USAID FIRMS PROJECT

Feasibility for Establishing Cold Storage Facility for Fruits in Multan

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Abstract

Post-harvest losses of fresh produce have become an issue in all the countries in general and in developing countries in particular. In Pakistan, these losses are reported to be very high but no specific reference on the subject, giving detail and magnitude of these losses with respect to major commodities, could become available. Few studies explain the status of one or two commodities but in depth, analysis of the situation could not be found. This report identifies the magnitude of post-harvest losses of fruits and vegetables, with specific reference to fruit and vegetable market, Multan, occurring due to mandi operations. For this, commodities arriving the market were evaluated, first on their arrival and then at wholesale level.

Utility of cold storages, in reducing the post-harvest losses, is an accepted fact. Status of cold storage facilities, presently available in Multan, and commodities being stored, were evaluated through personal visit of all the stores. Feasibility for establishing a cold store, keeping in view the weaknesses of present cold stores, has also been provided in the report. Mango being an important fruit of the area was studied in detail, with respect to post-harvest losses, from the point of harvest up to wholesale level. Causes and reasons of losses and their magnitude were assessed to make recommendations for the improvement of situation. Information regarding commission agents working in the market was obtained and their role in the functioning of market was also explained. Volume of commodities arriving in the market was estimated to quantify the losses in physical as well as in monetary terms.

Finally, important findings regarding post-harvest losses in fruits and vegetables, cold storage facilities, mandi operations, losses in mango and arrival of commodities were made and necessary recommendations, for the improvement of affairs, were also made part of the report.

Acronyms

APO	Asian Productivity Organization
F&V	Fruit and Vegetable
Mandi	Wholesale Market Place
PHC	Pre-Harvest Contractor
Pharia	Wholesaler in the Market
Ladania	Trader-Supplying Produce from One Market to Another
SOW	Scope of Work

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Executive Summary

Losses of horticultural produce are a major problem in the post-harvest chain. Post-harvest losses of fruits and vegetables in the country are high enough, and the causes of these losses are so diverse, that a great deal of research and training is needed if prevention measures are to be improved. According to Asian Productivity Organization (APO) these losses range from 30-40% in developing countries.

For the evaluation of the situation and to figure out the measures for its improvement, present study was conducted in District Multan and its fruit and vegetable market. Assessment of post-harvest losses, which occur due to mandi operations, was done for the commodities currently arriving in the market. For the purpose commodities under study were evaluated, with respect to the losses, first on their arrival in the market and then at wholesale level (table- 2 & 7). Information regarding arrival timings of the commodities, place of origin, auction timings and about disposal pattern of the commodities was also obtained (Table 1 & 6). Handling practices within the mandi were also noted.

Based on post-harvest losses of fruits and vegetables, magnitude of monetary loss was also estimated (Table 3 & 8).

Mango, being the main fruit of the area, export of which is showing an increasing trend, was studied in detail from the point of its origin (harvest) up to wholesale level. For this purpose three mango orchards were visited to witness the harvesting, packing and transportation activities. Pre-harvest contractors and labor doing the job was evaluated with respect to their knowledge about harvesting and handling practices. Vigilance of pre-harvest contractor in supervising the process and its impact on the magnitude of losses was also viewed critically (table- 4). Assessment of produce loss and its causes was made at each stage (table - 5).

Cold storage plays an important role in reducing the post-harvest losses. The main focus of the study was to see the feasibility of establishing a cold storage facility for fruits in Multan and its impact on reducing the losses. For this it was necessary to see the status of cold storage facilities presently available in Multan. All the cold stores in Multan were visited to get the information regarding their storage capacity, technology under use, temperature control methods, commodities presently being stored, their seasonality, period of storage and charges for storage (table 9 &10). In the light of above, recommendation was made for a better and improved facility of cold storage at Multan.

Survey of commission agents working in fruit and vegetable market was also conducted to get information about their business practices and specialization in the export of commodities, if any.

To determine the magnitude of post-harvest monetary loss, it was necessary to estimate the quantum of commodities arriving in the market in a year. For this, required information was collected from the weigh bridge installed at the entry point of mandi and was compiled.

Feasibility for establishing a modern cold store, with all the required facilities, and its impact in reducing the losses was also prepared and made part of this report.

Some of the major findings of the study are summarized as under:

There was little awareness among the commission agents and wholesalers (pharias), working in mandi, about the proper handling of produce. Commission agents were found least concerned

about the handling practices in the mandi as they know that the platform will be cleared at the time of auction and any damage caused will not affect their business.

Big fruit and vegetable markets, like one in Multan, also serve as feeding markets to the smaller markets in the adjacent areas.

It was found that there is a buyer for each category and quality of produce. Mandi is cleared every day, it is very rare that something is left unsold, particularly at commission agents' level but it includes distress selling due to non-availability of proper and convenient cold storage facility..

About 50% of produce arriving in any large market, is purchased by the ladania (trader) who takes it to other adjacent markets to meet the demand there. The retailers directly purchase only about 5 to 10% of produce arriving in the market. Mostly the retailers make their purchases from the wholesalers (pharias).

Arrival of any commodity in the market is planned by the supplier to reach the market just before the auction time, so that it may reach the consumer in the shortest possible time to avoid any loss.

It is important that anything which reaches the market should be disposed of/sold within the specified time frame, otherwise it losses freshness/quality and any delayed sale is at a much lower price which leads to distress selling at commission agents' level.

Belly packing in case of mango is common and is a major cause of post-harvest loss in the shape of pressed fruits.

Bananas are transported without introducing any packing system. Bunches are then dumped on each other in the truck as a result post-harvest losses during transportation are high.

In case of fruits highest post-harvest loss, up to wholesale level, was noted in bananas (16.40%) followed by grapes (13.26%) and plums (11.90%).

In case of vegetables maximum post-harvest loss was recorded in tomatoes (14.92%) followed by potato fresh, coming from Northern Areas, (12.70%) and bringel (12.65%).

An annual post-harvest monetary loss of rupees 295.54 million in case of fruits and rupees 517.4 million in case of vegetables was recorded, (total rupees 812.94 million), only with respect to the commodities under study in this report, arriving in fruit and vegetable market Multan. From this, one may very well imagine about the magnitude of monetary losses if all the commodities and markets are taken into account.

The farmers sell more than 90% mango orchards to the pre-harvest contractors. Pre-harvest contractor is the key person in the supply chain of mango (in other fruits also) as he is connected with both, supply and demand, ends of chain.

Most of the problems, related to post-harvest life of the produce, originate from the point of harvesting and packing.

Maximum post-harvest loss in case of mango (32.35%) was noted to be because of physically pressed fruits followed by sap contaminated (17.65%).

Cold storage facilities presently available in Multan district are of traditional type, established mainly for few selected commodities, which include potato, apple, banana, pomegranate, etc. and lack basic facilities like thermostat based temperature control and without any relative humidity control equipment. 50% of the cold stores do not have their own generator as alternate arrangement in case of electricity failure.

People operating the cold stores have little awareness about storage potential and temperature and relative humidity requirements of different commodities as a result capacity are underutilized. The cold store situated near to the fruit and vegetable market Multan was found storing maximum number of commodities only due to advantage of access by the mandi people. It highlights the need of establishing a proper cold store, with all facilities, in the market vicinity. There are 201working commission agents in fruit and vegetable market Multan dealing in fruits and vegetables. Only one commission agent (Sabri & Co.) is an exporter of fruits – mainly of citrus and mangoes.

There was an arrival of 16, 20, 25,000 kgs of fruits and 37, 77, 40,500 kg of vegetables in fruit and vegetable market Multan, during the period from July 2009 to June2010.

With respect to arrival of commodities in the market, banana stood at number one position in fruits and potato in vegetables with a total arrival of 2, 93, 00,000 kgs and 4,86,61,000 kgs, respectively, during the period mentioned above

1. Introduction

1.1 Background

Pakistan has been blessed with diverse agro climatic conditions favoring production of a variety of fruits and vegetables. Total production of fruits and vegetables in Pakistan is 13.21 million tons (2008-09) out of which share of fruits is 7.05 million tons and that of vegetables is 6.16 million tons. Fresh fruits and vegetables are inherently perishable. During the process of distribution and marketing, substantial losses are incurred which range from a slight loss to total spoilage. The fruit and vegetable sector has a vital role in farm income enhancement, poverty alleviation, employment generation, food security and sustainable agriculture. Economic growth, rise in income levels and change in dietary patterns have made both the production and consumption of fruits and vegetables increasingly important. This sector, however, suffers greatly from postharvest losses. According to Asian Productivity Organization (APO), some estimates suggest that in developing countries about 30-40% of fruits and vegetables are lost or abandoned after leaving the farm gate. Postharvest management determines the food quality and safety, competitiveness in the market, and the profits earned by producers. The postharvest management of fruits and vegetables in the country is far from satisfactory. The major constraints include inefficient handling and transportation, poor technologies and inadequate facilities for storage, processing, and packaging; involvement of too many diverse actors; and poor infrastructure. Huge postharvest losses result in diminished returns for producers, waste of food, resources and human effort. In addition to that it also leads to rejection of fruit and vegetable consignments in international markets due to quality deterioration or not meeting the required standards. Further, as fresher fruits and vegetables are needed to supply the growing population, as more produce is transported to non-producing areas, and as more commodities are stored longer to obtain year-round supply, postharvest loss prevention technology measures become paramount. So, it is evident that the only way to cope with the present situation is to give a massive thrust to reduction of postharvest losses in order to make available more food from the existing level of production. Most of the problems relating to marketing of fruits and vegetables and high postharvest losses can be traced to their perishability. Perishability is responsible for high marketing costs, distress selling which leads to market gluts, price fluctuations and other similar problems. At low temperatures, perishability is considerably reduced and the shelf life is increased. To achieve this, cold storage of fruits and vegetables is the only solution.

1.1.1 Status of Cold Storage and Its Potential

Cold storage reduces the rate of biochemical changes in fresh foods (known as ‘respiration’ and ‘senescence’) and also slows down the growth of contaminating micro-organisms. The reason for storing fruits and vegetables in a cold store is therefore to extend their life beyond the harvest season. This may be because they can achieve a higher sale price out of season or at some later stage or for food security reasons but the strongest motive behind storage of any commodity, by the private people, is profit earning. However, cold storage is expensive – both in terms of establishing the store and the operating costs. Therefore, it is essential that this is only considered where the expected sale price of the stored commodities justifies their storage. The cold storage facilities now available are mostly for single commodity like potato, orange, apple, banana, pomegranate, etc. which results in poor capacity utilization. Living foods such as fruits

and vegetables have some natural protection against the activities of microorganism. The best method of preserving these items is to keep the product alive and at the same time retard the natural enzyme activity, which will retard the rate of ripening and maturity.

The factors that control the shelf life of fresh crops in cold storage include:

- The type of food and variety or cultivar.
- The part of the crop selected (the fastest growing parts have the highest respiration rates and the shortest storage lives).
- The condition of the food at harvest (the presence of damaged or microbial contamination, and the degree of maturity).
- The temperature during harvest and storage.
- The relative humidity of the storage atmosphere, which also influences weight loss due to drying out.
- The composition of storage atmosphere

1.1.2 Perishability and Food Loss

All fruits, vegetables and root crops are living plant parts containing 65 to 95 percent water, and they continue their living process after harvest. Their postharvest life depends on the rate at which they use up their stored food reserves and their rate of water loss. When food and water reserves are exhausted, the produce dies and decays. Anything that increases the rate of this process may make the produce inedible before it can be used.

1.1.3 Definition of Terms

It is necessary to define exactly what it means by the term “postharvest food loss” if we are going to have a manageable problem with known boundaries.

“POSTHARVEST” refers to the moment of separation of the edible commodity from the plant that produced it by a deliberate human act with the intention of starting it on its way to the table. The postharvest period ends when the food comes into the possession of final consumer.

“FOOD” means weight of wholesome edible material that would normally be consumed by humans. Inedible portions such as skins, stalks, leaves and seeds are not food.

“LOSS” means any change in the availability, edibility, wholesomeness or quality of the food that prevents it from being consumed by people

1.1.4 Cause of Loss

The cause of losses in the postharvest food chain can mainly be classified into two groups

1.1.4.1 Primary Causes of Loss

Primary causes are those that directly affect the food which include biochemical, microbiological, chemical, biochemical reactions, mechanical, physical, physiological and psychological.

1.1.4.2 Secondary Causes of Loss

Secondary causes of loss are those that lead to conditions that encourage a primary cause of loss. They are usually the result of inadequate or non-assistant capital expenditures, technology

and quality control. It includes inadequate harvesting, packaging and handling skills, lack of inadequate containers for the transport and handling of perishables, storage facilities inadequate to protect the food, inadequate transportation to move the food to market before it spoils, inadequate refrigerates storage, traditional and inadequate processing and marketing systems and finally the bumper crop overload the postharvest handling system and exceed the consumption need and cause excessive wastage.

1.1.4.3 Sites of Loss

Losses may occur anywhere from the point where the food has been harvested or gathered to the point of consumption. For the sake of convenience it can be broken down into the following

1.1.4.3.1 Harvest

The separation of the commodity from the plant that produced it. In case of roots, tubers and bulbs the commodity is lifted out of the soil.

1.1.4.3.2 Preparation

The preliminary separation or extraction of the edible from the non-edible portion, e.g., the peeling of fruits and vegetables.

1.1.4.3.3 Preservation

Preservation is the prevention of loss and spoilage of foods. For example the sun-drying of fruits, the use of refrigeration and the use of fungicide to inhibit mold growth in fruits.

1.1.4.3.4 Processing

Processing is the conversion of edible food into another form more acceptable or more convenient to the consumer, for example the manufacture of fruit juice and the canning of fruits and vegetables.

1.1.4.3.5 Storage

Storage is the holding of foods until consumption. Most storage is common storage (ambient temperature) but there are extensive storage capacities that can hold food under refrigerated or controlled atmosphere conditions.

1.1.4.3.6 Transportation

All forms of transportation used to convey foods from the point of production to the ultimate point of consumption.

2. Methodology and Coverage

The challenge of this consultancy, defined in the SOW, was “to estimate post-harvest losses of fruits and vegetables in fruit and vegetable market Multan, occurring due to “mandi” operations and in the light of that to see the feasibility of establishing a cold storage facility in the vicinity of market and to evaluate its impact in reducing the losses.

The final report should also include:

- Post-harvest loss assessment in case of mango from the point of its harvest up to the level of wholesaler (pharia) in the market.
- Current status of cold storage facilities in Multan and type of commodities presently being stored in the cold storages.
- Survey of commission agents working in the market.
- Evaluation of quantum of commodities coming into the market.
- Recommendation regarding use of modern technologies in the establishment of cold store.
- Feasibility for Establishing a Cold Storage Facility

2.1 Estimation of Post-harvest Losses of Fruit and Vegetables

The study was conducted with reference to Multan district and its fruit and vegetable market. Postharvest losses occur throughout the supply chain from the point of harvesting/picking till it is consumed by the ultimate consumer. There appears to be no established, generally accepted, methodology for determining post-harvest losses of fresh produce. At whatever level of precision postharvest loss is determined the value will be specific in time and location. This is due to the fact that loss is function of the condition of the material, the prevailing environment, the nature and intensity of bio-degenerating organisms and the crop material management. In the supply chain the product passes through different hands and at every step it needs to be dealt with lot of care being a living part of the plant and usually containing 65 to 95 percent water. There are some pre-harvest issues which subsequently result in food loss which include cultural practices, fertilization, irrigation and some disease attack. Then is the harvesting/picking stage at which if carelessness is shown it results in big post harvest losses. Proper packing technique and material used for the purpose is also very important because the produce is to be transported to distant markets. Any improper packing (like belly packing most common in case of mangoes) or use of poor quality packing material may result in big loss of the produce and its effects keep on appearing throughout the chain till it is consumed or thrown away. Transportation is also an area where chances of occurring of loss are high. Mostly during transportation the product is overloaded to minimize the transportation cost which ultimately results in product loss specifically in the lower layer of the produce. Any technical fault during transportation or rainfall on the produce may result in huge loss. It is particularly important in case of the produce coming from remote areas like tomatoes presently coming from Peshawar, peaches and plum from Swat and such other commodities coming from Sind and Baluchistan. One such incidence was physically witnessed when a tomato consignment, coming from Peshawar, was delayed by one day, due to technical fault, and could not reach at the auction time. More than 80% of produce was lost. It is usually beyond the human control but such incidences are common.

The supplier, to reach just before the auction time so that it may reach the consumer within the minimum possible time, usually plans arrival of produce in the mandi. For the estimation of

postharvest losses at mandi it was necessary to evaluate the produce status on its arrival at mandi. For the purpose of fruits and vegetables, currently arriving from different areas, were evaluated on their arrival to see the status of losses. The dealing person (commission agent) was interviewed, through a questionnaire, to get the other relevant details like origin of the produce, arrival and auction timings, disposal pattern i.e. the types of buyers, percent of produce purchased by the traders from other markets and by the wholesalers from the same market who keeps the produce within the market for its onward sale to retailers and others. Their views regarding present cold storage facilities and any improvements required were also recorded. Awareness regarding storage potential of different commodities and current storage practices was also recorded.

The main buyer in the mandi, who makes his purchases from the commission agent and keeps the commodities within the mandi for their onward sale to different buyers, is the wholesaler (pharia). His role was to be critically viewed as he is the only person in the mandi who owns/retains the commodity for some time and if there were some losses at mandi those can only occur at this stage. Commodities, currently arriving in the mandi, were further evaluated at wholesalers' level to see if there is any change with respect to the losses. Wholesalers (pharias) dealing in different commodities were interviewed, through a questionnaire, to get other relevant information regarding his purchase timings, mode of taking the produce to his selling place, any value addition made at his level, disposal pattern of the produce and also about the quantity left unsold.

2.1.1 Limitations

Scope of Work states the post-harvest losses to be estimated which occur due to mandi operations i.e., the losses that occur from the point of arrival of produce in the market till it is disposed of and goes out of the market. It just shows a part of the process and does not explain in detail the causes and magnitude of losses for the total supply chain. For proper estimation of post harvest losses, detail study, of selected commodities, from the point of harvest to the retail level, is necessary to be conducted to get a clear picture of the situation.

Feasibility of establishing a cold store was proposed to be studied with respect to the losses, which occur within mandi due to mandi operations. The losses so estimated are of small magnitude and if the feasibility is seen only in the light of these losses, the cold store facility may not appear feasible. Cold store is a commercial enterprise and its establishment needs to be evaluated in the light of total business potential available.

2.2 Post-Harvest Loss Assessment in Case of Mangoes

Multan is mainly a famous mango producing area, which is an important fruit of the season for domestic consumption as well as for export. Its supply chain was studied in detail from the point of its harvest up to the level of wholesaler (pharia) in the market. For the purpose mango, farms were visited to see different practices at the harvesting and packing level. Then it was evaluated on its arrival in the market and at wholesale level to see the total postharvest losses up to that level.

2.3 Current Status of Storage Facilities in Multan and Types of Commodities Presently Being Stored in the Cold Storage

Information regarding total number of cold storages working in Multan district was collected from different sources and all the cold storages were visited to get the required information through a questionnaire. Information about commodities currently being stored and awareness of the relevant people regarding the subject was also assessed. Current status of technology under use was also seen.

2.4 Survey of Commission Agents/Wholesalers Working in the Market

A survey of commission agents working in the market was conducted to get different information about their business.

2.5 Evaluation of Quantum of Commodities Arriving in the Market

Normally it is difficult to collect information pertaining to different commodities with multiple origins, arriving at different timings. No record of arrivals is maintained at any level in the mandis. Fortunately, there was a weighbridge at the entry point of mandi. Everything entering the market is weighed and its detail is recorded. The required information was compiled from the available record.

2.6 Feasibility for Establishing a Cold Storage Facility

Feasibility for establishing a cold storage facility, near fruit and vegetable market, was prepared by Mr. Ali Khan, Finance Specialist, USAID FIRMS Project. He was provided with the basic information, for the preparation of feasibility, collected through the survey of cold storages presently working in Multan.

3. Results and Explanation

3.1 Post-Harvest Loss Assessment at Mandi

Being a focused district of USAID FIRMS Project, the study was conducted in Multan and its fruit and vegetable market. Required information was collected from fruit and vegetable market, cold stores and mango orchards in Multan district during the period from 05.07.2010 to 30.07.2010. Postharvest loss assessment of any commodity generally starts from the point of its harvesting/picking and the total supply chain is observed with respect to the handling practices and loss assessment at each stage. In the present study, as the focus was to observe the post harvest losses of various commodities, presently arriving in the fruit and vegetable market Multan, which occur due to the mandi operations, a detailed analysis of the pattern/timings of arrival of the produce, its auction and disposal time, disposal pattern, types of buyers and the percent of produce which remains in the market and that which instantly goes out of the market, was conducted. Disposal pattern of different commodities, shown in table 1 and 6, is time specific and keeps on changing with the change in arrival pattern of produce. Purpose was to see what percentage of the produce remains within the market and for how long and what mandi operations are conducted during the process.

Table 1 Arriving and Disposal, Pattern of Fruits

Sr. No.	Commodity	Origin	Arrival Time	Auction Time	Selling Time of Wholesaler/ Stay of Produce in the Market	Disposal pattern of produce (Percent purchased by)		
						Whole Saler	Trader	Retailer
01	Apple	Baluchistan	Up to 4 PM also at night	4 PM & 6 AM	6-10 AM/ 14-18 Hrs.	40	55	5
02	Peaches	Swat	Up to 4 PM also at night	5 PM & 6 AM	6-10 AM/ 14-18 Hrs	40	55	5
03	Plum	Swat	Up to 4 PM also at night	5 PM & 6 AM	6-10 AM/ 14-18 Hrs	40	55	5
04	Banana	Sind, Ali Pur	Any time	Morning	-	5	20	70
05	Grapes	Quetta	At night	7-9 AM	8-10 AM/ 8-10 Hrs.	20	60	20
06	Pomegranate	Ali Pur	Up to11 PM	4 AM	5-10 AM/ 6-10 Hrs.	65	25	10
07	Mango	Local Multan	At night	8-11 AM	6-10 AM/ 4 - Days	25	50	25

Source: Based on Survey of the Markets

3.2 Post-Harvest loss Assessment of Fruits

Postharvest loss assessment of any commodity is a tedious job as it is mainly done on the basis of personal observation at the spot and one has to decide about the fate of the produce i,e., whether to place the commodity in the category of clean and edible or to declare it a loss. The decision depends on how you define the loss and the acceptability of the produce by the people. A specific commodity in its particular state may be declared a loss in the developed countries because its acceptability by the people may be zero while in the developing countries, like Pakistan, it may not be declared a loss because it has the acceptability of being eaten by the people. In Pakistan, there is a buyer for each category and quality of produce. Only the completely rotten fruits or vegetables are discarded or thrown away. Most of the commodities are graded and marketed in different categories depending on their quality. The best quality produce is graded as A and remaining as B and C. Grading is done based on quality and size. Losses in case of A category produce are very low as compared to B and C category. The assessment of loss was made based on type and quality of commodities reaching the market. It is very likely that the worst part of the commodity might have been disposed or marketed locally at the time of harvest. Further, at retail level there are significant losses. So estimation of losses made in this study should not be taken for the total supply chain as these are specific to the quality of commodities arriving the market and were estimated up to wholesale level. Assessment of loss for different categories of produce was made separately and a cumulative loss for a specific commodity was calculated based on percent share of each category in the total arrival of the commodity in the market. At market level little changes were observed in the quality of produce as the stay of commodities in the market, purchased by the wholesalers, is just for few hours. Major cause of loss in the market at wholesale level is the quantity left unsold. It does not happen very often because the wholesaler tries his level best to sell the total quantity purchased. But due to some reasons like little buyer turn out, rainfall or poor quality of produce purchased, some part is left unsold. Major part of that unsold commodity goes waste or is sold at much lower price next day. At commission agents level total arrival of any commodity is sold during auction. It is very rare that something is left unsold. Even in case of over-supply of any commodity, commission agents make their best effort to dispose off the total arrival even if it is sold at a lower price (distress selling) because of the fear of product loss due to deterioration in quality next day as there is no reliable and convenient cold storage facility or competition with fresh arrival of the same commodity next day or overheads involved. A commodity wise assessment of loss is given below:

3.2.1 Apple

Presently the variety of apple arriving in the market from Quetta was Gaja. It is packed in wooden crates of approximately 18 kg capacity and transported through trucks. A truck load carriers around 800 crates. It takes 20 hours to reach the market. First auction is done in the evening and second in the morning. Maximum stay of the commodity in the mandi was estimated to be from14 to 18 hours. There are many categories of the produce. Minor losses were observed in the best category while as the category of produce goes down the ratio of losses goes up. The disposal pattern of the produce shows that the wholesalers purchased only 40 percent of the produce, arriving the market,, which remains within the market, for its onward sale to the retailers. While the traders (in local language called ladania) purchased 55 percent who takes the produce to other smaller markets to meet the demand there and only 5 percent was purchased directly by

Figure 1 Different Varieties of Apple

the retailers from the commission agent. Post-harvest losses on the arrival of produce at mandi were estimated to be 8.70 percent while up to wholesale level these were recorded to be 10.20 percent showing a net loss of 1.5 percent at wholesale level. The losses on the arrival of produce were mainly due to rotten fruits in the lower category or due to physical damage caused during packing and transportation. While the losses at wholesale level were because of increase in quantity of rotten fruits, some physical damage due to improper handling and because of the quantity of fruit left unsold. Out of the unsold fruit, major part goes waste and remaining is sold at much lower price.

Apple has the storage potential and it can be stored for about six months. The varieties stored are Kala Kullu and Safaida. An early variety of apple “Gaja” is also stored during the season for a short time for instant monetary gains.

3.2.2 Peach

Peaches were found to be coming from Swat. Produce was packed in cardboard crates of around 8 kg capacity. Mode of transport used for transporting the commodity from the producing area to the market was trucks. A truck load carries 1000 to 1200 crates. It takes 24 hours to reach the market. There are mostly two or three categories of produce arriving in the market. Category A constitutes about 70 percent of the total arrival while the lower categories constitute 30 percent. Commodity is auctioned twice firstly in the evening and secondly in the morning. Disposal of the produce is same as in case of apple i.e., 55% by trader (ladania) and 5% by the retailer purchase 40% by the wholesaler Total stay of the produce in the market, purchased by wholesaler, was estimated to be 14 to 18 hours as the wholesaler completes his selling up to 10 AM. Quantity purchased by the traders and retailers is instantly taken away. It is very rare that some quantity of the produce, arriving in the market, is left unsold at commission agent level.

Figure 3 Varieties of Peaches

Figure 2 Damaged Fruits

After the introduction of improved grading and packing practices for the fruits, coming from northern areas, the quality of fruits arriving the markets has improved. Minor or almost no post harvest losses were observed in the best category of produce. In the lower categories high losses were observed. Post-harvest losses on the arrival of produce at mandi were estimated to be 7.94 percent while up to wholesale level these were recorded to be 9.56 percent showing a net loss of 1.62 percent at wholesale level. Losses on the arrival of produce were because of some diseased and physically damaged and pressed fruits while at wholesale level these were because of careless handling, repacking and sometimes because of left over stocks.

3.2.3 Plum

Point of origin of plum was also Swat. Produce was found coming in different packaging and in different weights. Smaller packs carrying around two kg fruit were of cardboard and larger packs with ten kg capacity were made of wood. Some medium size cardboard crates, with a capacity of 6-7 kg fruit, were also found being used for the purpose. There were about three categories of fruit. In smaller packs, best quality fruit is packed with almost no damaged piece while in

larger packs the ratio of damaged/diseased fruits was high. Number of crates per truckload varies depending on the size of the crates. 24 hours is the total traveling time of truck from the point of origin to the market. Wholesaler purchased 40% of the total quantity arriving in the market while trader (ladania) and retailer purchased 55 and 5 percent respectively. Wholesaler takes the commodity purchased to his selling place through labor that carries it on their heads or back. Handling of produce by labor was not careful. The damage caused during handling does not appear instantly but it appears as the time passes. Total stay of the produce in the market, purchased by wholesaler, was estimated to be 14 to 18 hours. Post-harvest losses on the arrival of produce in mandi were estimated to be 9.88 percent while the losses, which occur in the mandi at wholesale level, were estimated to be 2.02 percent. It makes the total post-harvest losses of 11.90 percent up to wholesale level

3.2.4 Banana

Main producing areas of banana in Sindh include Khair Pur, Mir Pur Khas, Sukkur and Hyderabad. In Punjab banana is produced in Ali Pur but the quality of produce is not as good as that of Sind. Banana is harvested in its green form and is transported to its destination markets direct from the field. Trucks are the mode of transport. It takes about 24 hours to reach the truck from the producing area to the market. Bananas are transported without introducing any packing system. Bunches are simply dumped in the truck on each other. One truckload carries about 250 mounds of unripe banana, which comprise of about 900 to 1000 bunches. During transportation, 10 percent bunches in summer and 2 percent in winter ripens which are sold at 10% price. Total effect of all the above-mentioned factors accounts for 9.1 percent post-harvest loss as the produce reaches the market. Then the bananas are placed in cold store for ripening. It takes 5-6 days in summer and 12-13 days in winter to ripen the fruit. During the ripening process post-harvest losses were estimated to be 6.1 percent. These were because of rotting of fruit and separation of banana pieces from the bunch, which are sold at 15 percent of actual price. A further 1.2 percent loss was also recorded at wholesale level. In this way total post-harvest losses up to the wholesale level comes out to be 16.4 percent. Only 5 percent of produce, arriving the market, is purchased by the wholesalers while 20 percent by the traders and 70 percent by retailers.

Figure 4 Different Varieties of Bananas

3.2.5 Grapes

Presently the grapes were arriving from Quetta. Packing was of wooden crates with some places left blank for the purpose of ventilation. A cushioning of grass had been provided on all sides of the crate to protect the commodity. Cushioning on the top of the crate was thick enough so that it may bear the burden of upper crates during transportation. Truck usually reaches at night and auction is done in the morning. Drivers were awarded with cash for timely arrival because if the truck is delayed due to any reason and it does not reach before the auction time, owner of the produce may suffer huge financial loss because of reduced auction price or high post-harvest losses. 20% of total arrival was purchased by the wholesalers, 60% by traders and 20% by retailers. Post-harvest losses on the arrival of produce at mandi were estimated to be 11.56 percent and at wholesale level 1.7 percent. In this way the total post harvest losses up to wholesale level comes out to be 13.26 percent.

3.2.6 Pomegranate

Point of origin of pomegranate was Ali Pur. It is mostly brought to the market without any proper packing. A large piece of cloth or of any other strong material is used to tie the fruit together. One pack carries 40 kgs of fruit. Sometimes wooden crates are also used for the purpose. It is usually marketed in three grades. Grading is basically done on the basis of size and condition of the fruit. Main problem related to its quality was bursting of fruit. 65% of fruit was purchased by the wholesaler, 25% by the trader and 10% by the retailer. Arrival and auction timings were 11 PM and 12 at night to 4 am respectively. Post-harvest losses on the arrival of produce were estimated to be 9.1% while at wholesale level another loss of 1.3% was noted. In this way up to wholesale level, total post-harvest losses of 10.40% were noted.

Figure 5 Pomegranates

Table 2 Estimated Post-Harvest Losses of Fruits

Sr. No	Commodity	On Arrival at Mandi (%)	At Wholesale Level (%)	Total Loss (%)
01	Apple	8.70	1.50	10.20
02	Peaches	7.94	1.62	9.56
03	Plum	9.88	2.02	11.90
04	Banana	9.10	7.30	16.40
05	Grapes	11.56	1.70	13.26
06	Pomegranate	9.10	1.30	10.40

Source: based on the Survey of the Market

In percentage terms banana showed the highest losses (16.40%) followed by grapes (13.26%) and plums (11.90%).

3.2.7 Post-Harvest Monetary Loss

Table 3 Estimated Post-Harvest Monetary Losses of Fruits

`	Commodity	Total Arrival During the Year (Kgs)	Losses up to Wholesale Level (Kgs)	Monetary Losses (Rs. in Million/Year)
01	Apple	25404500	2591259	77.77
02	Peaches	4250000	406300	12.19
03	Plum	4450000	529550	15.89
04	Banana	29300000	4805200	144.17
05	Grapes	7750000	1027650	30.83
06	Pomegranate	4707500	489580	14.69

	Total	**-**	**-**	**295.54**

Source: Bases on the Findings of the Survey

Monetary loss was calculated by multiplying the quantity of loss with a minimum average price of Rs. 30/Kg. used for all the commodities (based on the prevailing prices in the market). Banana recorded the highest loss in terms of quantity (2591259 Kgs) and value (Rs. 144.17 million) followed by apples and grapes with a monetary loss of Rs. 77.77 million and Rs. 30.83 million respectively. A total loss of 295.54 million rupees per year was recorded, up to wholesale level, only with respect to the commodities shown in table 3. It reflects the drainage of hard-earned revenues and resources due to non-adoption of proper post-harvest management practices and lack of appropriate storage facilities.

3.3 Mango- Post Harvest Loss Assessment from Orchard to Wholesale Level

Multan is the major mango growing area with a 72% share in the total area under mango orchard in Punjab. All the main varieties of mango are grown here. An increase of 32.23% was noted in the export value of mangoes in 2008-09 over 2007-08. Post-harvest life of mango has always remained an issue for local as well as for export marketing. Presently the mango is being exported to distant, better paying, markets through air cargo. It increases the overhead costs which reduces competitiveness of Pakistani mangoes in international market. To the nearby Middle East markets mango is being exported via sea through reefer containers because total traveling time is less.

Major issue in the total matter is the harvest and post-harvest care of the produce. To evaluate the present status of the matter, harvest and post-harvest practices were observed throughout the supply chain. Post-harvest loss assessment was made in detail by identifying different causes and their share in the loss instead of giving just one figure. Details are given below:

3.3.1 Harvesting and Packing

To observe the harvesting and packing practices three mango orchards were visited. Detail of observations are given in table 4:

3.3.2 Harvesting

Information given in the table 2 shows that harvesting of mango is usually started at around 7 to 8 AM. Reason explained by pre-harvest contractors (PHC) for delayed start of harvesting was the presence of dew on the ground, which makes the fruit wet and it, deteriorates the quality and appearance of the fruit. Maturity testing, on the basis of brix level, is not done before deciding to harvest the fruit. The common method adopted is the ripening of fruit on the tree. There might be mature and immature fruits present on the tree at the same time but when harvesting is started total fruit is harvested. The immature fruit subsequently shows shrinkage. Target for the days' harvest also affect the quality of produce. If a high target is given, labor performs the job with speed and

Figure 6 Unripe Mangoes

carelessness to achieve it, which results in high damage of the produce which is evident in case of orchard 1.

Presence and vigilance of the PHC at the place of harvesting and packing is the most important factor in the quality of produce harvested. The PHC in case of orchard 1 was found sitting idle at the packing place while the harvesting was on at a distance of one kilometer. When harvesting place was visited labor was doing the job without taking any care by throwing the fruit directly on the ground in spite of the fact that all the necessary facilities like long stick with a net basket at its end, the most common method used for harvesting mangoes, and foam cushions on the ground for throwing fruit on them had been provided. The only thing lacking was the close supervision by the PHC. The result was clear, as the percentage of damaged fruits was highest in case of orchard 1. In case of orchard, 2 and 3 the labor was found doing the job with care by harvesting the fruit in the net basket, which may contain 5-6 fruits. Then the harvested fruits are thrown individually by the labor on a foam cushion/bag filled with wheat bhusa, to save them from any damage. After harvesting, fruit is left as it is for an hour or two under the tree for de-sapping. Harvesting with the help of clippers was not found any where as it was reported to be highly time consuming

3.3.3 Evaluation for Losses

At the harvesting place, fruits were evaluated for losses. It was observed that clean fruits in case of orchard number 1, 2 and 3 were 45.83%, 45.28% and 57.81% respectively and sap contaminated were 23.33%, 22.64% and 14.06% respectively. Similarly, ratio of diseased fruits in case of above-mentioned three orchards was 18.33%, 26.42% and 26.56% respectively and that of physically damaged fruits was 12.50%, 5.66% and 0% respectively. The highest physical damage (12.50%) was found in case of orchard 1 and lowest (0%) in case of orchard 3, which clearly represents the ground situation with respect to vigilance and supervision of the PHC. Mean values of three cases were calculated to get the representative information which are: clean fruit 49.64%, sap contaminated 20.51%, diseased 23.77% and physically damaged/bruised 6.08%.

Figure 7 Mangoes in Process

Table 4 Harvesting and Packing Practices at Orchard Level

Description	Orchard 1	Orchard 2	Orchard 3
Time of Harvest	07 AM	08 AM	08 AM
Target of Harvest	1600 crates	220 crates	1200 crates
Vigilance/Presence of Contractor	Not present at harvesting place	Personally involved in the process	Contractor & his son actively supervising the process
Distance between Harvesting and Packing Place	One KM (Approx.)	40 Meter (Approx.)	60 Meter (Approx.)
Transportation to Packing place	Through tractor trolley	By labor on their head	By labor on their head
Clean fruit	45.83%	45.28%	57.81%
Sap Contaminated	23.33%	22.64%	14.06%

Diseased	18.33%	26.42%	26.56%
Physically damaged/bruised	12.50%	5.66%	NIL
De-sapping	Done	Done	Done
Packing Method	Belly packing-4” High	Belly packing-4” High	Belly packing-2” High
Training received on harvesting/packing	None	None	None

Source: Based on the information collected during orchards visits and personal observation.

3.3.4 Farms to Packing Areas

Then the fruit was collected in big baskets, in local language called “tokras”, for its shifting to the packing place usually established within the orchard. In case of orchard 1 fruit was being shifted through a tractor trolley by placing the tokras on each other. It damages the fruit in the lower layer of tokras. In case of orchard 2 and 3 fruit was being shifted manually by the labor.

Figure 8 Transport of Fruit

3.3.5 Packing

At the packing places, fruits were again evaluated to find out if there were any changes. For all the three cases there was an overall average increase of 10% in sap contaminated fruits and 8% in physically damaged fruits. The status of produce on its arrival at packing place was – clean fruits 47.10%, saps contaminated 22.56%, diseased 23.77% and physically damaged 6.57%. Fruits were unloaded and graded by the labor. There are three grades usually made for local marketing which are VIP, Super and Special. Grades are made based on size and quality of fruit. Ratio of VIP, Super and Special grades in the total harvest of produce was found to be 65%, 25% and 10% respectively. Packing is done by the separate labor. Fruits are filled tightly in the wooden crates with a cushioning of newspaper on all sides of the crate. There were two sizes of crates i.e., 9 Kg capacity and 12 Kg capacity. Fruits were filled more than the capacity of the crate. Level of the fruit is higher than the top level of the crate (belly packing). After filling the crate it is nailed from one side, the other side is nailed by shaking the crate first, and then the other side of the cover is forced to come closer to its proper place for nailing, failing which the cover is pressed with the help of the foot and then it is nailed. Packed fruit is transported through tractor trolley to the local market and through truck to any distant market. Crates are placed on each other. In this way the weight of upper crates affects the quality of fruit in the lower layers of crates due to belly packing. Mostly the transport is overloaded to minimize the transportation cost.

Figure 10 Packing in Crates

Figure 9 Packaging

3.3.6 Training Needs

No one of the contractors, supervisors and laborers reported about obtaining any kind of training. Need of training was strongly felt at each level. Pre-harvest contractor is the key person in the chain because the farmers sell more than 90% orchards to the PHC. He owns the commodity, bears the risk and is connected with both, demand and supply, ends of the chain. Most of the problems related to post-harvest life of the produce originate from the point of harvesting and packing – the orchard. He must be focused for training purposes

3.3.7 Upon Arrival at Mandi

The fruit was evaluated on its arrival in the fruit and vegetable market Multan. It was revealed that 39.47% of fruit was free from any disorder on its arrival in the wholesale market, while 60.53% fruit was affected with one or the other factor as explained here – sap contaminated – 23.68%, diseased – 13.16%, physically damaged/bruised – 13.16% and physically pressed – 10.53%. Only 20% of total production of the area comes to the local market and remaining 80% is marketed to other markets throughout the country or exported. 80% of the fruit, which is marketed, is unripe. At first stage in the market the unripe fruit is purchased by different buyers as per detail given here - wholesalers (20%), traders (70%) and retailers (10%). Traders take the fruit to other adjacent markets while retailers take it to their shops. Only 20% of fruit coming to market, which is purchased by the wholesalers, remains within the market.

3.3.8 At Wholesale Level

Wholesaler takes the fruit to his selling place where he repacks it, changes its newspaper cushioning, puts carbide (material used for ripening of fruit) in it and leaves it for ripening. It takes four days to ripen the fruit. A further evaluation of ripened fruit, which is sold to the retailers, was made. The post-harvest losses at this stage were estimated and it was revealed that only 20.59% fruit was free from any type of disorder while major share in the fruit quality loss at this stage was of the physically pressed fruits (32.35%) followed by sap contaminated (17.65%), diseased (14.71%) and physically damaged/bruised (14.70 %).

Table 5 Types of Post-harvest Losses of Mango

Description	At harvest level (%)	At packing place (%)	On arrival at mandi (%)	At wholesale level (%)
Clean fruit	49.64	47.10	39.47	20.59
Sap contaminated	20.51	22.56	23.68	17.65
Diseased	23.77	23.77	13.16	14.71
Physically damaged	6.08	6.57	13.16	14.70
Physically pressed	-	-	10.53	32.35

Source: Based on observations made during visits of mango orchards and Mandi.

3.4 Vegetables-Post Harvest Loss Assessment

A commodity wise assessment of losses for different vegetables is given below:

3.4.1 Potato-Fresh

Figure 11 Transporting Potatoes

Fresh potatoes were found arriving from Para Chanar, Meeran Shah, Vana and Quetta. It takes about twenty-four hours to reach the truck to the market. It is marketed in 100 kg jute bags and is usually of mix quality. It reaches the market up to 04 pm and is auctioned at 05 pm. 50% of total arrival is purchased by the wholesalers while 45% by traders and 5% by the retailers. Due to long transportation time and hard producing areas, post-harvest losses are high which are estimated to be 9.6% on its arrival in the market and 12.7% up to whole sale level. It makes 3.1% as net post-harvest losses within mandi. These were because of leftover stocks and increase in the already damaged potatoes. Potatoes coming from hilly areas, in the present season (July to October) are not stored and are consumed fresh.

3.4.2 Potato-Store

Supply areas of stored potato were Sahiwal, Okara, Mian Chanu and from local cold stores of district Multan. Information regarding arrival and auction timings and disposal pattern of produce are same as mentioned for fresh potatoes. It is also marketed in 100 kg jute bags. Post-harvest losses on the arrival of produce in the mandi were estimated to be 7.8%. A further loss of 2.7% was noted up to wholesale level. It makes the total post-harvest losses up to wholesale level as10.50%. High post-harvest losses, in case of stored potatoes, were noted when the storage of the commodity was delayed and it is placed in the store when temperature has started rising. Due to heat factor, its post-storage life is very short and if, due to any reason, its marketing and consumption is delayed, major part is lost. Fresh potato from Punjab starts arriving the market from October and continues till May. It has the storage life of about six months.

3.4.3 Onion

Onion is the commodity, which is always marketed fresh. Due to different seasons and climates in the country it is produced throughout the year in different parts of the country. In case of any shortage, the supplies are augmented from Afghanistan and India. In the present season (July-August), supplies were coming from Quetta, Harnai, Dukki and Peshawar. It reaches the market up to 04 pm and is auctioned at 05 pm. 50% of total quantity arrived is purchased by the wholesalers for its onward sale to the retailers next day morning, 45% by traders to be taken to other adjacent markets and 5% directly by the retailers. There were three categories/qualities of onion arriving the market. Post-harvest losses in case of A category were minimum and in category C these were maximum. Post-harvest losses on the arrival of produce in the market were estimated to be 8.2% and at wholesale level, these were 1.85%. In this way, total post-harvest loss up to wholesale level comes out to be 10.05%.

3.4.4 Tomato

Fresh tomato remains available throughout the year. Sometimes coming from local fields, sometimes from tunnels and in summers from Peshawar, Mardan, Quetta, Qila Saifullah and Lorali. Tomato coming from comparatively hot areas like Peshawar and Mardan has a very short post-harvest life, resulting in high post-harvest losses, against the one coming from cold areas like Quetta, Lorali, etc. It is marketed in wooden crates of different capacity. Tomato is a highly perishable commodity and in case of any delay in its arrival in the market, post-harvest losses may reach up to 80-90% of produce. Its arrival time in the market is up to 04 pm and auction time is 05 pm. 45% of total arrival is purchased by the wholesalers while traders and retailers purchase 50% and 5% of total arrival respectively. Post-harvest losses on arrival of produce in the market were estimated to be 10.45% and at wholesale level 4.47% making the total post-harvest losses up to wholesale level as 14.92% which is highest among the vegetables.

3.4.5 Tinda (Baby Squash)

Presently Tinda was arriving the market from Sindh. Transported through train in A/C luggage boggy, which takes 15 hours to reach Multan. It reaches the market up to 12 noon and is auctioned at 04 pm. 50% purchased by wholesaler and 50% by the trader. It is marketed in plastic bags of 70 kg capacity, two plastic bags are joined together to make one piece to minimize the transportation cost. Wholesaler sells the produce next day morning from 05 to 09 am, so the produce stays in the mandi from 17 to21 hours. Post-harvest losses on the arrival of produce in mandi were estimated to be 7.65% and at wholesale level 8.95%. Net losses in mandi comes out to be 1.3%. Losses were noted to be because of physical damage, diseased effect, over mature produce and left over stocks.

Figure 12 Baby Squash

3.4.6 Okra

Okra is produced in small quantities in all vegetable growing areas but main producing areas include Multan and Kamalia. Presently local produce of Multan was coming to the market. It is usually marketed in plastic and jute bags of 20 kg and 40 kg capacity respectively. Use of plastic bag for the purpose is not recommended because it leads to suffocation and damages the produce. Presently 100% quantity arriving in the market was being purchased by the wholesalers while during the season 90% is purchased by the traders, who take it to other markets, and only 10% is purchased by the wholesalers. It is also marketed to distant markets which include Swat, Mardan, and Peshawar and further marketed to Afghanistan. To maintain the freshness ice blocks are used for distant marketing. It is a less perishable commodity and is handpicked that's why post-harvest losses are low. Over mature produce is not liked for consumption. It reaches the market up to 02 pm and is auctioned at 05 pm. During transportation in summer season, when the produce is packed in plastic bags, it may heat up and inner part is wasted. Post-harvest losses on arrival at market were estimated to be 6.80% while at wholesale level a further loss of 1.50% was recorded which makes the total post-

Figure 13 Okra

harvest losses as 8.30%. The losses are mainly due to disease/damage, over mature and heating up of produce and also because of left over stocks.

3.4.7 Bitter Gourd

Sources of arrival of produce were Mailsi, Arif Wala and from local fields (Multan). It is marketed in plastic bags of about 30 kg capacity and jute bags of 50 kg capacity. It reaches the market up to 02 am and auctioned from 03 am to 05 am. 90% purchased by wholesaler and 10% by trader. Post-harvest losses on arrival of produce at mandi and up to wholesale level were noted to be 9.2% and 10.8% respectively showing a net loss of 1.6% at wholesale level. Post-harvest losses were mainly either due to physical damage or ripening during transportation and marketing of produce.

3.4.8 Bringel

Supplies of produce were coming from Okara, Sahiwal, Mailsi and Chichawatni. It takes about 8 hours to reach the market. Packed and marketed in plastic bags of 20 kg capacity. Arrival time of produce in the market was up to 03 am and it is auctioned at 04 am. Wholesalers' purchase 90% of produce arriving in the market and 10% is purchased by the retailers. Post-harvest losses were mainly because of physical damage, diseased produce and shrinkage of produce during transportation, which was estimated to be 11.25% on arrival at mandi and 12.65% up to wholesale level.

Figure 14 Bringel

3.4.9 Cauliflower

Origin of produce was Lorali (Baluchistan) and it takes 20 hours to reach the market. Packed in plastic bags of about 20 kg capacity. Local produce starts arriving in the market from September. Produce reaches the market up to 04 pm and auction starts at 05 pm. 50% purchased by wholesaler and 50% by trader. Post-harvest losses on arrival at mandi were estimated to be 9.69%. A further loss of 1.8% was recorded at wholesale level. The total loss comes out to be 11.49%. Causes of losses were damage during transportation, loss of freshness and left over stocks.

Table 6 Arrival and Disposal Pattern of Vegetables

Sr. No	Commodity	Origin	Arrival Time	Auction Time	Selling Time of Wholesaler/ Stay of Produce in the Market	Disposal pattern of produce (Percent purchased by)		
						Wholesaler	Trader	Retailer
01	Potato (store)	Okara, Sahiwal, etc	Up to 4 PM	5 PM	5-10 AM/ 13-18 Hrs.	50	45	05
02	Potato (fresh)	Vana, Zhob,	Up to 4 PM	4:30 PM	5-10 AM/ 13-18 Hrs	50	45	05
03	Onion	Quetta,	Up to 4	4:30 PM	5-10 AM/ 13-	50	45	05

		Peshawar	PM		18 Hrs			
04	Tomato	Peshawar, Quetta	Up to 4 PM	5 PM	5-10 AM/ 13-17 Hrs	45	50	05
05	Tinda (Baby Squash)	Hyderabad	Up to 12 Noon	4 PM	5-9 AM/ 17-21 Hrs.	50	50	-
06	Lady Finger	Local, Kamalia	Up to 2 AM	4 AM	5-10 AM/ 1-6 Hrs.	100	-	-
07	Bitter Gourd	Local, Arif Wala	Up to 2 AM	3-5 AM	5-7 AM/ 2-4 Hrs.	90	10	-
08	Bringel	Okara, Sahiwal, etc	Up to 3 AM	4 AM	5-10 AM/ 1-6 Hrs.	90	-	10
09	Cauliflower	Lorali	Up to 4 PM	5 PM	5-10 AM/ 13-18 Hrs.	50	50	-
10	G. Pepper	Local,Lorali	Up to 4 PM	5 PM	5-10 AM 13-18 Hrs.	100	-	-
11	Arvi (Arum)	Local	Up to 4 PM	4 PM	5-10 AM/ 13-18 Hrs.	30	70	-
12	Lemon	Sind	Up to 2 PM	4 PM	5-10 AM	50	50	-

Source: Based on the Survey of the Market

3.4.10 Green Pepper

Multan is the main producing area of green pepper. Its full production season is from February to May. Presently local produce was arriving in small quantities. The produce coming from Lorali was augmenting the supplies. The wholesalers were purchasing 100% of produce arriving the market. In full production season 90% is purchased by the traders taking it to other markets and only 10% is purchased by the wholesalers. It is usually of one grade but different varieties are produced. It is marketed in 40-50 kg jute bags and 20 kg plastic bags. It reaches the market up to 04 pm and is auctioned at 05 pm. Wholesaler dispose of their purchases next day morning from 05 to 10 am. Post–harvest losses were estimated to be 6.5% on arrival at market and 7.8% at wholesale level making the net post-harvest losses at mandi as 1.3%. losses were mainly due to physical damage, disease effect, ripening during transportation and marketing and left over stocks.

3.4.11 Arvi (Arum)

Multan is the main producing area of the commodity and total supply was coming from local areas. It takes about 4-5 hours to reach market from field. Marketed in jute bags of 50 kg and 100 kg capacity. Reaches market up to 04 pm and is auctioned at the same time. 70% of produce arriving the market was purchased by the traders and 30% by the wholesalers. About 10% loss was recorded up to arrival of produce at mandi and 11.7% up to wholesale level.

Table 7 Estimated Post Harvest Losses of Vegetables

Sr. No	**Commodity**	**On Arrival at Mandi (%)**	**At Wholesale Level (%)**	**Total Loss (%)**
01	Potato (fresh)	9.60	3.10	12.70
02	Potato (store)	7.80	2.70	10.50
03	Onion	8.20	1.85	10.05
04	Tomato	10.45	4.47	14.92
05	Tinda (Baby Squash)	7.65	1.30	8.95
06	Lady Finger	6.80	1.50	8.30
07	Bitter Gourd	9.20	1.60	10.80
08	Bringel	11.25	1.40	12.65
09	Cauliflower	9.69	1.80	11.49
10	Green Pepper	6.50	1.30	7.80
11	Arvi (Arum)	10.00	1.70	11.70
12	Lemon	10.50	1.60	12.10

Based on the Survey of the Market

Sr. No	Commodity	On Arrival at Mandi (%)	At Wholesale Level (%)	Total Loss (%)
01	Potato (fresh)	9.60	3.10	12.70
02	Potato (store)	7.80	2.70	10.50
03	Onion	8.20	1.85	10.05
04	Tomato	10.45	4.47	14.92
05	Tinda (Baby Squash)	7.65	1.30	8.95
06	Lady Finger	6.80	1.50	8.30
07	Bitter Gourd	9.20	1.60	10.80
08	Bringel	11.25	1.40	12.65
09	Cauliflower	9.69	1.80	11.49
10	Green Pepper	6.50	1.30	7.80
11	Arvi (Arum)	10.00	1.70	11.70
12	Lemon	10.50	1.60	12.10

3.4.12 Lemon

Currently the source of supply of produce was Sind. It takes 16 hours to reach the market. Marketed in wooden crates of about 12 kg packing. Categorized in three categories A, B and C. Post-harvest losses in category A were minimum and in category C were maximum. Total post-harvest losses on arrival of produce at mandi were estimated to be 10.5% and at wholesale level these were 12.1%. Losses were mainly because of disease effect and bursting of produce

3.4.13 Post-Harvest Monetary Loss

Table 8 Estimated Post Harvest Monetary Losses of Vegetables

Sr. No.	Commodity	Total Arrival During the Year (Kgs)	Losses up to Wholesale Level (Kgs)	Monetary Loss (Rs. in Million/Year)
01	Potato	48661000	5644676	112.9
02	Onion	41950000	4404750	88.1
03	Tomato	27100000	4043320	80.9
04	Tinda-Baby Squash	8300000	742850	14.9
05	Lady Finger	19400000	1610200	32.2
06	Bitter Gourd	26326000	2843208	56.9
07	Bringel	20330000	2571745	51.4
08	Cauliflower	10083000	1158537	23.2
09	Green Pepper	16400000	1279200	25.9
10	Arvi (Arum)	7150000	836550	16.7
11	Lemon	5920000	716320	14.3
	Total	-	-	517.4

Source: Based on the findings of the survey

Monetary loss was calculated by multiplying the quantity of loss with a minimum average price of Rs. 20/Kg. used for all the commodities (based on the prevailing prices in the market). Highest post harvest loss, up to wholesale level, in terms of both quantity and value was shown by potato (112.9 million rupees) followed by onion (88.1 million rupees) and tomato (80.9 million rupees). In percentage terms the highest loss was recorded in tomato (14.92%) followed by potato (12.70%). In total a post harvest monetary loss of 517.4 million rupees per annum was recorded up to wholesale level in fruit and vegetable market Multan only for the commodities mentioned in table given above. If monetary losses of both, fruits and vegetables are accumulated, it comes out to be 812.94 million rupees per year. This loss is calculated for selected commodities and with respect to one market only. From here, one can very well imagine about the magnitude of losses if all the markets and commodities are taken into account. This is a huge wastage of resources, which are already scarce, only because of

careless handling, non-adoption of proper harvesting and post harvest management practices. It also highlights the problem of non-availability of proper storage facilities, which can play an important role in reducing these losses.

3.4.14 Stakeholders in Market Process and Risk Bearing

There are mainly three categories of stakeholders in market process. These include suppliers, commission agents and buyers. Suppliers make supplies to the market, own the commodity and bear the risk. They include farmers, pre-harvest contractors and traders. Commission agent is a business entity working in the market. It facilitates the trade, sells the produce of suppliers, through auction, to the buyers, and charges his commission. Commission agent makes advances to the suppliers to fulfill their needs and extends credit facility to the buyers. He does not own the produce so there is no risk involved on his part. On the other side of the supply chain there are buyers. Buyers include wholesalers, retailers and traders. In addition to that, sometimes, processors and exporters also fulfill their requirements from the market. Wholesalers make their purchases from commission agent for onward selling to the retailers, own the commodity and bear the risk. Traders (in local language called Ladania), after purchasing the produce from the commission agent, take it to the other adjacent markets to fulfill the demand there, own the commodity and bear the risk. Similarly, retailers, after purchasing the produce from the commission agent, take it to his selling place for selling it to the consumers. They also own the produce and bear the risk.

Risk of loss relates to the ownership of produce. As long as you are owner of a commodity, you have to bear any kind of loss occurring to the produce. In the market process buyers and sellers, as described above, own the produce and are supposed to bear 100% loss, occurring due to any reason until the ownership is changed through selling the produce to the next buyer. Commission agent only facilitates the trade, does not own the produce so there is no fear of any loss on his part. Despite of that, being custodian of the produce of supplier, he is supposed to take care of the produce as a matter of his reputation. Losses in the market are mainly of two types – loss due to any damage or loss of freshness because of delayed selling and loss due to distress selling because of oversupply of produce or because of a low turnout of buyers.

3.4.15 Distress Selling and Roles of Cold Stores

During the survey it was revealed that commission agents and wholesalers make their best effort to sell the total arrival of produce at, whatever the price may be, to avoid any loss because of loss of freshness of produce or increase in the percentage of damage of produce and resultantly selling it at throwaway price next day morning. The reason identified was the non-availability of any convenient cold storage facility in the vicinity of market where any leftover stocks may be stored conveniently without any loss of freshness of produce. In this way a cold store, facility, in the vicinity of market, will play an important role in reducing the losses, maintaining the freshness of produce and helping the commission agents and wholesalers to avoid distress selling.

3.5 Current Status of Cold Storage Facilities at Multan

To see the status of cold storage facilities at Multan, a list of cold stores, along with their addresses, was obtained from relevant department. All the stores in district Multan were visited and the relevant persons were interviewed. Information regarding the covered area, storage capacity, type of machinery under use, gas used as cooling agent, temperature control method,

availability of generator was obtained through a questionnaire. Information so obtained is summed up in table 9

Table 9 Current Status of Cold Storage Facilities in Multan

Sr. #	Name/Year of Estt./Contact No.	Covered Area	Storage Capacity	Machinery Used	Cooling Agent	Temp. Control	General Avail-ability
01.	[redacted]	24 Marlas	65,000 Crates*	Local	Ammonia	Manual	No
02.	[redacted]	100 Marlas	70,000 Crates*	Local	Ammonia	Manual	No
03.	[redacted]	40 Marlas	24,000 Bags**	Local	Ammonia	Manual	Yes
04.	[redacted]	50 Marlas	10,000 Bags**	Local	Ammonia	Manual	Yes
05.	[redacted]	50 Marlas	10,000 Bags**	Local	Ammonia	Manual	-
06.	[redacted]	40 Marlas	80,000 Crates*	Local	Ammonia	Manual	Yes
07.	[redacted]	40 Marlas	16,000 Bags**	Local	Ammonia	Manual	Yes
08.	[redacted]	-	1,10,000 Bags**	Local	Ammonia	Manual	Yes
09.	[redacted]	-	4000 Bags**	Local	Ammonia	Manual	No
10.	[redacted]	-	20 Trucks*** Banana	Local	Ammonia	Manual	No
11.	[redacted]	80 Marla	80,000 Crates*	Local	Ammonia	Manual	Yes
12.	[redacted]	6240 SFT	12,000 Bags**	Local	Ammonia	Manual	-
13.	[redacted]	30 Marlas	7,000 Bags**	Local	Ammonia	Manual	Yes
15.	[redacted]	-	-	Local	Ammonia	Manual	-

Source: Based on information collected during the visits of cold stores.

* 20 Kg per crate, ** 100 Kg per bag, *** 250 mounds per truck

There are 19 cold stores in district Multan. Information regarding 15 cold stores has been given above. One cold store was under construction, which was being constructed within the fruit and vegetable market Multan (Modern Cold Store). Information regarding three other cold stores could not be collected due to non-availability of the relevant person or refusal by the person met to provide any sort of information.

It is revealed from the information in table 9 that all the cold stores presently working in district Multan are using locally manufactured machinery in which ammonia gas is used as cooling agent. Storage capacity of stores ranged from 4000 bags to 1, 10,000 bags of 100 kg, which are mostly of potato. Temperature control is manual which is not a reliable way of controlling the temperature in the store. Thermostat is normally recommended to be used for the purpose. Only fifty percent stores had their own generators as alternate arrangement in case of electricity failure. Incidences of commodity loss in the cold store, due to electricity breakdown, are common. Further information regarding the commodities presently being stored in the cold stores, their period of storage and charges, was also obtained. Detail of information is given in table 10.

Table 10 Commodities Presently Being Stored in Cold Stores

Sr. No.	Commodity	Seasonality & Storage Period	Charges
01	Apple	Aug. to May, 6 Months	Rs. 18-25/Month/Crate of 20 Kg
02	Potato	March to Oct., 3 Months (Ration) 6 Months(Seed)	Rs. 180 to 200/Bag of 100 Kg/3 Mon. Rs. 280 to 350/Bag of 100 Kg/6 Mon.
03	Banana	Throughout the year, Peak Season Aug. to Dec. Ripening Time 6 to 13 Days	Rs. 5000 to 7000/Truckload of 250-300 Mounds.
04	Kinnow/Malta	Feb./Mar to May/June, 45 Days	Rs. 15 - 20/Crate of 15 Kg/Month
05	Pomegranate	Sep. - Dec., Three Months	Rs. 20 to 25/Month/Crate 0f 20 kg
06	Mango	June - Aug., for 7-10 days (for export)	Rs. 10/Crate of 8 kg
07	Carrot/Cabbage	June to July, For 1 - 2 Months	Rs. 50/month/bag of 50 kg
08	Green Pepper	Aug. to Sep., For 15 - 20 days	Rs. 50/month/bag of 50 kg
09	Tomato	March/April, For One Month	Rs. 15/month/crate of 12 kg
10	Peaches/Plum/Apricot	One month	Rs. 15 to 20/crate/month
11	All types of Dry Fruit	Two months	Rs. 80/bag of 100 kg
12	Cherry/Strawberry	One month	Rs. 15/packet of 4-5 boxes

Sr. No.	Commodity	Seasonality & Storage Period	Charges
13	Litchi	One month	Rs. 40/packing
14	Flowers	One month	Rs. 100/packing
15	Cream	One month	Rs. 60/35 kg drum
16	Cauliflower	One month	Rs. Rs. 50/month/bag of 50 kg
17	Cucumber	One month	Rs. Rs. 50/month/bag of 50 kg
18	Capsicum	June-July, 1 - 2 months	Rs. 20-25/crate of 12-14 kg
19	Garlic/Ginger	One month	Rs. 18/20 kg bag/month
20	Eggs	One month	Rs. 4500/200 Mounds. Load
21	Meat	8-10 Days	Rs. 150/packing of 3 Mounds.

Source: Based on information collected during the survey of cold stores.

Information regarding seasonality and period of storage, given in the table 10, is based on the field information reported by the mandi people and cold store operators. Potato and apple are the most common commodities presently being stored in the cold stores. Placing of banana in the cold store is part of its ripening process, which is completed in six days during summer and in thirteen days during winter. Pomegranate is also a commodity, which is stored for some long time (3 months), and its storage is also common. Storage period of other commodities range from few days to one and half month. Commodities like eggs, dry fruits, meat and flowers are also places in the cold stores. Most of the stores deal in only potato, apples and banana. One store situated in the vicinity of fruit and vegetable market Multan was found storing all sort of commodities having storage potential. It indicates that establishment of a cold store closer to the market will be a more viable option because overheads for the people storing the product are minimum.

3.6 Commission Agents Working in Food and Vegetable Market Multan

Fruit and vegetable market Multan is a big market, which not only fulfills the requirements of local population but also serves the needs of adjoining areas up to a radius of about 150 kilometers. Commodities arriving from distant areas like peaches, plum and apricot from Swat, apples and grapes from Baluchistan, lemon and some other vegetables from Sind, first arrive in fruit and vegetable market Multan and from their traders from different markets make their purchases as per their demand and take the produce to other markets. Commission agents are in regular contact with the suppliers and keep on updating them regarding the demand of any

commodity in the market. Commission agents get handsome return against these services by charging the suppliers and buyers in different ways, which, according to a common view, is much more than the services provided by them.

There are about 201 working commission agents in fruit and vegetable market Multan. Out of these 14 commission agents deal in fruits and 17 in vegetables while remaining 170 commission agents deal in both fruits and vegetables. Only one commission agent (Sabri & Co.) is an exporter of fruits – mainly of mangoes and citrus. List of working commission agents is given in the appendices part of the report.

No record of wholesalers was being maintained by any agency. According to an estimate there are about 2000 wholesalers working in the market.

3.7 Arrival of Fruits and Vegetables in Fruit and Vegetable Market Multan

Detail of arrival of fruits and vegetables in fruit and vegatble market Multan is given in table 11 (fruits) and table 12 (vegetables).

Table 11 Arrival of Fruit in Fruit and Vegetable Market Multan (July 2009-June 2010)

Sr. #	Commodity	July 2009	Aug. 2009	Sep. 2009	Oct. 2009	Nov. 2009	Dec. 2009	Jan. 2010	Feb. 2010	Mar 2010	Apr 2010	May 2010	June 2010	Total Arrival
1	Mango	6000000	2550000	-	-	-	-	-	-	-	-	1109000	7453000	17112000
2	Apple	2100000	3054500	7600000	3800000	1600000	1200000	900000	950000	1200000	1600000	1400000	-	25404500
3	Plum	1100000	900000	-	-	-	-	-	-	-	-	1280000	11700	4450000
4	Apricot	1200000	600000	-	-	-	-	-	-	-	-	1600000	12500	4650000
5	Peaches	1300000	800000	900000	-	-	-	-	-	-	-	600000	6500	4250000
6	Kolachi	250000	300000	-	-	-	-	-	-	-	-	-	-	550000
7	Water melon	1200000	600000	800000	-	-	-	-	-	-	3200000	1600000	8500	8250000
8	Papaya	-	-	-	-	-	-	-	-	200000	400000	300000	3000	1200000
9	Banana	2400000	2800000	3000000	3000000	2700000	2200000	1600000	1800000	2000000	2700000	2700000	24000	29300000
10	Cheeku	-	-	-	-	-	-	110000	130000	200000	300000	250000	2800	1270000
11	Grapes	950000	4000000	1600000	850000	350000	-	-	-	-	-	-	-	7750000
12	Guava	150000	350000	400000	580000	650000	1300000	2200000	2400000	2400000	-	-	-	10430000

Sr. #	Commodity	July 2009	Aug. 2009	Sep. 2009	Oct. 2009	Nov. 2009	Dec. 2009	Jan. 2010	Feb. 2010	Mar 2010	Apr 2010	May 2010	June 2010	Total Arrival
13	Pomegranate	487500	600000	1200000	1200000	300000	180000	170000	190000	230000	150000	-	-	4707500
14	Sweet orange	300000	300000	1400000	1300000	-	-	-	-	-	-	-	16000	4600000
15	Pear	-	-	730000	480000	352000	110000	-	-	-	-	-	-	1672000
16	Percimen	-	-	240000	800000	800000	140000	-	-	-	-	-	-	1980000
17	Malta	-	-	1200000	200000	3900000	2200000	1260000	1050000	-	-	-	-	9810000
18	Kinno	-	-	-	759000	900000	3200000	3400000	3600000	2100000	1300000	-	-	15259000
19	Loquat	-	-	-	-	-	-	-	-	-	600000	-	-	600000
20	Honey dew melon	-	-	-	-	-	-	-	-	-	-	300000	1600000	1900000
21	Falsa	-	-	-	-	-	-	-	-	-	-	330000	1200000	1530000
22	Melon	-	-	-	-	-	-	-	-	400000	1200000	2550000	1200000	5350000
	Total	-	-	-	-	-	-	-	-	-	-	-	-	162025000

Source: Based on information collected from the weighbridge installed at the entry of market.

Total arrival of fruits in fruit and vegetable market Multan, from July 2009 to June 2010, remained 162025000 kgs. (Table 11). With respect to arrival in the market banana stands at number one position with a total arrival of 2, 93, 00,000 kgs. as it remains available throughout the year mainly from Sind and Apple stands at number two position with a total arrival of 2,54,04,500 kgs. During the season apple keeps on arriving fresh from Baluchistan and Northern Areas while during off season it is supplied from the cold stores as it has good storage potential of about six months. Mango stands at number three with a total arrival of 1, 71, 12,000 kgs. Multan is a main mango producing area but according to an estimate, only 20% of total production is marketed locally while the remaining is marketed to other markets of the country or is exported. Kinnow, guawa and malta with total arrivals of 1, 52, 59,000 kgs., 1, 04, 30,000 kgs and 98, 10,000 kgs stand at fourth, fifth and sixth position respectively, with respect to their arrival.

Table 12 Arrival of Vegetables in Fruit and Vegetable Market Multan

Sr. #	Commodity	July 2009	Aug. 2009	Sep. 2009	Oct. 2009	Nov. 2009	Dec. 2009	Jan. 2010	Feb. 2010	March 2010	April 2010	May 2010	June 2010	Total Arrival
1	Potato	4300000	4050000	4200000	4000000	3431000	3480000	3000000	3600000	4800000	4400000	4600000	4800000	48661000
2	Onion	3900000	3700000	3800000	3650000	2800000	2850000	2700000	2900000	3650000	4150000	3800000	4050000	41950000
3	Tomato	2600000	2200000	2600000	2100000	1800000	2200000	1600000	1700000	1800000	2600000	2800000	3100000	27100000
4	Garlic	1400000	1300000	1450000	1250000	1050000	1120000	1050000	1130000	1650000	1750000	1580000	1750000	16480000
5	Ginger	1150000	1100000	1200000	1300000	1200000	1350000	980000	950000	1280000	1550000	1450000	1570000	15230000
6	Capsicum	150000	260000	120000	270000	340000	150000	240000	270000	240000	140000	120000	140000	2440000
7	Bottle gourd	2200000	1800000	2400000	1900000	950000	850000	1100000	1300000	2600000	2400000	1800000	1950000	21250000
8	Ridged gourd	1200000	1226000	1300000	900000	-	-	-	-	150000	1450000	1600000	1400000	9226000
9	Bitter gourd	2300000	2100000	1200000	1600000	-	-	-	-	800000	3500000	3000000	2600000	26326000
10	Lady finger	3500000	2800000	2400000	1400000	-	-	-	-	500000	3800000	2700000	2300000	19400000
11	Tinda (Baby Squash)	1700000	1400000	1800000	1100000	-	-	-	-	-	800000	900000	600000	8300000
12	Summer Squash	900000	600000	1200000	-	-	-	-	-	-	-	-	-	2700000
13	Brinjal	3400000	2400000	2700000	2200000	1200000	1350000	900000	1050000	1050000	1500000	1200000	1380000	20330000
14	Spinach	1100000	1400000	1300000	1400000	1400000	1550000	1130000	1300000	1600000	1400000	1300000	1100000	15980000
15	Cucumber	700000	800000	200000	400000	280000	300000	280000	260000	1200000	2000000	80000	600000	7100000

Sr. #	Commodity	July 2009	Aug. 2009	Sep. 2009	Oct. 2009	Nov. 2009	Dec. 2009	Jan. 2010	Feb. 2010	March 2010	April 2010	May 2010	June 2010	Total Arrival
16	Green Pepper	160000	170000	180000	160000	900000	850000	750000	700000	120000	160000	180000	190000	16400000
17	Arvi (Arum)	150000	160000	900000	700000	-	-	-	-	-	-	650000	180000	7150000
18	Lemon	700000	900000	400000	600000	250000	250000	270000	300000	400000	250000	400000	120000	5920000
19	Cabbage	200000	260000	300000	700000	600000	450000	900000	980000	280000	131000	900000	950000	10350000
20	Cauliflower	-	300000	205300	113000	160000	120000	700000	800000	140000	900000	-	-	10083000
21	Peas	-	-	150000	300000	800000	900000	800000	900000	128000	-	-	-	5130000
22	Ash gourd	-	-	-	-	-	180000	400000	505000	852500	-	400000	450000	2787500
23	Turnip	-	-	-	120000	180000	200000	160000	130000	850000	400000	-	-	9150000
24	Carrot	-	-	-	600000	108000	156000	110000	125000	180000	300000	-	-	7690000
25	Methi (fenugreek)	-	-	-	500000	900000	750000	400000	550000	600000	-	-	-	3700000
26	Moongra (Rat tailed radish)	-	-	-	700000	400000	280000	600000	500000	-	-	-	-	2480000
27	Radish	-	-	-	210000	225000	210000	180000	165000	-	-	-	-	9900000
28	Misc.	-	-	-	400000	-	-	-	-	140000	350000	600000	177700	4527000
	Total	-	-	-	-	-	-	-	-	-	-	-	-	377740500

There was an arrival of 37, 77, 40,500 kg of vegetables, from July 2009 to June 2010, in fruit and vegetable market Multan (table 12). With respect to arrival potato stands at number one position with a total arrival of 486, 61,000 kg. Fresh supplies of potato remain available from Punjab during major part of the year. During remaining part of the year potato is supplied from cold stores. During off-season in Punjab, supplies of fresh potatoes come from Northern areas and from Baluchistan due to favorable conditions there. Onion is the second largest commodity with respect to its arrival in the market with a total arrival of 4,19,50,000 kg. It is available fresh throughout the year and its supplies keep on coming from different parts of the country. In case of any shortage, the supplies are augmented from Afghanistan and India. Tomato is the third largest commodity with respect to its arrival in the market – 2, 71, 00,000 kg. Mostly it is supplied fresh as fresh supplies keep on arriving from different parts of the country. Sometimes it is stored for a short time (one month). Bitter gourd, bottle gourd and bringel, with total arrival of 26326000 kg, 21250000 kg and 20330000 kg stand at fourth, fifth and sixth position respectively, with respect to their arrivals

3.8 Recommendation Regarding the Use of Modern Technologies in the Establishment of Cold Storage

All fruits and vegetables require specialized post-harvest treatment, appropriate temperature and relative humidity for their storage. The cold storage facilities presently available are mostly for a single commodity like potato, apple, orange, grapes, pomegranates, etc. which results in poor capacity utilization. It was revealed during the current evaluation of cold storage facilities in Multan district that cold stores presently working in Multan are built for the storage of few commodities or for bananas only. There is no thermostat based temperature control. Temperature is controlled manually by opening the door of the store repeatedly and after reaching, the desired level of temperature machine is stopped. Cold store owners/operators are not aware of the temperature and relative humidity requirements, pre-cooling method and storage life days often differ.

t commodities. They store all the available commodities under similar conditions which results in poor storage of commodities. Storage conditions for fruits and vegetables are given in Appendix V for the guidance of relevant people. There is no reliable way of maintaining and checking the level of relative humidity in the store. Most of the stores have two or three big rooms and different commodities are stored in one room at a temperature and relative humidity level which might be suitable for one commodity but might not be suitable for the other. During off-season, the commodities, normally stored in different roams, are placed in one room to save the electricity cost.

The minimum requirement of cold store is that all the deficiencies mentioned above should be removed. Temperature control should be thermostat based; relative humidity level should be properly maintained and monitored through proper equipment. There should be different rooms/compartments in the cold store with independent temperature and relative humidity control so that different commodities, with different atmosphere requirements, may be stored separately.

Understanding the Technology

A cold storage unit incorporates a refrigeration system to maintain the desired room environment for the commodities to be stored. A refrigeration system works on two principles:

Vapor absorption system (VAS), and Vapor compression system (VCS)

VAS, although comparatively costlier, is quite economical in operation and adequately compensates the higher initial investment. Wherever possible such a system should be selected to conserve on energy and operational cost. However, it has its own limitations with respect to temperature requirements of different commodities below a certain level.

VCS is comparatively cheaper than VAS. There are three types of VCS systems available depending upon the cooling arrangements in the storage rooms i.e., diffuser type, bunker type and fin coil type. Diffuser type is comparatively costlier and is selected only when the storage room heights are low. The operational cost of such units is also higher. Bunker type is the cheapest and is preferred when storage room heights normally exceeds 11.5 m. Its operational cost is also low. Fin coil type, although about 5% costlier than the bunker type, is very energy efficient with low operational cost and higher space availability for storage of produce. Such system is used for units with room heights of 5.4m onwards. A comparison of electrical loads & energy savings, refrigerant requirement and space savings in all the three systems are given in Table 13.

Table 13 Comparison of energy savings, refrigerant and space requirement of cooling units of a 4000 MT cold storage

Item	Unit	Type of Vapour Compression System		
		Diffuser	Bunker	Fin coil
Installed Electrical load	hp	180	128	124
Installed Electrical load	kW	134.28	95.49	92.50
Energy saving	%	-	29	31
Refrigerant requirement	kg	1,520	2,200	380
Space requirement for cooling system	cu m	452	670	36

In a refrigeration system, refrigerants are used to pick up heat by evaporation at a lower temperature and pressure from the storage space and give up the heat by condensation at a higher temperature and pressure in a condenser. Freon used to be a common refrigerant but as it causes environmental degradation; its use is going to be banned. Therefore, Ammonia is being increasingly used and preferred for horticultural and plantation produce cold storage units.

Although several types of compressors and condensers are available, medium speed reciprocating compressors and atmospheric condensers are preferred because of the relatively lower cost, energy efficiency and ease in maintenance.

While selecting size of the equipment, care should be taken to assess all loads and proper provision should be made to take care of the peak demand during summer loading and aging of the equipment. Heat load factors normally considered in a cold storage design are:

- Wall, floor and ceiling heat gains due to conduction
- Wall and ceiling heat gains from solar radiation

- Load due to ingression of air by frequent door openings and during fresh air charge.
- Product load from incoming goods
- Heat of respiration from stored product
- Heat from workers working in the room
- Cooler fan load
- Light load
- Aging of equipment
- Miscellaneous loads, if any

3.8.1 Controlled Atmosphere Storage

Controlled atmosphere storage (CA) involves altering and maintaining an atmospheric composition that is different from air composition (about 78% N2, 21% O2, and 0.03% CO2); generally, O2 below 8% and CO2 above 1% are used. Optimum concentrations of oxygen and carbon dioxide lower respiration and ethylene production rates, reduce ethylene action, delay ripening and senescence, retard growth of decay causing pathogens, and control insects. O the other hand, CA conditions unfavorable to given commodity can induce physiological disorders and enhance susceptibility to decay. However, different types of crops, and even different cultivars of the same species, require different atmospheres for successful storage, and each therefore needs to be independently assessed. If the oxygen concentration is too low, it can produce off-flavors or discoloration in some types of fruits and vegetables. But the main disadvantages of controlling the cold store atmosphere are economic: the cost of setting up a controlled atmosphere store and the cost of monitoring of gas composition are both high (twice those of normal cold storage); unless high-value short-season crops are stored, which substantially increase in price out of season, it may be difficult to justify the costs. Also the store has to be fully used for a single crop, because of the different gas compositions required by different crops, and there may be competition from other producing areas that have different harvest seasons. For these reasons, it is unlikely that controlled-atmosphere cold stores will be suitable for producers in developing countries.

3.8.2 Importance of Cold Chain Management

The cold chain is the management of produce temperature, from harvesting through to the consumer, to maintain the quality of the product. Maintenance of Cold chain is the best way to minimize all forms of deterioration after harvesting, including – Weight loss resulting in wilting and limpness, softening, bruising, unwanted ripening, color changes, texture degradation and development of rots and moulds.

Good cold chain management results in the consumer receiving a product of “fresh’quality, leading to greater satisfaction and increased demand.

Maintaining the cold chain is the responsibility of everyone who handles fresh produce, from production to retail sale. A breakdown in temperature control at any stage will impact on the final quality of the product, although the effect may not be visible until several days later. Without the proper management of cold chain, the consumer will not be able to enjoy the produce in the best possible condition.

3.8.3 Importance of Establishing a Cold Storage Facility

Objectives

- To provide cold storage facility to the commission agents, wholesalers, traders, processors, exporters, pre-harvest contractors, retailers and farmers.
- To enhance shelf life of fresh produce, reduce losses, smoothen supplies and stabilize prices.

Target Clients for Cold Store

- Primary Clients – Primary clients of cold store facility include commission agents, wholesalers, traders, processors, exporters, pre-harvest contractors, retailers and farmers of fresh produce.
- Secondary Clients – Secondary clients include dry fruit dealers/wholesalers, flower and ornamental plant merchants, meat dealers, milk processors and egg merchants.

Key Segments for Cold Store

- Main Commodities to be Stored – include potato, banana, apples, pomegranate, kinnow/malta and mangoes.
- Additional Commodities – include almost all kinds of fresh fruits and vegetables like Carrot/Cabbage, Green Pepper, Tomato, Peaches/Plum/Apricot, Cherry/Strawberry, Leeche, Cauliflower, Cucumber, Capsicum, Garlic/Ginger, etc.

Service Benefits Offered to Clients

- Reduction in post-harvest losses of fresh produce at wholesale and retail level.
- Increase in shelf life of fruits and vegetables.
- Off-season availability of fresh produce.
- Avoiding distress selling by the commission agents/wholesalers.
- Controlling the supplies of fresh produce avoiding market gluts.
- Avoiding price crash in case of oversupply.
- Value addition of commodities.

4. Financial Analysis

4.1 Introduction

There is a tremendous market potential for the project given the local demand. The business will focus only on provision of cold store services on rental basis. Analyzing the demand it is proposed that the factory be in close proximity to wholesale vegetable and fruit markets.

The financial forecast is based on a 100% equity model. The 10-year financial projections are very conservative:

- An NPV discount rate of 18% (weighted average cost of capital) has been used for project cash flows.
- The NPV for the project is Rs. 20.1 million, which is linked to the free cash flow figures.
- Inflation rate of 8% is used, which affects not only costs but wage growth rates as well.
- Local sales show growth at 8%, keeping in view the industry trends and the recessionary trend in the Pakistani economy.

Planned project requires an investment of Rs. 49.6 million, which includes capital costs of Rs. 48 million and working capital requirement of Rs. 1.5 million. Despite the conservative projections, the cold store project is a viable project, with a healthy project IRR of 26% and a project payback period of 4.6 years.

The project's major investment of Rs. 28.9 million is in machinery and equipment and Rs. 19 million in the construction of the plant building.

It is assumed that with respect local sales, the capacity utilization in year 1 is 60%. Capacity utilization is assumed to grow at a rate of 7% p.a. and will be capped at 95% maximum. Since the project will be a commercial concern therefore the effective tax rate applicable on the venture will be 16%.

The 10-year projections are based on the following key assumptions:

4.2 Financial Viability

The financial model for the project is based on extensive research and analysis. The income statement, balance sheet and cash flow statements for the project are attached in the appendix. Based on the assumptions below, the project is economically viable

4.3 Underlying Assumptions

4.3.1 Project Capacity

The project consists of a cold store building on an area of 16300 square feet with another 3200 square feet of pavement and driveway. The cold store will have 6 rooms having a total installed capacity of holding 3,600,000 kg of fruit and vegetables. Capacity utilization will be 60% in the

first year; it will increase at a rate of 7% annually and will be capped at 95%, in year 6, at 3,420,000 kg.

4.3.2 Revenue Assumptions

Sale price is worked out to be Rs.0. 3 per kg per month, same for all the types of fruit and vegetables stored there. The sales price is assumed to increase at a rate of 7% per annum, an accurate assumption reflecting historic company trends and industry trends.

In addition, since the input costs (mainly electricity) are assumed to grow at a rate of 7% p.a. increase in sales price is sufficient to cover increased costs.

4.3.3 Machinery and Equipment

The machinery will be bought second hand from the local market and depreciated over 10 years. The cost of equipment purchase is as follows:

Table 14 Equipment Cost

Item	Quantity	Rate	Total
Cooling Plant		3,100,000	3,100,000
Wooden Planks (No.s)	120	36,000	4,320,000
Steel Shelves (Tons)	108	65,000	7,020,000
Insulation (square feet)	54,678	200	10,935,600
Generator		2,000,000	2,000,000
Electric Fitting		1,600,000	1,600,000
Total Machinery & Equipment			28,975,600

Machine ordering & installation can be completed in maximum of 10 days. The civil works need to be completed before installation of machinery and equipment.

4.3.4 Operating Costs

Cost of goods sold is made up of electricity costs, generator costs, and the machine maintenance costs. These costs are divided on total capacity and the unit cost comes to about Rs. 0.39 per kg.

The direct labor costs are those related to moving goods into and out of the cold store. The direct labor costs add to about Rs. 0.30 per kg. The casual labor requirement is calculated to be 1/8 man-day per ton.

4.3.5 Administration and Labor Costs

The optimum number of direct laborers and administration staff has been worked out as 58- keeping the capacity utilization level of the unit under consideration. The total labor expense of indirect labor for year 1 is as follows:

Table 15 Labor Expenses (one year)

Description	No. of Heads	Monthly Salary	Annual Costs
Plant Manager	1	15,000	180,000
Cold Store Operator	2	12,000	288,000
Peon	2	7,000	168,000
Guards	1	7,000	84,000
Total:			720,000

4.3.5.1 Tax Rate

Since the project is a commercial venture the tax rate used is 16%. This rate has been used in Weighted average Cost of Capital (WACC) calculations for discounting cash flows.

4.3.5.2 Depreciation Rates

The relevant straight-line depreciation rates for plant & equipment used in the financial statements is 10%.

4.3.5.3 Insurance Expense

Machinery & equipment is insured at the rate of 5% per year of the book value

4.3.5.4 Cash

Cash-in-bank at the start of operations is assumed to be Rs. 100,000. Interest on cash-in-bank is earned at a rate of 10% p.a.

4.3.5.5 Amortization of Pre-Operating Costs

Total pre-operating costs of Rs. 49,000 are amortized over a 5-year period at the rate of 10%.

4.3.5.6 Salvage Value

The salvage value of the project is calculated the salvage value of Machinery & Equipment. In this case, the salvage value at year 10 is 10% of original book value of the asset and amounts to Rs. 12,430,810.

Table 16 Income Statement

Income Statement

Rs. in actuals

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenue		8,640,000	10,477,440	12,529,786	14,818,120	17,365,426	19,186,908	20,529,991	21,967,091	23,504,787	25,150,122
Cost of goods sold		1,224,000	1,469,616	1,740,251	2,038,072	2,365,422	2,588,592	2,743,604	2,908,158	3,082,855	3,268,338
Gross Profit		7,416,000	9,007,824	10,789,535	12,780,048	15,000,003	16,598,316	17,786,387	19,058,933	20,421,932	21,881,784
General administration & selling expenses											
Administration expense		588,000	385,200	412,164	441,015	471,887	504,919	540,263	578,081	618,547	661,845
Insurance expense		1,448,780	1,303,902	1,159,024	1,014,146	869,268	724,390	579,512	434,634	289,756	144,878
Depreciation expense		3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885
Amortization expense		9,800	9,800	9,800	9,800	9,800	-	-	-	-	-
Subtotal		5,897,465	5,549,787	5,431,873	5,315,846	5,201,840	5,080,194	4,970,660	4,863,600	4,759,188	4,657,608
Operating Income		1,518,535	3,458,037	5,357,662	7,464,202	9,798,164	11,518,122	12,815,727	14,195,333	15,662,744	17,224,176
Other income		345,915	1,197,857	2,418,670	3,933,449	5,765,005	7,974,067	10,549,588	13,542,505	17,004,522	20,994,319
Earnings Before Interest & Taxes		1,864,450	4,655,894	7,776,332	11,397,650	15,563,168	19,492,189	23,365,316	27,737,837	32,667,265	38,218,495
Interest expense		-	-	-	-	-	-	-	-	-	-
Earnings Before Tax		1,864,450	4,655,894	7,776,332	11,397,650	15,563,168	19,492,189	23,365,316	27,737,837	32,667,265	38,218,495
Tax		298,312	744,943	1,244,213	1,823,624	2,490,107	3,118,750	3,738,450	4,438,054	5,226,762	6,114,959
NET PROFIT/(LOSS) AFTER TAX		1,566,138	3,910,951	6,532,119	9,574,026	13,073,062	16,373,439	19,626,865	23,299,783	27,440,503	32,103,536
Balance brought forward			1,566,138	5,477,089	12,009,208	21,583,234	34,656,295	51,029,734	70,656,599	93,956,382	121,396,885
Total profit available for appropriation		1,566,138	5,477,089	12,009,208	21,583,234	34,656,295	51,029,734	70,656,599	93,956,382	121,396,885	153,500,421
Dividend		-	-	-	-	-	-	-	-	-	-
Balance carried forward		1,566,138	5,477,089	12,009,208	21,583,234	34,656,295	51,029,734	70,656,599	93,956,382	121,396,885	153,500,421

Table 17 Balance Sheet

Income Statement

Rs. in actuals

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenue		8,640,000	10,477,440	12,529,786	14,818,120	17,365,426	19,186,908	20,529,991	21,967,091	23,504,787	25,150,122
Cost of goods sold		1,224,000	1,469,616	1,740,251	2,038,072	2,365,422	2,588,592	2,743,604	2,908,158	3,082,855	3,268,338
Gross Profit		7,416,000	9,007,824	10,789,535	12,780,048	15,000,003	16,598,316	17,786,387	19,058,933	20,421,932	21,881,784
General administration & selling expenses											
Administration expense		588,000	385,200	412,164	441,015	471,887	504,919	540,263	578,081	618,547	661,845
Insurance expense		1,448,780	1,303,902	1,159,024	1,014,146	869,268	724,390	579,512	434,634	289,756	144,878
Depreciation expense		3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885
Amortization expense		9,800	9,800	9,800	9,800	9,800	-	-	-	-	-
Subtotal		5,897,465	5,549,787	5,431,873	5,315,846	5,201,840	5,080,194	4,970,660	4,863,600	4,759,188	4,657,608
Operating Income		1,518,535	3,458,037	5,357,662	7,464,202	9,798,164	11,518,122	12,815,727	14,195,333	15,662,744	17,224,176
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Interest expense		-	-	-	-	-	-	-	-	-	-
Earnings Before Tax		1,864,450	4,655,894	7,776,332	11,397,650	15,563,168	19,492,189	23,365,316	27,737,837	32,667,265	38,218,495
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Balance brought forward			1,566,138	5,477,089	12,009,208	21,583,234	34,656,295	51,029,734	70,656,599	93,956,382	121,396,885
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Dividend		-	-	-	-	-	-	-	-	-	-
Balance carried forward		1,566,138	5,477,089	12,009,208	21,583,234	34,656,295	51,029,734	70,656,599	93,956,382	121,396,885	153,500,421

Table 18 Cash Flow Statement

Income Statement											
											Rs. in actuals
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenue		8,640,000	10,477,440	12,529,786	14,818,120	17,365,426	19,186,908	20,529,991	21,967,091	23,504,787	25,150,122
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Depreciation expense		3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885	3,850,885
Amortization expense		9,800	9,800	9,800	9,800	9,800	-	-	-	-	-
Subtotal		5,897,465	5,549,787	5,431,873	5,315,846	5,201,840	5,080,194	4,970,660	4,863,600	4,759,188	4,657,608
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Interest expense		-	-	-	-	-	-	-	-	-	-
Earnings Before Tax		1,864,450	4,655,894	7,776,332	11,397,650	15,563,168	19,492,189	23,365,316	27,737,837	32,667,265	38,218,495
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Dividend		-	-	-	-	-	-	-	-	-	-
Balance carried forward		1,566,138	5,477,089	12,009,208	21,583,234	34,656,295	51,029,734	70,656,599	93,956,382	121,396,885	153,500,421

4.3.6 Impact of Reducing Post Harvest Losses

Post-harvest losses, up to wholesale level, as estimated in this report, range from 9.56% to 16.40% in case of fruits and 7.80% to 14.92% in case of vegetables. When these losses are converted into monetary terms it comes out to be 294.1 million rupees for fruits and 517.4 million rupees for vegetables per year. The total loss, when summed up both for fruits and vegetables, a huge figure of rupees 811.5 million rupees emerges. This is with respect to the commodities under study in this report and up to wholesale level only. If estimated for all the commodities and total supply chain is studied, one can very well imagine about the magnitude of losses. Further, if the results are applied to all the markets in Punjab or Pakistan, there will be an alarming situation. Major causes of these high losses include poor harvesting and packing techniques, improper transportation and road conditions, careless handling in the markets, distress selling and left over stocks at commission agents' and wholesaler level. Further little awareness, at the cold store owners/operators' level, about the storage potential and requirements of different fruits and vegetables, which leads to under-utilization of available storage capacity, is another cause of these losses. Losses due to distress selling and unsold left over stocks at market level are mainly because of non-availability of proper cold storage facilities in the vicinity of the market, about which many have reported. It highlights the need of establishing a cold storage facility easily accessible by the relevant people in the market. It will bring investment, generate employment, smooth out the supply of commodities, stabilize prices and reduce the losses. According to a careful estimate, if such a facility is established, there will be a reduction in losses by 25%.

4.4 Principal Findings

On the basis of information obtained during the study, from the visit of fruit and vegetable market, mango orchards and cold storages in Multan, some principal findings were made which are summarized below:

- Post-harvest losses with in mandi, due to market operation, are of small magnitude.
- There was little awareness among the commission agents and wholesalers (pharias), working in mandi, about the proper handling of produce
- Commission agents were found least concerned about the handling practices in the mandi as they know that the platform will be cleared at the time of auction and any damage caused will not affect their business.
- The commission agents mostly occupied auction sheds constructed for auctioning/stacking of produce and produce arriving the market was stacked/auctioned on the road directly exposed to the sunlight.
- Big fruit and vegetable markets, like one in Multan, also serve as feeding market to the smaller markets in the adjacent areas.
- It was found that there is a buyer for each category and quality of produce.
- Mandi is cleared every day, it is very rare that something is left unsold, particularly at commission agents' level but it includes distress selling due to unavailability of proper and convenient cold storage facility.
- About 50% of produce arriving in any large market, like Multan, is purchased by the ladania (trader) who takes it to other adjacent markets to meet the demand there.
- The retailers directly purchase only about 5 to 10% of produce arriving in the market. Mostly the retailers make their purchases from the wholesalers (pharias).
- Arrival of any commodity in the market is planned by the supplier to reach the market just before the auction time, so that it may reach the consumer in the shortest possible time to avoid any loss.
- It is important that anything which reaches the market should be disposed off/sold within the specified time frame, otherwise it losses freshness/quality and any delayed sale will be at a much lower price. It leads to distress selling at commission agents' level.
- Belly packing in case of mango is common which is a major cause of post-harvest loss in the shape of pressed fruits.
- Bananas are transported without introducing any packing system. Bunches are dumped on each other in the truck as a result post-harvest losses are high.
- In case of fruits highest post-harvest loss, up to wholesale level, was noted in bananas (16.40%) followed by grapes (13.26%) and plums (11.90%).

- In case of vegetables maximum post-harvest loss was recorded in tomatoes (14.92%) followed by potato fresh, coming from Northern Areas, (12.70%) and bringel (12.65%).
- An annual post-harvest monetary loss of rupees 295.54 million in case of fruits and rupees 517.4 million in case of vegetables was recorded, (total rupees 812.94 million), only with respect to the commodities under study in this report, arriving in fruit and vegetable market Multan. From this one may very well imagine about the magnitude of monetary losses if all the commodities and markets are taken into account.
- The farmers sell more than 90% mango orchards to the pre-harvest contractors.
- Pre-harvest contractor is the key person in the supply chain of mango (in other fruits also) as he is connected with both, supply and demand, ends of chain.
- Most of the problems related to post-harvest life of the produce, originate from the point of harvesting and packing.
- Maximum post-harvest loss in case of mango (32.35%) was noted to be because of physically pressed fruits followed by sap contaminated (17.65%).
- Cold storage facilities presently available in Multan district are of traditional type, established mainly for few selected commodities, which include potato, apple, banana, pomegranate, etc. and lack basic facilities like thermostat based temperature control and without any relative humidity control equipment. 50 percent cold stores don't have their own generator as alternate arrangement in case of electricity failure.
- People operating the cold stores have little awareness about storage potential and temperature and relative humidity requirements of different commodities as a result capacity are underutilized.
- The cold store situated near to the fruit and vegetable market Multan was found storing maximum number of commodities only due to advantage of access by the mandi people. It highlights the need of establishing a proper cold store, with all facilities, in the vicinity of market.
- There are 201 working commission agents in fruit and vegetable market Multan dealing in fruits and vegetables. Only one commission agent (Sabri & Co.) is a exporter of fruits – mainly of citrus and mangoes.
- There was an arrival of 16, 20, 25,000 kgs of fruits and 37, 77, 40,500 kgs.of vegetables in fruit and vegetable market Multan, during the period from July 2009 to June2010.
- With respect to arrival of commodities in the market, banana stood at number one position in fruits and potato in vegetables with a total arrival of 2, 93, 00,000 kgs and 4,86,61,000 kgs respectively, during the period mentioned above.

5. Recommendations

- Training at various levels, to different actors of the supply chain from harvest to retail level, is a dire need of the time to create awareness among them regarding proper handling practices.
- Establishment of pilot packinghouses in the field, for proper grading and packing of fruits and vegetables, which minimizes again and again handling by the individuals, coupled with development of intensive training programs for the improvement of product quality and reduction in post-harvest losses.
- Encouraging the establishment of processing industry so that category C produce, not having good market value and in which post-harvest losses are high, may be diverted towards processing for proper utilization.
- Linking operations and actors involved more closely and systematically, modernizing marketing infrastructure and technologies, capacity building of individual actors, and strengthening the policy/institutional settings for better marketing.
- Pre-harvest contractor is the key person, particularly in fruits, in the supply chain as he is linked with both, demand and supply ends, of the chain. He must be focused with respect to trainings on harvesting/picking and handling techniques. He may play a great role, if trained properly, in the reduction of post-harvest losses.
- Commission agents, wholesalers and workers in fruit and vegetable markets must be provided trainings on the aspect of handling and storage of fruits and vegetables.
- Current facilities of cold storage are of traditional type, lacking basic facilities. The owners/operators should also be provided trainings regarding storage requirements and storage potential of fruits and vegetables. They should also be facilitated in the improvement of existing cold storage facilities.
- Encouraging establishment of modern cold storage with all required facilities in the vicinity of fruit and vegetable market. Incentives to build cold storage facilities will bring investment, cut food wastage generate employment and smoothen the supply chain of fruits and vegetables.
- Proper packing system must be introduced for the transportation of banana to minimize losses.
- Post-harvest loss assessment of fruits and vegetables should be made from the point of harvest/picking up to retail level instead of estimating losses within the mandi only.
- Seminars should be arranged to raise awareness regarding causes of losses, handling practices and storage of commodities.

6. Appendices

Appendix 1 List of Commission Agents, Fruit and Vegetable Market, Multan

	Name of Firm	Proprietor	Works in Fruit/Vegetable	Contact #
1	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
2	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
3	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
4	[redacted]	[redacted]	Fruit	[redacted]
5	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
6	[redacted]	[redacted]	Fruit/Vegetable also an exporter	[redacted]
7	[redacted]	[redacted]	Vegetable	[redacted]
8	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
9	[redacted]	[redacted]	Fruit	[redacted]
10	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
11	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
12	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
13	[redacted]	[redacted]	Fruit	[redacted]
14	[redacted]	[redacted]	Vegetable	[redacted]
15	[redacted]	[redacted]	Fruit	[redacted]
16	[redacted]	[redacted]	Vegetable	[redacted]
17	[redacted]	[redacted]	Vegetable	[redacted]
18	[redacted]	[redacted]	Vegetable	[redacted]
19	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
20	[redacted]	[redacted]	Fruit	[redacted]
21	[redacted]	[redacted]	Fruit	[redacted]
22	[redacted]	[redacted]	Vegetable	[redacted]
23	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
24	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
25	[redacted]	[redacted]	Fruit/Vegetable	[redacted]

	Name of Firm	Proprietor	Works in Fruit/Vegetable	Contact #
26	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
27	[redacted]	[redacted]	Vegetable	[redacted]
28	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
29	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
30	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
31	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
32	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
33	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
34	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
35	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
36	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
37	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
38	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
39	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
40	[redacted]	[redacted]	Fruit/Vegetable	[redacted]
41	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
42	[redacted]	[redacted]	Fruit	[redacted]
43	[redacted]	[redacted]	Fruit	[redacted]
44	[redacted]	[redacted]	Vegetable	[redacted]
45	[redacted]	[redacted]	Vegetable	[redacted]
46	[redacted]	[redacted]	Fruit	[redacted]
47	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
48	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
49	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
50	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
51	[redacted]	[redacted]	Fruit	[redacted]
52	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
53	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
54	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
55	[redacted]	[redacted]	Fruit / Vegetable	[redacted]

	Name of Firm	Proprietor	Works in Fruit/Vegetable	Contact #
56	[redacted]	[redacted]	Fruit	[redacted]
57	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
58	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
59	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
60	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
61	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
62	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
63	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
64	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
65	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
66	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
67	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
68	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
69	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
70	[redacted]	[redacted]	Fruit	[redacted]
71	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
72	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
73	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
74	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
75	[redacted]	[redacted]	Vegetable	[redacted]
76	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
77	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
78	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
79	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
80	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
81	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
82	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
83	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
84	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
85	[redacted]	[redacted]	Fruit / Vegetable	[redacted]

	Name of Firm	Proprietor	Works in Fruit/Vegetable	Contact #
86	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
87	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
88	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
89	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
90	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
91	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
92	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
93	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
94	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
95	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
96	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
97	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
98	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
99	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
100	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
101	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
102	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
103	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
104	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
105	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
106	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
107	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
108	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
109	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
110	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
111	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
112	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
113	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
114	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
115	[redacted]	[redacted]	Fruit / Vegetable	[redacted]

	Name of Firm	Proprietor	Works in Fruit/Vegetable	Contact #
116	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
117	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
118	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
119	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
120	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
121	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
122	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
123	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
124	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
125	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
126	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
127	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
128	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
129	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
130	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
131	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
132	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
133	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
134	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
135	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
136	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
137	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
138	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
139	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
140	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
141	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
142	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
143	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
144	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
145	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
146	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
147	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
148	[redacted]	[redacted]	Fruit / Vegetable	[redacted]

	Name of Firm	Proprietor	Works in Fruit/Vegetable	Contact #
149	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
150	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
151	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
152	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
153	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
154	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
155	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
156	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
157	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
158	[redacted]	[redacted]	Vegetable	[redacted]
159	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
160	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
161	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
162	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
163	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
164	[redacted]	[redacted]	Garlic, Turmeric	[redacted]
165	[redacted]	[redacted]	Vegetable	[redacted]
166	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
167	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
168	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
169	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
170	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
171	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
172	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
173	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
174	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
175	[redacted]	[redacted]	Fruit	[redacted]
176	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
177	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
178	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
179	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
180	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
181	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
182	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
183	[redacted]	[redacted]	Fruit / Vegetable	[redacted]

	Name of Firm	Proprietor	Works in Fruit/Vegetable	Contact #
	[redacted]	[redacted]		[redacted]
184	[redacted]	[redacted]	Fruit	[redacted]
185	[redacted]	[redacted]	Vegetable	[redacted]
186	[redacted]	[redacted]	Vegetable	[redacted]
187	[redacted]	[redacted]	\	[redacted]
188	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
189	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
190	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
191	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
192	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
193	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
194	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
195	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
196	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
197	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
198	[redacted]	[redacted]	Fruit / Vegetable	[redacted]
199	[redacted]	[redacted]	Vegetable	[redacted]
200	[redacted]	[redacted]	Vegetable	[redacted]
201	[redacted]	[redacted]	Vegetable	[redacted]

Appendix 2 Wholesalers (Pharias) Fruit and Vegetable Market, Multan

Sr. #	Name	Contact No.
1	[redacted]	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		

Appendix 3 Cold Store Owners/Operators in District Multan

Sr. #	Name of Cold Store	Name of Owner/Operator	Contact Number
01.	[redacted]		
02.			
03.			
04.			
05.			
06.			
07.			
09.			
10.			
11.			
12.			
13.			
15.			
16.			
17.			

Appendix 4 Owners/Pre-harvest Contractors (PHC) of Mango Orchards

Sr. No.	Name of Owner/PHC	Contact No.
1.	[redacted]	
2.		
3.		
4.		
5.		
6.		

Appendix 5 Storage Conditions for Fruits and Vegetables

Fruits and Vegetables	Temperature F	% Relative humidity	Pre-cooling Method	Storage Life Days	Ethylene sensitive
Apples	30—40	90-95	R,F,H	90-240	Y
Apricots	32	90-95	R,H	7-14	Y
Asparagus	32-35	95-100	H,I	14-21	Y
Avocados	40-55	85-90		14-28	Y
Bananas	56-58	90-95		7-28	Y
Beans, snap	40-45	95	R,F,H	10-14	Y
Beans, lima	37-41	95		7-10	
Beets, root	32	98-100	R	90-150	
Blackberries	31-32	90-95	R,F	2-3	
Blueberries	31-32	90-95	R,F	10-18	
Broccoli	32	95-100	I,F,H	10-14	Y
Brussels sprouts	32	95-100	H,V,I	21-35	Y
Cabbage	32	98-100	R,F	90-180	Y
Cantaloupe	36-41	95	H,F	10-14	Y
Carrots, topped	32	98-100	I,R	28-180	Y
Cauliflower	32	90-98	H,V	20-30	
Celery	32	98-100	I	14-28	Y
Cherries, sweet	30-31	90-95	H,F	14-21	
Corn, sweet	32	95-98	H,I,V	4-6	
Cranberries	36-40	90-95		60-120	
Cucumbers	50-55	95	F,H	10-14	Y
Eggplant	46-54	90-95	R,F	10-14	Y
Endive	32	90-95	H,I	14-21	Y
Garlic	32-34	65-75	N	90-210	
Grapefruit	50-60	85-90		28-42	
Grapes	32	85	F	56-180	
Kiwifruit	32	95-100		28-84	Y
Leeks	32	95-100	H,I	60-90	Y

Fruits and Vegetables	Temperature F	% Relative humidity	Pre-cooling Method	Storage Life Days	Ethylene sensitive
Lemons	50-55	85-90		30-180	
Lettuce	32	85-90	H,I	14-21	Y
Limes	48-50	85-90		21-35	
Mushrooms	32	95		12-17	
Nectarines	31-32	95	F,H	14-18	Y
Okra	45-50	90-95		7-14	
Onions, bulb	32	65-70	N	30-180	
Onions, green	32	95-100	H,I	7-10	
Oranges	32-48	85-90		21-56	
Peaches	31-32	90-95	F,H	14-28	Y
Pears	32	90-95	F,R,H	60-90	Y
Peas, in pods	32	95-98	F,H,I	7-10	Y
Peppers, bell	40-55	90-95	R,F	12-18	Y
Peppers, hot	45-50	60-70	R,F	14-21	Y
Pineapple	45-55	85-90		14-36	
Plums	32	90-95	F,H	14-28	Y
Potatoes, early	50-60	90	R,F	56-140	
Potatoes, late	40-50	90	R,F	56-140	Y
Pumpkins	50-60	50-75	N	84-160	
Raspberries	32	90-95	R,F	2-3	Y
Rutabagas	32	98-100	R	120-180	
Spinach	32	95-100	H,I	10-14	Y
Squash, summer	41-50	95	R,F	7-14	Y
Squash, winter	50-55	50-70	N	84-150	
Strawberries	32	90-95	R,F	5-10	
Sweet potatoes	55-60	85-90	N	120-210	Y
Tangerines	40	90-95		14-28	
Tomatos	62-68	90-95	R,F	7-28	Y
Turnips	32	95	R,H,V,I	120-150	

Fruits and Vegetables	Temperature F	% Relative humidity	Pre-cooling Method	Storage Life Days	Ethylene sensitive
Watermelon	50-60	90	N	14-21	
F=forced-air cooling , H=hydrocooling, I=package icing, R=room cooling V=vacuum cooling, N=no precooling needed					
Sources: USDA Agricultural Marketing Service, Kansas State University Cooperative Extension Service					

Appendix 6 Literature Review

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Appendix 7 Questionnaire for Cold Store Operators

I -Information Regarding Cold Storages

1. Name and address._____
2. Proprietor/name of the person interviewed._____
3. Contact number._____
4. Total area._____
5. Covered area._____
6. Number of rooms/ compartments._____
7. Year of establishment._____
8. Storage capacity: (i) Bags (100kg) _____(ii) Crates (20 kg)_____
9. Capacity utilization during the yea (%)._____
10. Machine capacity/ size (local/ imported)._____
11. Gas used: (i) Ammonia (ii) Freon
12. Major commodities stored:

    (i)Name (ii) Season / Period of storage (iii) Temp. Requirement

    (iv) Relative Humidity Requirement (v) Charges
13. Generator availability: (i) Yes / No (ii) Capacity (iii) Cost
14. Temperature control: (i) Automatic (ii) Manual
15. Relative Humidity Control (i) Automatic (ii) Manual
16. Employment: A. Permanent (i) Labour heads (ii) Salary per month

    B.Contractual (i) Contractor rates (a) Rs./bag (100 kg) (b) Rs./crate (20 kg)

    (c) Usual number of labourers employed during the year_____

(d) Payment per day_____

II - Post-harvest Loss Assessment

1) Name. _____ 2) Category (a) Com. Ag. (b) Pharia

3) Contact no. _____ 4) Commodity_____

5) Origin. _____ 6) Time to reach Market._____

7) Arrival Time._____ 8) Auction Time._____

9) Selling Time by Pharia._____

10) Category of Produce: (i) A. (ii) B. (iii) C.

11) Category wise Distribution of total arrival: (i) A. % (ii) B. %(iii) C. %

12) Purchased by (a) Pharia % (b) Ladania % (c) Retailer %

13) Value addition at wholesale level_____

14) Assessment of Losses:

		Loss Assesssment w.r.t. Category of Produce (%)		
	Type of Loss	(A)	(B)	(C)
(a) On Arrival	(i)			
	(ii)			
	(iii)			
	(iv)			
(b) At Wholesale Level	(i)			
	(ii)			
	(iii)			
	(iv)			

15) Storage Potential of Commodity_____

16) Requirement of Improved Storage in the Vicinity of Market Yes. No.

17) Benefits: (i)
(ii)
(iii)

18) Are you satisfied with the present cold storage facilities? (i) Yes (ii) No , If not, why?
(i)
(ii)
(iii)
(iv)

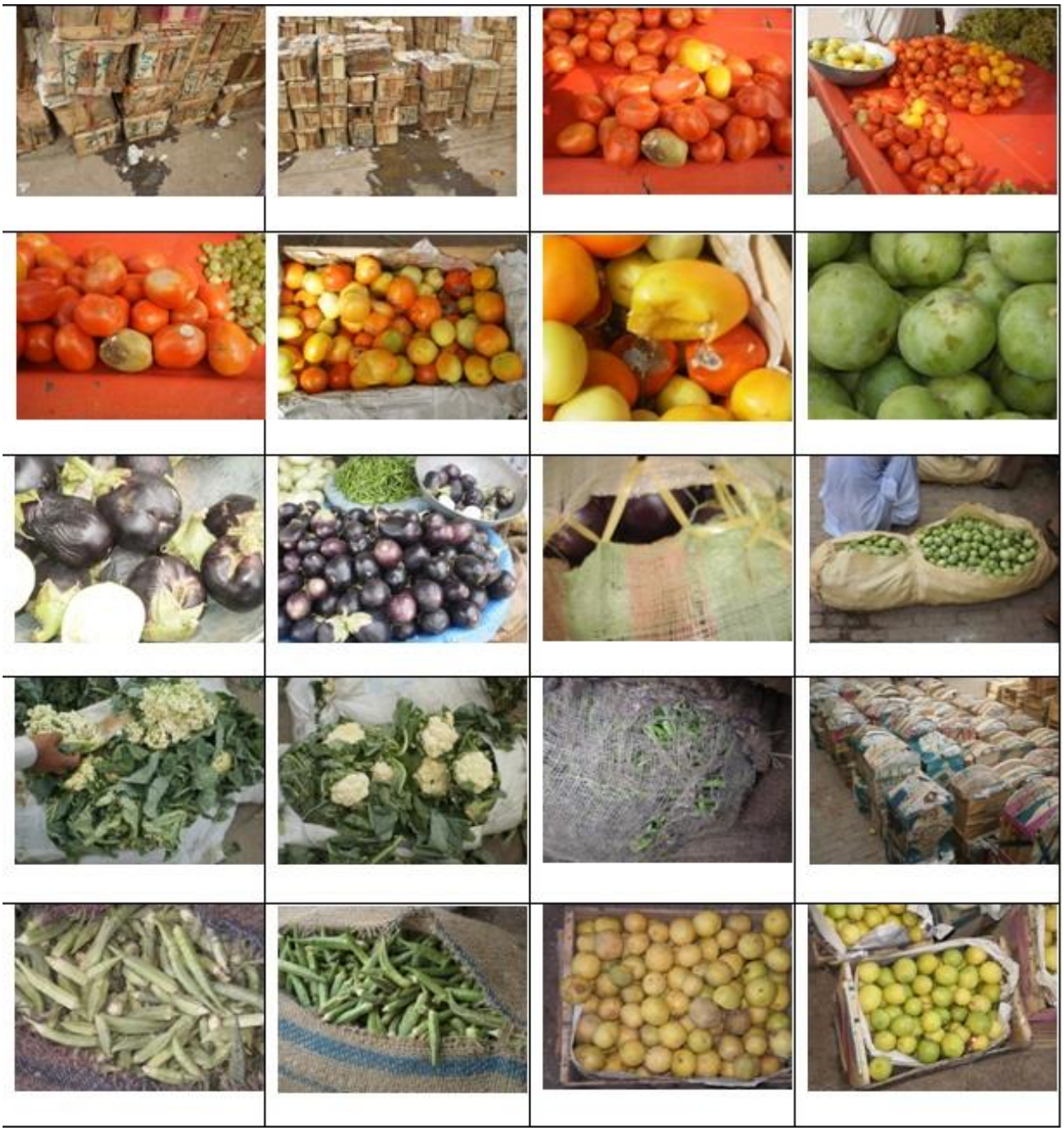
19) Total Volume received is sold or not?

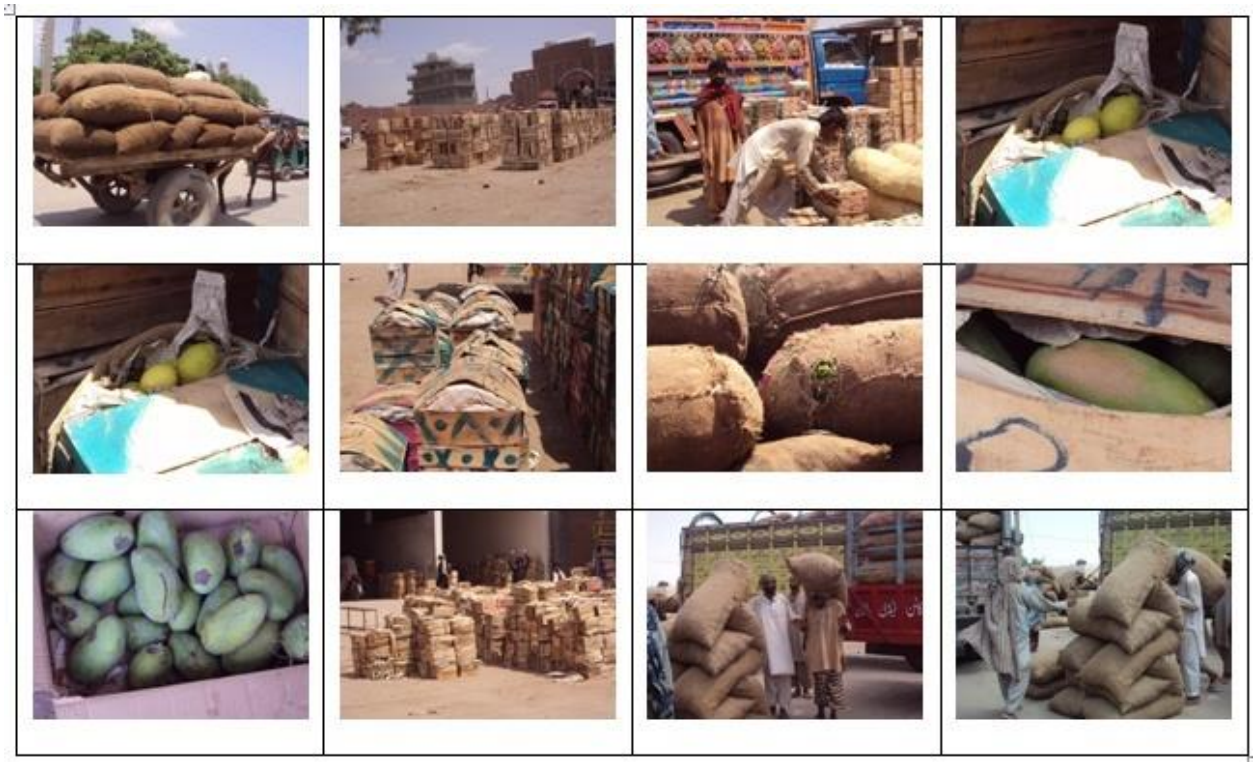
(i) If not, how do they deal with leftover stock?

(ii) If yes, is it distress selling at low price?

20) Awareness Regarding Cold Storage of Commodities. (i) Good (ii) Fair (iii) Poor

Appendix 8 Picture Gallery





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