Pakistan J. Agric. Res. Vol. 26 No. 3, 2013

ASSESSMENT OF POST-HARVEST LOSSES OF PLUM IN SWAT, PAKISTAN

Muhammad Shahzad*, Akhter Ali**, Abdul Hayee Qureshi**, Naveed Jehan*, Imran Ullah* and Majid Khan*

ABSTRACT:- Plum is an important stone fruit of Pakistan after peach. It is prone to post harvest losses at different levels during its production and consumption. Evaluating post harvest losses in the marketing channel of the plum was necessary for the stake holders to make informed decision about harvest and post harvest practices. This study was conducted in Swat district in 2012 to quantify these losses at different levels using four different questionnaires. Proportionate stratified random sampling technique was used for the collection of data from different categories of respondents and tehsils. Post harvest losses were estimated through percentage method. The most important reasons were poor harvesting methods, over maturity, insufficient cold storage facility, poor grading, low-quality packaging materials and poor infrastructure. Total post harvest losses in the marketing channel of the plum were 21.51% of which 5.12% occurred at farm level, 1.44% at wholesale level, 6.31% at retail level, and 8.64% at the consumer level. Harvesting at proper maturity, using experienced labor and storage facility can reduce extent of post harvest losses of plum.

Key Words: Plum; Post Harvest Losses; Packaging; Pakistan.

INTRODUCTION

Plum (*Prunus domestica*) is an important stone fruit after peach in terms of area and production in Pakistan. Different varieties of plum (*Fazle mananai*, *Faramusa*, *Beauty* and *Late mananai*) are grown in varying quantities in different climatic conditions neither too hot nor cold. In Pakistan, it is mostly grown in the provinces of Balochistan and Khyber Pakhtunkhwa. The main producing areas of plum are Kalat, Mardan, Mastung, Nowshera, Peshawar, Pishin, Quetta, and Swat. Pakistan ranks 17th for plum production in the world with total production of 67,000t. The share of the province of Khyber Pakhtunkhwa is 47% in total production of the country, whereas Swat district contributes about 17% of the plum production in the province (GoP, 2009).

Most of the plum fruit is consumed at the domestic level, whereas a slight share is exported to the neighboring countries like India, Bangladesh, Gulf countries and Sri Lanka. It is rich in iron, vitamin A, vitamin C and fibers and being consumed as fresh, dry, canned, and preserved

*Department of Applied Economics, PARC- Institute of Advance Studies in Agriculture, National Agricultural Research Centre, Islamabad, Pakistan.
** CIMMYT, Pakistan, National Agricultural Research Centre, Islamabad, Pakistan.
***Social Sciences Research Institute, National Agricultural Research Centre, Islamabad, Pakistan.
Corresponding author: msdresearcher2011@gmail.com

into jams and jellies (Gunnes, 2003). Soft texture of plum makes it prone to post harvest losses at different stages of marketing (Muhammad, 2012). Technically post-harvest losses refer to the measurable quantitative and qualitative losses such as change in the availability, edibility, wholesomeness and quality of a produce at different stages of its shipment from point of harvest to the point of consumption (Troger et al., 2007). Primary factors of the post harvest losses are biological (rodents, birds, animals); microbiological (fungus, bacteria); chemical (reaction of the nutrients, contamination with pesticides and other chemicals); biochemical (enzymes activated reactions); mechanical (bruising, cutting and puncturing); physical (excessive or insufficient heat or cold); physiological respiration, sprouting in dormancy) and psychological (human aversion). The secondary factors which encourage these primary factors are inadequate harvesting method, packaging, transportation, storage and some environmental factors like temperature, humidity and solar radiation (Shah and Farooq, 2006; Gangwar et al., 2007; Rehman et al., 2007; Khan et al., 2008; Adeoye et al., 2009; Buyukbay et al., 2011). The magnitude of post harvest losses is subject to variation from time to time and country to country (Liu, 1990). Post harvest losses were 23% on the average for different varieties of peach in Swat (Khan et al., 2008). In Peshawar valley tomato post harvest losses were estimated to be 20% (Rehman et al., 2007). The scarcity of storage and transportation resulted in 25-40% post harvest losses in Pakistan (Aujla et al., 2007).

Horticulture is an important sub sector, where plum occupies an important position after peach, which provides livelihood to thousands of families in Swat. Any effort for reducing the post harvest losses will greatly help in increasing their incomes. Reduction of quantitative losses is a high concern in developing countries and qualitative losses in developed countries (Kader, 2005). Such losses are the major factor of food insecurity and economic loss to the farmers (Admassu, 2003). Reduction of post harvest losses can increase food availability, decrease the needed area for its production and conserve the natural and financial resources by adopting better management practices. Therefore, this study was conducted to estimate the extent of post-harvest losses of plum and suggest measures for reduction of post harvest losses.

MATERIALS AND METHOD

The study was based on primary data which were collected by using structured questionnaires for different categories of respondents namely growers/contractors, wholesalers, retailers and consumers. Proportionate stratified random sampling technique was used for the collection of data. Swat district was purposively selected on the basis of its highest share in the total production of plum in the province of Khyber Pakhtunkhwa. Four tehsils (Barikot, Babozi, Charbagh and Khwazakhela) were selected on the basis of their share of land under plum orchards for the estimation of post harvest losses. Area under plum in these tehsils was 338.78, 40.81,

81.63 and 40.81 ha, respectively while in the district total plum area was 612.24 ha.

Proportionate random sampling technique was used for selection of sample from different categories of intermediaries. It was observed during preliminary survey that about 70% growers sold their orchards to pre-harvest contractors. Total number of the contractors was 154 whereas growers who marketed plum at their own were 52. Total 110 contractors and 34 growers were included in the sample on the basis of area under plum in each tehsil for the required information. Total number of wholesalers was 68 confined to the main fruit market (*mandi*) of Mingora, where 250 retailers were dealing in the plum fruit. In total 40 wholesalers and 70 retailers were included in the sample on the basis of 95% confidence level and 10% confidence interval. Among the tehsils, sample was distributed proportionally on the basis of population. To get the extent of consumer level losses 15 consumers were also interviewed. After determining the sample size from different tehsils respondents were selected randomly. Total sample size was 269 respondents of different categories.

Marketing channel show the flow of plum from point of production to point of consumption. Different intermediaries like contractors, commission agents, wholesalers and retailers were involved to constitute main chain between producers and consumers. In other channels one or more of the intermediaries were excluded between producers and consumers.

Estimation of Post-Harvest Losses

Post harvest losses were estimated by percentage and averages method at each of the categories of intermediaries' viz., growers / contractors, wholesalers, retailers and consumers (Khan et al., 2008; Gangwar et al., 2007; and Murthey et al., 2007). Post-harvest losses are of two types viz., quantitative and qualitative. Quantitative losses were the thrown away plum while qualitative losses were calculated through the decrease in value of the plum deteriorated and were sold at lower grades. Quantitative post- harvest losses were determined as:

$$\text{Percentage Loss} = \frac{Q_l}{Q_t} \times 100$$

Where,

Q_l = Quantitative loss

Q_t = Total quantity (net quantity + discarded quantity)

Value of the post harvest losses in monetary terms was worked out as below;

$$ML = P_O \times Q_{O\,(purchased)} - (P_O \times Q_{O\,(sold)} + \sum(P_{nlg} \times Q_{nlg})$$

Where,

ML = Monetary value of total losses

P_O = Price of observed grade

$Q_{O\,(purchased)}$ = Total quantity purchased of observed grade

$Q_{O\,(sold)}$ = Quantity sold of observed grade

P_{nlg} = Price of next lower grades

Q_{nlg} = Quantity of next lower grades

Value of quantitative losses was estimated by the following equation:

$VQL = P_A \times Q_A + P_B \times Q_B + P_C \times Q_C + \sum (P_{nlg} \times Q_{nlg})$

Where,

VQL= Value of quantitative post-harvest losses,

P = Prices,

Q = Quantities,

A, B, C = Grades,

nlg = Lower grades

Partial losses which arise due to grade deterioration were worked out as below;

PL = ML - VQL

Where,

PL = Partial losses

Total post harvest losses were estimated by summing and adjusting the percentage of losses at each of the categories of intermediaries for the total produce.

$TL = L_{G/C} + L_W + L_R + L_C$

Where

TL = Total losses (%)

$L_{G/C}$= Losses at grower/contractor level (%)

L_W = Losses at wholesale level (%)

L_R = Losses at retail level (%)

L_C = Losses at consumer level (%)

RESULTS AND DISCUSSION

Marketing Channel of the Plum

The channel through which the plum passes from producers to consumers is the marketing channel of the plum (Figure 1). Plum fruit is demanded throughout the country while a slight share of it is also exported to the neighboring countries like Bangladesh, India, Sri Lanka, and Middle East countries. There were various channels but the most common channel was the one in which the plum reached from growers to the consumers through contractors, commission agents, wholesalers and retailers. In the other channels one or more of the intermediaries between growers and consumers were excluded. It was observed that 70% of the farmers sold their orchards to pre harvest contractors due to lack of

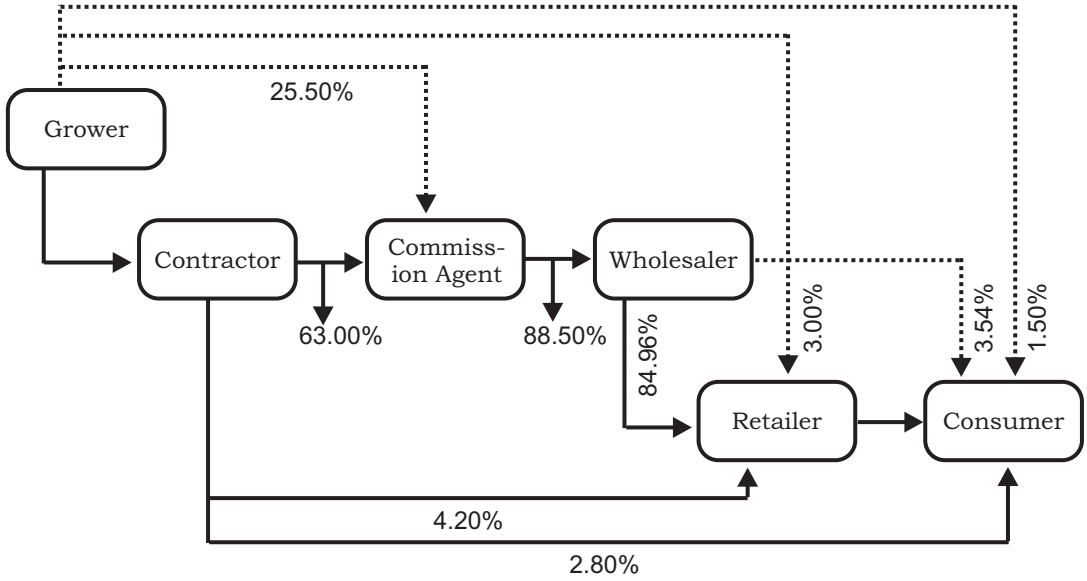

Figure 1. Marketing channel of plum

funds and management skills.

While dealing the standing orchard the contractors used to estimate the expected produce, cost on the management and the farm level losses of the fruit at different stages. Ultimate consumers got the plum in which 1.50% came directly from growers, 2.80% from contractors, 3.54% from wholesalers and 92.16% through retailers. At the retail level 3.00% of the plum reached from growers, 4.20% from contractors and 84.96 from the wholesale level. In the total of 88.50% plum at the wholesale level 25.50% came from growers and 63% from contractors through commission agents (Figure 1).

Characteristics and Practices of Farm Level Respondents

The respondents at farm level had 39.80 years of average age with 8.72 years of schooling years and 15.95 years of experience. They harvested and managed 2.25 orchards having 530 fruit bearing trees on the average. Labor skill is an important determinant of the post harvest losses and these respondents used 84% skilled labor and performed 3.7 pickings on the average. Average maturity (ripeness stage) of the plum they picked was 67.50%. They picked 34821 kg of plum on the net basis with a physical loss of 1830 kg using 24.93g of carbide per box on the average. Their average packaging cost was Rs.12 kg^{-1} of the plum. They transported their plum by 640 km, whereas the average distance of the input market was 2.62 km (Table 1).

Characteristics and Practices of Wholesale Level Respondents

Data about the personal characteristics, business volume, quality of the fruit and preferences for specific type of packaging material were taken from the wholesale level respondents. In total 40 wholesalers were interviewed who reported different characteristics. The mean age of the cardboard carton group respondents was 39.50 years with the average education and experience of 7.80 and 21.50 years, respectively. Respondents dealing in cardboard carton packed plum, examined 6% of the boxes before purchasing and dealt in 5,894 kg of A grade, 3,855 kg of B grade and 1,181 kg of C grade for a total volume of 10,755 kg with quantitative losses of 202 kg. On the other hand respondents of wooden crate group had mean age 46.60 years with education and experience of 8.25 and 21.85 years, respectively and examined 5% of the boxes. This group dealt in 5,047 kg of A grade, 5,715 kg of B grade and 1,000 kg of C grade for a total of 11,762 kg of total volume with the average quantitative losses of 357.48 kg. Difference in the losses

Table 1. Characteristics and practices of farm level respondents

Characteristics	Mean ± SD
Age (years)	39.80 ± 5.42
Education (schooling years)	8.72 ± 2.81
Experience (years)	15.95 ± 5.38
No. of orchards	2.25 ± 1.25
No. of trees / orchard	530.00 ± 502.30
Skilled labor used (%)	0.84 ± 0.11
No. of picking	3.70 ± 0.65
Maturity of fruits (ripeness stage)	0.67 ± 0.09
Net quantity (kg)	34821.00 ± 3057.00
Carbide /box (grams)	24.93 ± 18.52
Waste quantity (kg)	1830.00 ± 1796.00
Average price (Rs.)	280.30 ± 27.70
Destination (km)	640.00 ± 440.60
Cost of packaging (Rs./kg)	12.06 ± 0.93
Input market distance (km)	2.62 ± 1.61

Source: Field Survey, 2012

Table 2. Characteristics and practices of wholesalers respondents

Characteristics	Mean cardboard carton	Mean wooden crate	Mean difference	t-test
Age (years)	39.50	46.40	-6.90	1.46
Education (schooling years)	7.80	8.25	-0.45	0.44
Experience (years)	21.50	21.85	-0.35	0.09
Examined boxes (%)	0.06	0.05	0.01	1.15
Purchase qty (A -grade)	5894	5047	847	0.89
Purchase qty (B -grade)	3855	5715	-1860	1.25
Purchase qty (C -grade)	1181	1000	181	0.32
Total qty (kg)	10755.00	11762	-1007	0.45
Quantitative losses (kg)	202.12	357.48	-155.36	0.47
Losses (%)	1.77	1.27	0.5*	1.80

**** and * significant at 1%, and 10 % respectively.*
Source: Field Survey, 2012

was significant at 10% level (Table 2).

Characteristics and Practices of Retailers

Retailers are the final link between producers and consumers. One type of retailer (shopkeepers) was stationed at some specific place, while the other (hawkers) was mobile. They bought plum in auction, from whole-salers and some times in orchards from contractors/growers. They dealt in a variety of fruits but the hawkers usually deal in the seasonal fruits only. Respondents of cardboard carton group had mean age of 33.34 years, education of 4.34 years and experience of 12.75 years. They dealt in 90 kg of plum on the daily basis. Respondents of this group suffered quantitative losses of 4.5 kg on the average with the partial loss of Rs. 201 for a total monetary loss of Rs. 503. On the other hand, wooden crate group respondents had mean age of 35.31 years with 4.42 years of schooling and 13.87 years of experience. Respondents of this group examined 25% of the boxes while purchasing and kept open their shops for 13.04h daily on the average. In the total of 56 kg of daily volume, 53% was of A grade with the average physical loss quantity of 5.37 kg this observed a monetary loss of Rs. 429, whereas the value of partial losses was Rs. 125 on the average (Table 3).

Post Harvest Losses

Post harvest losses were estimated at four levels (farm, wholesale, retail and consumer).

Farm Level

Overall the post harvest losses at the farmers/ grower level were 4.85%, whereas contractors experienced post-harvest losses of 5.40%. On the average 5.12% post-harvest losses occurred at the farm level. Common reasons during harvest were misplacing the ladder/ stairs, climbing method of the pickers, bruising and injuries due to friction with the branches of fruit bearing tree, carrying basket/ crates to the pack-

Table 3. Characteristics and practices of retailers respondents

Characteristics	Wooden crate	Cardboard carton	Mean difference	t-test
Age (years)	35.31	33.34	1.97	0.66
Education (schooling years)	4.42	4.34	0.08	0.07
Experience (years)	13.87	12.75	1.12	0.51
Examined boxes (%)	0.25	0.28	-0.30	-0.55
Total quantity (kg)	56.00	90.00	-34.00	1.40
Quantitative losses (kg)	5.37	4.50	0.87	0.72
Losses (%)	10.92	6.54	4.38***	5.36
Value quantitative losses (Rs.)	303.00	332.00	-29.00	-0.32
Monetary losses (Rs.)	429.00	533.00	-104.00	-0.72
Partial losses (Rs.)	125.00	201.00	-76.00	-1.15

**** significant at 1% level*
Source: Field Survey, 2012

ing site and hasty packing by the packers. Fruit fall in plum is more because of the long and thin pedicel which sets in vibration in the tree due to placing of stairs. Farmers and contractors if act wisely and handle the orchards with care reduce the post harvest losses to a great extent. Education and experience increase know how and familiarity with the best practices which in turn reduce the magnitude of farm level losses. Experience of the labor and ripeness of the plum greatly affect the post harvest losses. The magnitude of post harvest losses can be reduced by 5-9% if harvested in proper maturity (Arazuri et al., 2006 and Buyukbay et al., 2011). At over maturity the fruit becomes easily susceptible to mechanical injuries, ruptures and cannot be packed due to their bad effect on the healthy fruits in the box (Table 4).

Wholesale and Retail Level

At the whole sale level percentage of quantitative loss was 1.52% and 1.44% of the total produce. On the overall basis wholesalers faced monetary loss of 1.7 and partial loss of 0.49%. The reason of these losses were the poor transport, pressing the boxes while nailing, injuries due to friction with the strips, tearing of cartons, mishandling by the labors, filling of bruised and infected fruits in the box, lack of cold storage facility and the fear of remaining unsold. At the whole sale level factors like experience, cold storage facility, examination boxes, dealing in good grades of fruits and labor skill can reduce the extent of post harvest losses. At the retail level the extent of quantitative losses was estimated to be 6.75%. After adjustment for the

Table 4. Farm level post-harvest

Type of respondent	Percentage of losses
Farmer	4.85
Contractor	5.40
Overall	5.12

Source: Field Survey, 2012

Table 5. Post-harvest losses at the wholesale and retail levels

(%)

Type of respondent		Physical losses	Monetary losses	Physical losses	Partial losses
Whole saler	%	1.52	1.73	1.24	0.49
	% of TP	1.44			
Retailer	%	6.75	9.55	6.30	3.25
	% of TP	6.31			

Source: Field Survey, 2012; TP = Total produce

post harvest losses, retail level were estimated to be 6.31% of the total produce. Monetary losses of 9.55% and partial losses of 3.25% occurred at this level. Reasons of losses at the retail level were not only related with the retailers but malpractices of other levels also had their effect in enhancing the magnitude of post-harvest losses, as if good quality fruits come from the farm level, less will be the losses (Murthey et al., 2007). Low quality of the plum, susceptibility to heat, lack of proper storage and dealing in more than the demand in quantity are the main reasons of the post harvest losses at the retail level (Table 5).

Total Post-harvest Losses

The overall magnitude of post harvest losses was 21.51% comprised 5.12% at the farm level, 1.44% at the wholesale level, 6.31% at the retail level and 8.64% at the consumption level. If the magnitudes are added only, with out adjustment for the losses at the previous levels, then magnitude of post-harvest losses will get overstated to 23.31% (Table 6). Overall 23.81% of the total losses occurred at the farm level, 6.69% at the wholesale level, 29.34% at the retail level and 40.16% of the total losses occurred at the consumer level. According to studies reporting the post harvest losses during and after harvest were 23% in peach (Khan et al., 2008), 28.84% in banana (Murthey et al., 2007) and 20% in tomato (Rehman et al., 2007). Literature revealed about 50% of the losses in fresh fruits and vegetables (Troger et al., 2007).The reasons of difference in the magnitude of post harvest losses were differences in the nature of fruits and improvement in the harvesting practices with the passage of time. There are also differences in the supply and demand of different fruits and plum is a minor fruit as compared to citrus, mango, dates and guava and is demanded throughout the country and they are sold in fresh form mostly within 5 days of their arrival in the market (Table 6).

RECOMMENDATIONS

The study was conducted to estimate post harvest losses of plum in Swat district. The losses have been estimated by percentage method at different level. The overall losses of 21.51% farm level share accounted for 23.81%, wholesale level for 6.69%, retail level for 29.34% and consumer level for 40.16%. At the farm level the reasons of losses were placing stairs

Table 6. Overall post-harvest losses of plum

Respondent category	Post-harvest losses (%)	Post-harvest losses (% age of total produce)*	Share of different categories (%)
Farm	5.12	5.12	23.81
Wholesale	1.52	1.44	6.69
Retail	6.75	6.31	29.34
Consumer	9.92	8.64	40.16
Total	23.31	21.51	100.00

Base has been reduced to 100 percent losses at the previous levels

in inappropriate manner, climbing method of the pickers on stairs, over maturity, shaking in the baskets while carrying the plum from tree to packing place, heaping of the fruits on the tarpaulin without any cushioning and hasty packing. Reasons of the wholesale level post harvest losses were poor transport, pressing the boxes while nailing, injuries due to friction with the strips, tearing of cartons, mishandling by the labors, lack of cold storage facility and the fear of remaining unsold. At the retail level reasons of the losses were malpractices at the previous levels (farm and wholesale), low quality of the plum, susceptibility to heat, lack of proper storage and dealing in more quantity than the demand are the main reasons of the post harvest losses at the retail level. Following are the recommendation to reduce the extent of post harvest losses.

- Application of recommended inputs in sufficient quantity and focus on pre harvest management by farmers and contractors.
- Government may provide cold storage facility in the plum producing areas.
- Agricultural research organization and NGOs may provide training on post- harvest management.
- Farmers and contractors should harvest the plum at proper maturity (ripeness).
- Farmers and contractors may provide incentives to labors for reducing the losses of the plum.
- Fruit should be packed in the box directly from the basket or crate used for collecting the plum from the trees.
- Scientists and researcher should develop proper maturity index and guide the farmers and contractors with expected shelf life of each index.
- Proper grading should be performed before packing.
- Same quality of the fruits should be packed throughout the box.
- Processing facility for value added products of the plum should be provided in the plum intensive areas.

LITERATURE CITED

Adeoye, I.B., O.M.O. Odeleye, S.O. Babalola, and S.O. Afolayan. 2009. Economic analysis of tomato losses in Ibadan Metropolis, Oyo States, Nigeria. Afri. J. Basic and Appl. Sci. 1(5-6):87-92.

Admassu, S. 2003. Post harvest

sector challenges and opportunities in Ethiopia. Ethiopian Agricultural Research Organization. Addis Ababa, Ethiopia.

Arazuri, S., C. Jaren, J.I. Arana, and J.J.P.D. Ciriza. 2006. Influence of mechanical harvest on the physical properties of processing tomato. J. Food Eng. 80:190-198.

Aujla, K.M., M. Abbas, K. Mahmood, and S. Saadullah. 2007. Marketing system of fruits, margins and export potential in Pakistan, Pakistan. J.Life Soc. Sci. 5(1-2):34-39.

Buyukbay, E.O., M. Ozunoz, and H.S.G. Bal. 2011. Post-harvest losses in tomato and fresh bean production in Tokat province of Turkey. Scientific Res. and Essays. 6(7):1656-1666.

Gangwar, L.S., D. Singh, and D.B. Singh. 2007. Estimation of post harvest losses in kinnow maindrain in Punjab using a modified formula. Agric. Econ. Res. Rev. 20:315-331.

GoP., 2009. Agricultural Statistics of Pakistan. District wise Area and Production of Plums. Economic Wing, Islamabad. p.190-191.

Gunnes, M. 2003. Some local plum varieties grown in Tokat province. Pakistan J. Appl. Sci. 3(5):291-295.

Kader, A.A. 2005. Increasing food availability by reducing post harvest losses of fresh produce, Proc. 5th Intern. Post Harvest Symp., Acta Hort. p . 682.

Khan, M., T. Rahim, M. Naeem, M.K. Shah, Y. Bakhtiar, and M. Tahir. 2008. Post harvest economic losses in peach production in district Swat. Sarhad J. Agric. 24(4):705-711.

Liu, F.W. 1990. Post harvest handling of horticultural crops in Asia. Department of Horticulture National Taiwan University.

Muhammad, S. 2012. *Umoor-e-baghbani* (an urdu publication), Kitab Markaz Publisher, Faisalabad.p .173-177.

Murthey, D.S., T.M. Gajnani, M. Sudha, and V. Dakshinamoorthy. 2007. Marketing losses and their impact on marketing margins. A case study of banana in Karnataka. Agric. Econ. Res. Rev. 20:47-60.

Rehman, M., N. Khan, and I. Jan. 2007. Post harvest losses in tomato crop. A case study of Peshawar valley. Sarhad J. Agric. 23(4):1279-1283.

Shah, N.A., and U. Farooq. 2006. Post harvest loss: Management and environmental conditions. The daily NEWS (Accessed on www.parc.gov.pk/articles/post harvest loss. html on November 2013).

Troger, K., O. Hensel, and A. Burkert. 2007. Conservation of onion and tomato in Niger. Assessment of post harvest losses and drying methods. Conference on International Agricultural Research for Development, University of Kassel-Witzenhausen and University of Gottingen.