydrate. The fruit is rich with important minerals contains important minerals like Potassium, magnesium, Sodium, Phosphorus, and Sulphur. Per capita consumption of mango in India was 1.95 kg per annum for rural and 2.43 kg per annum of urban population during 2011-12. Mango is grown in India in tropical and subtropical regions, almost in all states of India. However, it is mainly cultivated in, Andhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh and West Bengal.

Horticulture is growing popularity owing to the high value of horticulture produces than agriculture crops. Total horticulture production accounts 313.85 million tonnes with area of 25.49 million ha. During 2018-19. The production scenario of different fruits in India indicates that all the fruits occupied 6.65 million ha area with 98.58 million tonnes production and 14.42 tonnes/ha productivity during 2018-19. The major fruit crops grown in Chhattisgarh state are Mango, Guava, Lime, Litchi, Cashew-nut, Cheku, etc. The total area of the fruit crops in the state is 2, 56, 776 Ha. Along with the production of 25,42,241 MT in the year 2018-19. Mango accounts production of 20.80 million tonnes with area of 2.3 million ha during 2018-19. Agroclimatically mango can be grown in the whole part of the state successfully while the northern hilly area of Sarguja. During 2018-19, mango accounted production of 3956 metric tonnes and area of 1052 ha. In Durg district.

As a rule, post-harvest misfortunes of products of the soil are affected by numerous components. These variables incorporate misfortunes because of physical, physiological, mechanical and clean conditions. Mango is a highly perishable fruit. The perishability of the fruit is attributed to rapid deterioration after harvest. It is also susceptible to insect-pest infestation and decay causing postharvest losses due to lack of proper pre-harvest practices. Mango has a short shelf life and vulnerable to environmental stress especially high temperature.

Corresponding Author:
Arun Kumar Savaria
MBA (ABM) Student,
Department of Agri-Business
and Rural Management, CoA,
IGKV, Raipur, Chattishgarh,
India

Considerable quantities of mangoes are lost every year during harvesting, transport and marketing. However, very little information is available on the postharvest practices and losses of mango at the grower, collector, transport, and wholesaler and retailer levels. The technologies used in production and postharvest processing, handling, transportation and storage of mango in Bangladesh are mostly traditional. As a result, considerable quantity of production and postharvest losses are occurred.

In order to deliver a quality product to the market and ultimately to the consumer to command buyer attention and gives the grower a competitive edge, proper post-harvest management is the need of the hour. Nearly, 20-25 per cent of fruits are wasted due to faulty post-harvest practices during harvesting packaging, storage, grading etc. This wastage can be reduced to some extent through proper and scientific methods

Materials and Methods
A multi stage design was adopted. Zone was selected at first and second stage was district, while third stage was block selection and fourth stage of selection was villages. Farmers, wholesalers and retailers were the ultimate stage for collection of data. Chhattisgarh includes 27 districts, which contain 14 districts, i.e., Chhattisgarh 's plain region. Durg district holds the second highest fruit production, with technical development increasing rapid, so Durg district is intentionally chosen. Dhamda block out of 3 blocks in Durg district, the selection of villages is done by selecting 5 percent of total villages hence 8 villages are selected for the study. There were 10 farmers selected from each village and hence 100 farmers were interviewed from the Dhamda block. To estimate and evaluate the post-harvest losses at various levels, 15 retailers and 5 wholesalers were selected from Durg district.

Cost of cultivation
To work out the cost of cultivation standard Cost concept were used which includes cost A1, cost A2, cost B1, cost B2, cost C1, cost C2 and cost C3.
Cost A1: Consist of following items of costs:
1. Value of hired human labour (permanent & casual)
2. Value of hired and owned bullock labour
3. Value of hired and owned machinery
4. Value of seed (both farm-produced and purchased)
5. Value of manure (produced on farm and purchased) and fertilizers
6. Value of insecticides and fungicides.
7. Irrigation charges
8. Land revenue and other taxes.
9. Depreciation
10. Interest on the working capital.
11. Miscellaneous expenses (wages of artisans, and repairs tosmall farm implements)

Cost A2 = Cost A1+ rent paid for Leased-in Land.
Cost B1 = Cost A1+ interest on value of Owned Capital assets (excluding land)
Cost B2 = Cost B1+rental value of owned land + rent paid for leased in land
Cost C1 = Cost B1+ imputed value of Family Labour.
Cost C2 = Cost B2 + imputed value of Family labour.
Cost C3 = Cost C2 + 10 percent of cost C2 as managerial cost

Depreciation
Depreciation = Purchase value of the asset -junk value/ No. of useful years of life (expected life)

Input: output ratio = O/I

Where,
I = Total input and
O = Total output.

Post-Harvest Losses
Crop production undergoes a series of operations such as harvesting, drying, transportation, storage, whole selling and retailing before reaching the consumer, and there are sizable losses in crop output at all these stages. The data collected from the farmers included general information about the cultivation of food crops, methods of harvesting, storage system, mode of transportation and losses at farm level during post-harvest operations through enquiry method.

Factors affecting post-harvest losses

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + \ldots + a_9X_9 + e$$

Where,
Y: Post-harvest loss at farm level in quintals per hectare,
X_1: Area under crop
X_2: Age of the respondents in years,
X_3: Education of the respondents in years,
X_4: Production of crop in quintals per ha,
X_5: Distance of market from village.
X_6: Weather condition (dummy variable).
X_7: Timely labour availability (dummy variables).
X_8: Storage availability (dummy variables).
X_9: Transportation availability (dummy variables).
e: Random error.

Farmer's net price

$$NP_F = GP_F - \{C_F + (L_F \times GP_F)\}$$

Where,
NP_F = The net price received by the farmers (Rs./kg)
GP_F = The gross price received by farmers or wholesale price received by the farmer (Rs./kg)
C_F = The cost incurred by the farmers during marketing (Rs./kg) and
L_F = The physical loss in produce from harvest till it reaches the market (kg).

Marketing margins

$$MMw = [GPw - GP_F] - [Cw] - [Lw \times GPw]$$

Where,
MMw = Net margin of the wholesaler (Rs./kg)
GPw = The wholesalers' selling price or purchase price of retailer (Rs./kg)
Cw = The cost incurred by the wholesalers during marketing (Rs./kg) and
Lw = The physical loss in the produce at the wholesale level (per kg).

Net marketing margin of the retailer is given by

$MM_R = [GPR–GPW] – [CR] - [LR \times GPR]$

Where,
MM_R = Net margin of the retailer (Rs./kg)
GP_R = Price at the retail market or purchase price of the consumers (Rs./kg)
L_R = Physical loss in the produce at the retail level (per kg) and
C_R = The cost incurred by the retailers during marketing (Rs./kg).
Similarly, total marketing cost (Mc) incurred by the producer/seller and by various intermediaries was calculated as;

$Mc = C_F + Cw + C_R$

Total marketing loss (ML) in value of produce due to injury/damage caused during handling of produce from the point of harvest till it reaches the consumers was estimated as

per Eq. (6):

$ML = [L_F \times GP_F] + [Lw \times GPw] + [L_R \times GPR_R]$

Marketing efficiency
The present study, therefore, incorporated 'marketing losses as one of the components in the denominator of the formula suggested by Acharya and Agarwal (2001) for the measurement of marketing efficiency. The modified formula was expressed as:
$ME = NP_F/ MM + Mc + ML$

Results and Discussions
Economics of mango orchard
The mango orchard economics is shown in table 1 and it clearly shows that the costs of farming on large farms per hectare are higher than in small farms. Overall Rs. 78029.69 was found for an average cultivation cost per hectare. Culture costs displayed an upward trend as the agricultural scale increased. This is because major farmers spend more on new farming inputs.

Table 1: Input wise cost of cultivation of mango crop (Rs./ha.)

Sr. No.	Particulars	Small farms	Medium farms	Large farms	Overall
A.	Variable cost				
1.	Human labour				
	a. Family	11067.21 (14.69)	10123.39 (13.05)	9873.46 (12.33)	10252.89 (13.13)
	b. Hired	21261.67 (28.23)	22616 (29.15)	22942.27 (28.65)	22416.89 (28.72)
	Total human labour	32328.88 (42.93)	32739.69 (42.21)	32815.73 (40.99)	32669.78 (41.86)
2.	Bullock labour	1561.11 (2.07)	1664.97 (2.14)	1736.82 (2.16)	1668.71 (2.13)
3.	Machine labour	4382.78 (5.82)	4567.47 (5.88)	4838.17 (6.04)	4633.80 (5.93)
4.	Manure and fertilizers	12679.63 (16.89)	12881.23 (16.60)	13231.78 (16.52)	12976.07 (16.62)
5.	Plant protection	5332.22 (7.08)	5738.32 (7.39)	6224.71 (7.77)	5839.18 (7.48)
6.	Irrigation charges	3298.98 (4.38)	3577.63 (4.61)	3931.87 (4.91)	3655.31 (4.52)
7.	Interest on working capital	3132.63 (4.16)	3461.58 (4.46)	3821.69 (4.77)	3521.28 (4.52)
	Total variable cost	62716.23 (83.29)	64630.71 (83.33)	66600.77 (83.19)	64972.76 (83.26)
B.	Fixed cost				
8.	Depreciation	558.22 (0.74)	621.82 (0.80)	732.64 (0.91)	651.93 (0.83)
9.	Land revenue and taxes	12.00	12.00	12.00	12.00
10.	Interest on fixed capital	2683.67 (3.56)	2762.33 (3.56)	2891.11 (3.16)	2796.15 (3.58)
12.	Rental value of land	9321.32 (12.38)	9532.89 (12.29)	9814.47 (12.26)	9597.08 (12.29)
	Total fixed cost	12575.21 (16.70)	12929.04 (16.66)	13450.22 (16.80)	13057.18 (16.73)
	Total cost (A+B)	75291.44 (100)	77559.75 (100)	80050.99 (100)	78029.94 (100)

Cost and returns on the basis of cost concept
The expense and returns on the basis of cost principle in the development of mango orchard have been provided in the table 2 and figure that the per hectare cost A1, A2, B1, B2, and cost C1, C2 and C3 at the total level is Rs. 65636.69, Rs. 65636.69, Rs. 68432.84, Rs. 78029.92, and Rs. 78685.73, Rs. 88282.81, Rs. 97111.09 per hectare, respectively on the

sample farms. The estimated production per hectare over cost A1 is Rs. 136763.04, cost A2 is Rs. 136763.04, cost B1 is Rs. 133966.89, cost B2 is Rs. 124369.81 and cost C1 is Rs. 123714.00, C2 is Rs. 114116.92 and C3 is Rs. 105288.64 respectively. The production for various services also grew due to a higher production compared to the overall product costs, as the agricultural scale increased.

**Table 2:** Cost concepts in mango among various categories of farms (Rs/ha.)

Sr. No.	Cost	Small	Medium	Large	Overall
1.	Cost A1	63286.45	65264.53	67345.41	65636.69
2.	Cost A2	63286.45	65264.53	67345.41	65636.69
3.	Cost B1	67948.02	68026.86	70236.52	68432.84
4.	Cost B2	77269.34	77559.75	80050.99	78029.92
5.	Cost C1	79015.23	78150.25	80109.98	78685.73
6.	Cost C2	88336.55	87683.14	89924.45	88282.81
7.	Cost C3	97170.20	96451.45	98916.89	97111.09

Table 3 describes the yield value of the output by hectare and production costs per quintal of mango orchard on the sample farms. It reveals that the average yield per hectare of mango orchard has been achieved at Rs 780.55 and rises as farm size

decreases because of higher yields in place of the farm costs. The average gross revenue was Rs. 202399.73 per hectare and higher gross revenues is attributed to higher returns on large farms.

Table 3: Per hectare yield value of output and cost of production quintal of mango

Sr. No.	Particulars	Small	Medium	Large	Overall
1.	Yield (Qtl./ha)	94.13	101.58	102.23	100.01
2.	Price (Rs/Qtl.)	2016.14	2022.38	2029.11	2023.62
3.	Gross income	189779.25	205433.36	207435.91	202399.73
4.	Cost of cultivation	75291.44	77559.75	80050.39	78029.69
5.	Cost of production (Rs/Qtl.)	799.86	763.53	783.04	780.55
6.	Input output ratio	1:2.52	1:2.64	1:2.59	1:2.58
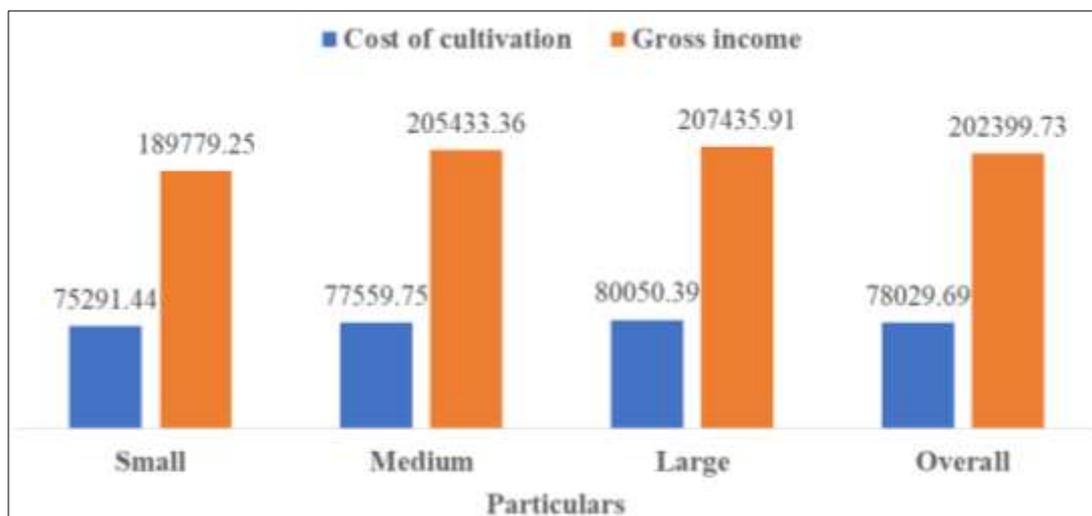
Fig 1: Graph representation of input and output of mango

Post-harvest losses in mango at farm level

These were estimated to be 18.28 kg/q in mango at the farm level. Losses in q/hectare were also worked out which was found to be 25.63 q per hectare. Losses were found maximum in handling and transportation (33.97 per cent to the total loss at farm level) followed by marketing being 28.39 per cent to the total losses in mango at farm level.

Table 4: Post-harvest losses of mango at farm level

Sr. No.	Stage	Losses (Kg/q)	Losses (q/ha)	Percentage
1.	Harvesting	4.42	4.7	24.17
2.	Grading & packaging	2.46	2.69	13.45
3.	Handling & Transportation	6.21	6.97	33.97
4.	Marketing	5.19	12.17	28.39
	Total	18.28	25.63	100.00

Post-harvest losses in mango at market level.

Post-harvest losses in mango at market label were estimated at wholesaler and retailer level. It has been reported that total post-harvest losses at market level was found 6.95 kg/q out of which contribution of losses at wholesaler and retailer level was 4.42 and 2.53 kg/q respectively. Maximum share of losses among different operations of marketing was found in transportation (wholesaler level) being 33.23 per cent to the total losses at market level. Contribution of losses in sorting and grading was found maximum among different operations at retailer level being 15.54per cent to the total losses at market level.

Table 5: Post-harvest losses of mango at market level

Sr. No.	Stage	Losses (Kg/q)	Percentage
1.	**Losses at wholesaler level**		
a.	Loading-unloading	0.28	4.02
b.	Sorting & grading	1.08	15.54
c.	Packaging	0.43	6.18
d.	Storage	0.32	4.60
e.	Transportation	2.31	33.23
	Sub total	4.42	63.56
2.	**Losses at Retailer level**		
a.	Loading-unloading	0.18	2.58
b.	Transportation	1.08	15.53
c.	Sorting Grading	0.98	14.10
d.	Selling	0.29	4.17
	Sub total	2.53	36.38
	Total	6.95	100.00

Table 6: Factors affecting post-harvest losses in mango at farm level

Sr. No.	Explanatory variables	Coefficients/Values	Standard error
1.	Intercept	17.2842	2.2354
2.	Area of the crop	- 0.0250	0.5980
3.	Yield of the crop	- 0.0313	0.0560
4.	Age of the respondent	0.0029	0.0227
5.	Education of the respondent	- 0.3385	0.4053
6.	Distance from the market	- 0.1485*	0.4057
7.	Weather (dummy)	- 0.0343*	0.3864
8.	Timely labour availability (dummy)	- 0.4906	0.4636
9.	Storage facility (dummy)	- 0.1155**	0.4932
10.	Transportation Facility (dummy)	- 0.4048**	0.4048
11.	R2	0.02	-
12.	F – Value	0.45	-
13.	Adjusted R2	- 0.03	-

** Level of significance $p<0.01$
* Level of significance $p<0.05$

Cost and margin of various agencies in the marketing of mango in various channels

Marketing channel I is the simplest having no involvement of intermediaries between farmers and consumers. It resulted into minimum cost in marketing thus making availability of produce in lesser price for customers. Generally, this type of marketing is done in local area. Hence price spread becomes lowest and producer share is highest.

Marketing channel II has the involvement of retailer in between producer and ultimate consumer which indicate cost incurring of producer and retailer as well. This will reduce the share percentage of producer from the consumer's paid price and margin will be gone in retailer hands.

Marketing channel III has the involvement of wholesaler and retailer in between producer and ultimate consumer. The function of wholesaler and retailer which plays the part in searching and creation of demand of consumer charge by their margin and cost incurred on various activities rendered by them.

Table 7: Representation of cost, margin in marketing through various channel of mango (Rs/quintal)

Sr. No.	Particulars	Channel I	Channel II	Channel III
A.	Cost incurred by producers			
1	Transportation	20	20	20
2	Loading, unloading &weighing	30	30	30
3	Sub total	50	50	50
4	producer's net price	1970	1970	1970
5	Producer's sale price	2020	2020	2020
B	Cost incurred by wholesaler			
1	weighing, loading and unloading			30
2	Gunny bags			30
3	Transportation			20
4	Sub total			80
5	wholesaler margin			200
6	wholesaler's sale price			2220
C	Cost incurred by retailer			
1	weighing loading and unloading		30	30
2	Transportation and storing		60	30
3	Gunny Bags		-	-
4	Sub total		90	60
5	Retailer margin		250	200
6	Retailer's sale price		2270	2420
D	Producer's share in consumer rupee	97.52	86.78	81.40
E	Price spread	2.48	13.22	18.60

Impact on price and margin after post-harvest losses in mango

The net price received by farmer can be given by subtracting total post-harvest losses and cost incurred in marketing from gross price received by farmers and in mango it is calculated as Rs. 146508.90 as shown in figure 2. Whereas, the marketing margin is as shown in figure varies as per the channel of marketing. The marketing efficiency is clearly highest in Channel III as compared to Channel II but the price spread is also highest.
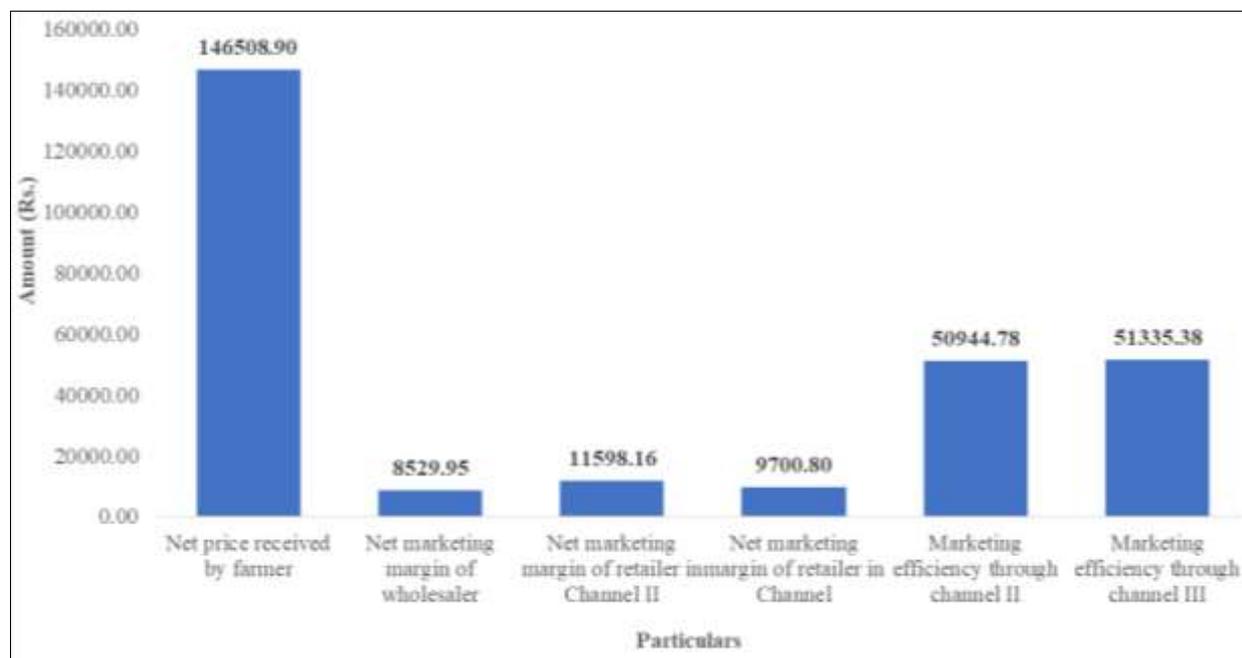
Fig 2: Price spread of mango after post-harvest losses

Conclusions
The average per hectare cost of cultivation of mango were calculated as Rs. 78029.69. Total post-harvest losses in mango was found 11.48 kg per quintal. The net price received by farmers of mango was calculated as Rs. 146508.9. Significant factors found affecting post-harvest losses negatively was timely labour availability and storage facility. So, by providing labours on the required time the post-harvest losses in mango at farm level can be reduced considerably. About 18.28 kg/q were losses found in mango at the farm level. Losses were found maximum in handling and transportation followed by marketing being 28.39 per cent to the total losses in mango at farm level, while at market level it was found 6.95 kg/q.

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