

Management of reusable plastic crates in fresh produce supply chains

A technical guide



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by

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Foreword

Increased fruit and vegetable production in many countries of Asia and the Pacific has not been accompanied by improvements in post-harvest handling to maintain quality and assure safety. FAO continues to provide technical support and to build capacities to reduce losses and to improve quality and safety management in fruit and vegetable supply chains. One such example is use of plastic crates for the bulk packaging of fresh produce.

The rapid adoption of reusable plastic crates for the bulk packaging of fresh produce is largely driven by consumer and market demand for produce that is safe and of high quality. The use of plastic crates in fresh produce supply chains offers new business opportunities for service providers such as farmers groups or clusters, cooperatives, traders, commercial farmers and even plastic crate manufacturers who are engaged in rental services to farmers. Plastic crates must, however, be appropriately managed and maintained in order to avert any risks associated with their use. This technical guide highlights Good Manufacturing Practices for the handling and storage of reusable plastic crates and protocols for their cleaning and sanitization. It also documents a model of an efficient management system for returnable plastic crates.

This guide is targeted primarily for use by returnable plastic crate service providers and stakeholders in fresh produce handling chains: producers, packing house operators, and transport and storage operators. Individuals who are involved with capacity building activities in horticultural chains as well as policy makers should also find it a useful reference.

He Changchui
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1. Introduction

1.1 Overview of key operations in fresh produce supply chains

An agricultural supply chain can be defined as the entire set of production, distribution, and marketing processes by which the consumer is supplied with a desired product (Woods, 2004). In many developing countries, the fresh produce industry is hampered by the lack of efficient and effective supply chains. In these countries, supply chains are generally not organized, are fragmented, long, and often involve many smallholder farmers that deliver produce to assemblers/collectors. Produce then moves through multiple layers of middlemen consisting of traders, wholesalers and retailers. Supply chains, therefore, involve a series of intermediaries, are characterized by poor information flows and the prevalence of spot transactions over long-term relationships between buyers and sellers. Traditional supply chains continue to handle bulk commodities for wet markets that serve the majority of urban populations in developing countries.

Increasing incomes of urban populations in many developing countries have brought about changes in food habits, resulting in more efficient and coordinated supply chains, and particularly those associated with higher value commodities and those which supply large-scale and modern retail markets such as supermarkets and hypermarkets.

Fresh fruit and vegetable supply chains may include key operations such as production, harvesting, packaging, transport, storage, wholesaling, and retailing.

1.1.1 Production

Production of fruits and vegetables in the Philippines, as in most developing countries, is generally carried out by smallholder farmers. Relatively few farmers are engaged in large, commercial production. Smallholder farmers seldom follow good agricultural practices that are essential for producing safe produce of high quality for consumers. Production practices greatly affect the quality of fruits and vegetables at harvest and their post-harvest quality and storage life. High quality and disease-free produce with a good

shelf life is the result of sound production practices and proper harvest and post-harvest handling (Bachman and Earles, 2000).

1.1.2 Harvesting

Produce must be harvested when it attains the appropriate stage of maturity. Harvest maturity varies in accordance with the crop concerned. Fresh produce is ready for harvest when it has developed to the ideal condition for consumption (FAO, 1989).

Fresh produce must be carefully handled in order to prevent damage such as bruising and skin breakage that could provide entry points for decay organisms. Appropriate harvesting containers should be used to facilitate field handling.

1.1.3 Packaging

Packaging operations start in the field after harvest. Fresh produce is packed in bulk using different types of packaging materials and is transported to packing stations or packing houses. In situations where packing houses are not available, packed produce is directly transported to wholesalers and retailers.

Apart from containing the fresh produce, packaging protects fresh produce during post-harvest handling and divides the produce into more manageable units. It also improves the presentation of the produce and thus its acceptability to traders and consumers. As a general rule, the more highly perishable a commodity, the greater the importance of the quality of the package and the more sophisticated the market, the more important the presentation of the package.

1.1.4 Transport

Produce must be transported to market in a timely manner in order to reach consumers in a fresh condition. As produce moves through the supply chain it may be transported by humans, animals, motor vehicles, boats or airplanes. Depending on the location of production of fresh produce, transportation may be necessary at several points of the supply chain, such as farm to cold storage (once), farm to packing station or house to cold storage (twice), farm to packing house to cold storage to market (three

times) or some other combination of locations. Each time the produce is transported from one point to another, it is handled, subjected to vibration, placed under pressure and subjected to a variety of conditions that may negatively impact on its quality and therefore, its marketability.

1.1.5 Storage

Storage is essential when the fresh produce outputs of smallholder producers must be consolidated to attain economies of scale during transport and distribution. Efforts must be made to control the storage environment in order to assure the maintenance of quality. In general, the temperature and the humidity of the environment in which the produce is placed are the major factors that impact on its quality during transit and storage. Under optimum conditions of temperature and humidity the storage life of fresh produce will be extended to the maximum.

1.1.6 Wholesaling

Smallholder producers of fruits and vegetables in developing countries are mainly concerned with production. Their awareness of marketing as a means of increasing income is either non-existent or limited to what they know from other farmers (FAO, 1989). Traders and commission agents who buy from many smallholder farmers, therefore, have an indispensable role to play in consolidating and bringing fresh produce to the wholesale market. Wholesale markets serve as a convenient place for the gathering of large volumes of produce from many sources and for dividing produce into small volumes for retailing to consumers.

1.1.7 Retailing

Retailers determine consumer demand for assorted types of fresh produce and have great influence on market prices. In retail markets of most developing countries, the quality of produce varies widely and consumers are likely to purchase most grades of produce offered. Fresh produce is retailed either in traditional wet markets or in more sophisticated modern markets such as supermarkets.

1.2 Role of service providers in supplying bulk packaging

Bulk packaging is an integral element in the marketing of fresh produce and provides an essential link between the producer and the consumer. Consumer demand for produce that is safe and of high quality has been a major driver of the shift from using traditional bulk packaging materials to the use of improved containers such as reusable plastic crates. In many developing countries, there has been the rapid adoption of plastic crates for bulk packaging of selected fresh produce items and this growth has offered new business opportunities for service providers such as farmers groups or clusters, cooperatives, traders, commercial farmers and foreign agribusiness firms, and even the plastic crate manufacturers who are engaged in rental services to farmers.

Effective use of returnable plastic crates, however, requires proper physical management in order to ensure appropriate logistical arrangements within the fresh produce supply chain. It is also imperative that proper hygienic management protocols are followed in order not to compromise the safety and quality of fresh produce transported in plastic crates. Service providers engaged in supplying bulk packaging materials such as returnable plastic crates must, therefore, establish clear guidelines and schemes for the efficient and effective physical and hygienic management of these crates. Special emphasis should be placed on the lower level categories of service providers whose awareness must be raised and who may need information on the management of plastic crates.

1.3 Purpose of the technical guide

The purpose of this technical guide is to provide an overview of the key operations of fresh produce supply chains, explain the basic concepts of bulk packaging, and review the various options available for the bulk packaging of fresh produce in developing countries. Desirable features and dimensions of plastic crates as well as the potential hazards associated with their reuse are described, including the relevant factors that drive the adoption of this type of bulk packaging. Good manufacturing practices for the handling and storage of plastic crates and protocols for cleaning and sanitizing them are outlined and discussed. Finally, a case study on a vegetable (lettuce) supply chain is presented to highlight a model of an efficient management system for returnable plastic crates.

This technical guide is targeted primarily at returnable plastic crate service providers as well as all stakeholders in fresh produce handling chains: producers, packing house operators, transport and storage operators, etc. Likewise, individuals who are involved in the provision of training in horticultural chain management, extension engineers as well as policy makers should also find the technical guide to be a useful reference.

2. Bulk packaging of fresh produce

2.1 Basic concepts

Packaging can be defined as the art, science and technology of “ensuring the safe delivery of a product to the ultimate consumer in sound condition, at the minimum overall costs.” (Selin, 1977). The art dimension of packaging relates to its importance as an effective marketing tool.

The term *package* usually refers to the container into which the produce is put. Packing refers to the act of putting the produce into a package and preparing the packaged produce for transport or shipment.

Depending on the intended purpose, packaging can be categorized as wholesale or bulk packaging, pre-packaging or retail packaging. This guide will focus on the bulk packaging of fresh produce.

2.2 The need for bulk packaging

Supply chains for fresh produce in developing countries are generally very complex. The movement of the produce from the farm to the consumer involves many handling steps and a large number of stakeholders. This high level of handling often adversely affects the quality of the produce, leading to post-harvest losses. Proper bulk packaging can facilitate the ease of handling and can result in quality improvement, improvement in the marketability of the produce and reduced losses.

2.3 Functions of bulk packaging

Bulk packaging serves two main functions. First, it serves to contain a convenient size or quantity of produce for easy handling and efficient marketing. Second, it protects the produce from all forms of injury and damage caused by rough handling (during loading, unloading and transport), pressure during stacking, moisture loss and heat. A third function of bulk packaging is to communicate information about the product, such as product name, content/weight, producer name, country of origin, trademark, handling and shipping instructions, etc.

3. Factors to be considered when choosing a bulk package

The selection of a particular type of bulk package for a given type of produce is dependent on technical factors, socio-economic factors and other factors such as those related to environmental concerns. These factors are explained below.

3.1 Technical factors

3.1.1 Nature of produce

The selection of a bulk package for fresh produce packaging is determined by the characteristics of the produce. The package should be strong enough to protect the produce from the rigours of handling yet sufficiently smooth to prevent mechanical injury such as abrasion and bruising. Consideration must also be given to the depth of the packaging container. Containers should be shallow enough to avoid crushing the bottom layers of produce. Small and delicate produce items must be packaged in rigid, shallow containers. Heavy, compact and hard produce items such as melons can be packed in flexible containers.

3.1.2 Mode of transport

The dimensions and design of the package selected must be appropriate for the mode of transportation to be used. Packages must be of appropriate design and must save on space, thereby reducing transport cost. Given that air freight costs are computed on a weight basis, fibreboard boxes or cartons which are relatively lightweight are generally preferred over wooden crates for air transportation of produce. In the case of land transport, containers of uniform shape with good stacking strength and that can be stacked easily in transport vehicles without damaging the produce are generally preferred.

3.1.3 Manner of loading

Vehicles can be either manually or mechanically loaded. Mechanical loading makes use of a forklift. Lightweight and convenience are important features of bulk packaging material for manual loading in order to eliminate

drudgery for workers and to mitigate the risk of dropping and damage to the produce during loading and unloading. Weight is not, however, a critical consideration for mechanical loading. Heavy bulk units on pallets are convenient when handled using forklifts. Given the large capital investment requirements of mechanical loading, it is often used by large enterprises.

3.1.4 Length of delivery route

As a general rule, the longer the delivery route, the greater the need to protect produce against forces during transit. The use of flexible packages or baskets is appropriate when transporting produce over short distances. For longer distances, stronger more rigid packages are required. Returnable containers are suitable for transportation to nearby or local markets; non-returnable ones are generally used for inter-island shipment and for export.

3.1.5 Type of post-harvest treatment

The type of post-harvest treatment, such as pre-cooling and storage, is also an important factor in determining the suitability of a bulk package. If produce is to be hydro-cooled or iced, containers should be water-proofed. If air-cooled, the container should be equipped with a sufficient number of holes or vents to facilitate cooling of the produce. If cool storage is required, the package should be moisture-resistant, strong and have the ability to withstand stacking pressure.

3.2 Socio-economic factors

3.2.1 Convenience and availability of packaging material

For local trade, convenience and availability are the main factors that determine the selection of a bulk package. The package should be readily available, preferably from more than one supplier. In the Philippines, for example, bamboo baskets are commonly used in bulk packaging of fresh produce because of the ready availability of bamboo. For convenience, the packaging material should be easy to assemble, fill and close either by hand or with the aid of a simple machine. If returnable, it should also be easy to transport when empty and should occupy less space than when fully loaded.

3.2.2 Type of market

The nature of the bulk package is to a large extent dictated by the requirement of the market. In the case of fresh produce intended for high-end markets such as supermarkets and institutional buyers, the package demanded is generally of higher quality, not only because of the need for better protection to maintain the high quality of the produce, but also because the buyer can afford the relatively higher cost of a better package. A tradeoff usually exists between the cost of packaging and the expected increase in return for produce of higher quality.

3.2.3 Cost of packaging material

In general, a package should be reasonably inexpensive when compared to the produce it contains. It should not cost higher than is necessary to achieve its purpose. High value produce can be packaged in relatively more expensive packages.

3.2.4 Cost of transport

The cost of transport is generally computed on the basis of weight, volume or the number of package units, depending on the type of transport used, i.e. air, sea or land. Given that the cost of transport by air is computed on a weight basis, air-freighted produce is generally packed in carton boxes. In the case of produce transported by land or by sea, cost is computed on the basis of volume or the number of package units. In situations where cost is based on volume, the lowest cost package with the largest volume is usually chosen. The produce should, however, be adequately protected against any damage that could reduce its expected return.

3.3 Other factors

3.3.1 Weather conditions during handling

If rain becomes a problem during handling, packages that are not waterproof or moisture resistant are unsatisfactory. An example is the use of carton boxes that rapidly lose their integrity on absorbing moisture. Although the use of waxed cartons will solve this problem, the process of waxing adds to the cost of the cartons.

3.3.2 Ecological protection

Growing concerns for the conservation of forest resources to maintain the ecological balance in many developing countries is an important consideration. The use of wood as packaging material is gradually decreasing, paving the way for the use of alternative packaging materials.

4. Bulk packaging options for fresh produce

4.1 Types of bulk packaging materials

Many bulk packaging options exist for fresh produce produced in developing countries. These generally include sacks, bags, baskets, cartons and crates.

4.1.1 Sacks

Sacks are flexible containers and are generally made of woven jute fibre or woven synthetic material such as polypropylene. Sacks are generally used in field handling and for transporting produce to the wholesaler or trader. When packed produce is sold, the sack is no longer collected by the seller and the cost of the sack is added to the cost of the produce. Plastic sacks originally used for packaging rice and other materials are generally recycled for packing fresh produce. Figures 1 and 2 show sacks used for bulk packaging of tomatoes and potatoes, respectively.

Figure 1. Tomatoes packaged in sacks



Figure 2. Potatoes packaged in sacks



The advantages of using sacks are their ready availability and cost-effectiveness. Sacks are relatively inexpensive and have a low weight to volume ratio. However, sacks provide relatively little protection against damage caused by compression, puncturing, vibration and impact injuries. Sacks also have poor vapour and heat transmission characteristics.

4.1.2 Bags

Two types of bags, namely net bags and plastic bags are used for bulk packaging. Both types of bags are flexible containers. Net bags are generally red in colour and are made of open mesh using polypropylene filaments. Net bags are best suited for packing relatively physically hard produce items such as potatoes, onions, lemons and garlic. Mesh or net bags vary in size. For the packaging of onions, the bag is 460 mm x 850 mm and can contain up to 32 kg. Figure 3 shows net bags filled with citrus.

Plastic bags used in bulk packaging are made from polyethylene films. Plastic bags are commonly used by traders for transporting highland vegetables such as lettuce, broccoli, cauliflower, cabbage, carrots, etc. to wholesale markets in urban centres (Figure 4). The capacities of the bags vary widely, from 5 kg to 25 kg, and even up to 50 kg in the case of bags used for cabbage. Typical dimensions of plastic bags used for bulk packaging are 16" x 24" with a capacity of 10 kg and 26" x 30" with a capacity of 15 kg.

Figure 3. Net bags filled with citrus fruits



Figure 4. Carrots packaged in plastic bags for transport to a wholesale market



Net bags and plastic bags are relatively inexpensive, readily available and have a low weight to volume ratio. Although net bags allow adequate ventilation of the packed produce, plastic (polyethylene) bags require holes to reduce the buildup of heat and to avoid excessive humidity inside the package. The major disadvantage of using either type of bag is the low level of protection against damage during handling, loading and unloading, and during transportation.

4.1.3 Baskets

Baskets are containers made of woven strips of fibrous materials. Bamboo baskets are widely used in the bulk packaging of fresh produce. Bamboo baskets come in different sizes and shapes. Those made from strips of the hard outer rind of the bamboo are stronger than those woven from the soft inner part and can be reused on several occasions. Most bamboo baskets can be nested when empty.

Bamboo baskets are semi-rigid containers, are relatively lightweight and can be produced in a range of sizes and shapes. Their hard and rough surfaces can, however, damage the produce. They must, therefore, be lined with a padding material such as leaves, old newspapers and/or rice straw, in order to protect produce from bruising.

A variety of baskets used as harvesting containers and for hauling and transport of fresh produce is shown in Figures 5 to 9.

Figure 5. Bamboo basket used as harvesting container for tomatoes



Figure 6. Baskets used for the bulk packaging of tomatoes



Figure 7. Bamboo basket used for the bulk packaging of lettuce



Figure 8. Bamboo basket used for the hauling of cabbage



Figure 9. Bamboo basket used for the packaging of carrots



4.1.4 Cartons

Cartons are boxes made of either solid or corrugated fibreboard. Solid fibreboard consists of three or more sheets of fibreboard glued together, whereas corrugated fibreboard is made of linerboard glued onto fluted sheets of fibreboard by means of water resistant adhesive. Corrugated fibreboard provides better protection than does solid fibreboard. Fibreboard boxes are rectangular in shape and come in

a range of sizes (Figure 10). Fibreboard containers are used to transport produce such as banana, mango, pineapple, papaya, etc. in export trade. To enhance market appeal, cartons are printed with attractive colours, a brand name and a label that displays information required by the importing country.

The advantages of using cartons or fibreboard boxes include low weight and thus ease of handling. Fibreboard boxes also have relatively soft walls that provide a cushioning effect to packed produce; they are collapsible for convenience during delivery but can be easily assembled. Fibreboard

Figure 10. Carton boxes used for the packaging of fruits



boxes are equipped with adequate ventilation holes for air exchange. These boxes, however, are of relatively lower stacking strength as compared to rigid containers, and their low resistance to high humidity and moisture could result in weakening of the boxes and thus preclude their reuse.

4.1.5 Crates

Crates are rigid containers that are rectangular in shape. Either wooden or plastic crates are used for the bulk packaging of fresh produce.

Wooden crates vary in size depending on the type of produce being packaged. They are manufactured with rigid corners against which planks are nailed. Spacing of the planks varies in accordance with the type of produce to be packaged. Wooden crates are commonly used as shipping containers for the domestic inter-island trade of bananas, pummelo, citrus, tomatoes and papayas in the Philippines. Wooden crates used for the packaging of tomatoes, pummelos and bananas are shown in Figures 11 to 13.

Wooden crates are relatively inexpensive when compared to plastic crates. They provide good ventilation and have high stacking strength. Their hard/rough surfaces may, however, damage soft produce. Furthermore, wooden crates are prone to bacterial and fungal contamination if the wood is untreated.

Plastic crates (Figure 14) are increasingly being used in the bulk packaging of fresh produce. The use of plastic crates is extensively discussed in Section 5.

Figure 11. Bulk packaging of melons in a wooden crate



Figure 12. Wooden crate used for bulk packaging of pummelo



Figure 13. Stacks of wooden crates filled with bananas



Figure 14. Reusable plastic crates



4.2 Cost of packaging

According to Schuur (1988), the cost of packaging is dependent on: a) the type of packaging; b) the size of the package; c) the design of the package; d) the number of packages purchased; e) transport and import costs and duties where applicable; f) assembly cost in the case of carton boxes; and g) the need for packaging accessories such as liners, pads and dividers.

Examples of cost analyses of different packaging containers for three commodities (mango, tomato, lettuce) are presented in Tables 1 to 3. The unit cost of packaging (packaging cost/kg) mangoes in plastic crates is lower than that of packaging them in either bamboo baskets or carton boxes (Table 1). Although the cost of acquiring plastic crates is higher than that of acquiring baskets or carton boxes, plastic crates can be reused several times. Similarly in the case of tomatoes, where bamboo baskets, wooden crates and plastic crates are compared (Table 2), plastic crates have the lowest unit packaging cost. In the case of lettuce (Table 3), polyethylene (PE) bags and plastic sacks (P4.33/kg) are more economical to use than are plastic crates and carton boxes.

Although it is important to compare the costs with the benefits of using different bulk packaging containers, it is difficult to estimate costs and benefits associated with reduced losses, increased goodwill of consumers, increased marketing efficiency, better quality of the produce and reduced handling time (Schuur, 1988).

Table 1. Costs (in pesos) of packaging mangoes in the Philippines using different bulk packaging containers

	Bamboo basket	Carton box	Plastic crate
Acquisition cost (pesos/unit)	5	5	450
Useful life	Once	Once	5 years* 150 times
Average cost per use	5	5	3
Number of packages per truck	96	152	102
Capacity per container (kg)	22	15	22
Volume per truck (kg)	2 112	2 280	2 244
Transport cost per container	3 000	3 000	3 000
Transport cost per kg	1.42	1.33	1.34
Packaging cost per kg	0.23	0.33	0.14
Packaging labour cost per kg	0.50	0.50	0.50
Handling labour cost per kg	0.60	0.60	0.60
Cost of care and maintenance of packaging materials per piece	0.00	0.00	2.50
Maintenance cost per kg	0.00	0.00	0.10
Total cost per kg (pesos)	2.75	2.76	2.68

Assumptions:

Transport facility: Elf truck (1.73 m x 3.383 m x 1.42 m)

Route: Pangasinan to Manila

Size of plastic crates: (52.1 cm x 36.4 cm x 30.5 cm)

Size of carton box: (48.3 cm x 33 cm x 21.6 cm)

3 layers @ 34 crates per layer

* Data supplied by Sanko Plastics Inc.

Utilization: 30 days per year

Size of bamboo baskets: (18 inches x 18 inches x 18 inches)

Table 2. Costs (in pesos) of packaging tomatoes in the Philippines using different bulk packaging containers

	Bamboo basket	Wooden crate	Plastic crate
Acquisition cost (pesos/unit)	15	12	450
Useful life	Once	Once	5 years* 300 times
Average cost per use	15.00	12.00	1.50
Number of package per truck	96	117	117
Capacity per container (kg)	33	30	30
Volume per truck (kg)	3 168	3 510	3 510
Transport cost per container	3 000	3 000	3 000
Transport cost per kg	0.95	0.85	0.85
Packaging cost per kg	0.45	0.43	0.05
Packaging labour cost per kg	0.50	0.50	0.50
Handling labour cost per kg	0.60	0.60	0.60
Care and maintenance of packaging materials per piece	0.00	0.00	2.50
Maintenance cost per kg	0.00	0.00	0.10
Total cost per kg (pesos)	2.50	2.38	2.10

Assumptions:

Transport facility: Elf truck (1.73 m x 3.383 m x 1.42 m)

Route: Pangasinan to Manila

Size of plastic crates: (50 cm x 30 cm x 30 cm)

3 layers @ 39 crates per layer; dimension of wooden box approximately the same as plastic crates

* Data supplied by Sanko Plastics Inc.

Utilization: 60 days per year

Table 3. Costs (in pesos) of packaging lettuce in the Philippines using different bulk packaging containers

	Plastic sack	Carton box	PE bag	Plastic crate
Acquisition cost (pesos/unit)	10	5	2.50	350
Useful life	Once	Once	Once	5 years* 300 times
Average cost per use	10	5	2.50	1.17
Number of packages per truck	104	102	200	102
Capacity per container (kg)	18	12	10	12
Volume per truck (kg)	1 872	1 224	2 000	1 224
Transport cost per container	5 000	5 000	5 000	5 000
Transport cost per kg	2.67	4.08	2.50	4.08
Packaging cost per kg	0.56	0.42	0.25	0.10
Packaging labour cost per kg	0.50	0.50	0.50	0.50
Handling labour cost per kg	0.60	0.60	0.60	0.60
Care and maintenance of packaging materials per piece	0.00	0.00	0.00	2.50
Maintenance cost per kg	0.00	0.00	0.00	0.10
Total cost per kg (pesos)	4.33	5.60	3.85	5.38

Assumptions:

Transport Facility: Elf truck (1.73 m x 3.383 m x 1.42 m)

Route: Benguet (farm) to Manila

Size of plastic crates: (52 cm x 35 cm x 27 cm)

3 layers @ 34 crates per layer

* Data supplied by Sanko Plastics Inc.

Utilization: (two seasons) 60 days per year

5. Plastic crates – a growing bulk packaging option for fresh produce

The use of plastic crates for the bulk packaging of fresh produce during harvest, post-harvest handling, transportation and storage is growing rapidly in developing countries.

5.1 Basic features of plastic crates

The basic features of plastic crates as bulk packaging containers for fresh produce are discussed briefly below.

5.1.1 Materials

Plastic crates are generally manufactured from high density polyethylene (HDPE), although some manufacturers make use of polypropylene in the manufacture of plastic crates. Polypropylene is scratch resistant whereas polyethylene offers greater strength against impact and provides a high level of protection against degradation by ultraviolet radiation from sunlight.

5.1.2 Structural design

Plastic crates can be categorized as *stacking*, *nesting*, *stacking and nesting*, or *collapsible* containers. These specific features are particularly important when empty containers are stored or transported with a view to economizing on transport space.

5.1.2.1 Stacking crates (Figure 15)

These crates have vertical walls and may or may not be covered. In situations where the crates are not covered, the stacking of crates provides a covering mechanism.

5.1.2.2 Nesting crates (Figure 16)

These crates have sloping walls that allow the containers to be inserted into each other (i.e. nested) when empty.

Figure 15. Stacking crates



Figure 16. Nesting crates



5.1.2.3 Stacking and nesting crates (Figure 17)

These containers can be stacked on top of each other or nested by inserting one crate into the other. Depending on the size of the crate, a space saving of approximately 57 percent can be achieved by nesting the crates. Three types of stackable nesting crates are applicable for bulk packaging:

- a. Crates with attached covers – these crates can be nested when the covers are open and can be stacked when the covers are closed.
- b. Crates with detachable covers – these crates can be nested when the covers are removed and can be stacked when the covers are in place.
- c. Crates with handles – the handles of these crates can be swung from the outside to allow stacking. When the handles are swung out the crates can be nested. The two handles are made of rust-free steel bars for easy handling (Figure 18).

Figure 17. Stacking and nesting crates



Figure 18. Stacking and nesting crate with two handles



5.1.2.4 Collapsible crates

The sides of collapsible crates are attached by either plastic or metal hinges and can be folded in order to collapse the container.

5.1.3 Perforation or ventilation holes

Plastic crates may or may not be equipped with perforations or ventilation holes. Those with ventilation holes are preferred for the field handling, transport and storage of fresh produce. They allow for adequate air flow through produce during cooling as well as during refrigerated transport or cold storage.

5.1.4 Ease of cleaning and disinfecting

Plastic crates have hard but smooth surfaces which make them easy to clean and disinfect.

5.2 Dimensions and types of plastic crates for fresh produce packaging

A number of fresh produce supply chains in developing countries have begun adopting plastic crates for bulk packaging during field handling as well as for the transportation of produce from on-farm packing houses to wholesale/retail markets. Commodities handled are usually high value

vegetables such as lettuce, cabbage, carrots, broccoli, beans, tomato, and fruits such as mango and citrus. External dimensions and types of plastic crates used for selected fruits and vegetables are described in Table 4.

Currently no specifications exist for the use of plastic crates in fresh produce supply chains. Stacking crates with ventilation holes are the most commonly used crates for the bulk packaging of fruits. Stacking-nesting type crates with ventilation holes and swing bar handles are generally preferred for the bulk packaging of vegetables.

Table 4. Specifications of plastic crates used in bulk packaging for different fresh produce supply chains in the Philippines

Commodity	Outside dimension (mm) (L x W x H)	Type of plastic crates	Full capacity (kg)	Application
Fruits				
Citrus var. satsuma and ponkan	520 x 362 x 260	Stacking crate with ventilation holes	25	Field handling; transport to wholesale and retail market
Mango var. 'carabao'	521 x 364 x 305	Stacking crate with ventilation holes	25	Field handling; transport to exporters' packing house
Vegetables				
Lettuce var. iceberg ^a	800 x 500 x 400	Stacking crate, closed type without ventilation holes	40	Field handling to on-farm packing house
	500 x 400 x 280	Stacking crate with ventilation holes	20	Pre-cooling; refrigerated inter-island transport to institutional market

Table 4. (continued)

Commodity	Outside dimension (mm) (L x W x H)	Type of plastic crates	Full capacity (kg)	Application
Lettuce var. iceberg ^b	560 x 390 x 283	Stacking-nesting crate with ventilation holes and swing bar handles, colour coded	20	Field handling to on-farm packing house; pre-cooling and refrigerated inter-island transport to institutional market
Lettuce var. red and coral (leafy type)	712 x 472 x 338	Stacking-nesting crate with ventilation holes and swing bar handles, colour coded	25	Field handling and transport to processing plant
Lettuce var. romaine, iceberg, and leafy types (red and coral)	560 x 390 x 283	Stacking-nesting crate with ventilation holes and swing bar handles	20	Field handling; cold storage; refrigerated transport to institutional market
Assorted vegetables (cabbage, carrots, beans, broccoli, tomato)	520 x 362 x 260	Stacking crate with ventilation holes	20	Transport handling from trading post to urban wholesale and retail market

^a Lettuce cluster farm located in Southern Philippines

^b Commercial lettuce farm in Southern Philippines

Table 5. Specifications of plastic crates used by suppliers of major supermarkets in the Philippines, for the bulk packaging of fresh produce

Commodity	Dimensions (mm) (L x W x H)	Type of plastic crate	Application
Supermarket A			
Supplier 1 (pineapple, papaya, banana)	500 x 360 x 300	Stacking crate with ventilation holes	Retail display
Supplier 2 (eggplant, onion, carrots, tomato, etc.)	500 x 360 x 300	Stacking crate with ventilation holes	Transport from off-farm packing house to supermarket; retail display
Supplier 3 (eggplant, onion, carrots, tomato, etc.)	600 x 420 x 300	Stacking crate with ventilation holes	Transport from off-farm packing house to supermarket; retail display
Supplier 4 (pineapple, durian, mangosteen, etc.)	600 x 400 x 300	Stacking crate with ventilation holes	Transport from off-farm packing house to supermarket; retail display
Supplier 5 (assorted fruits and vegetables)	500 x 320 x 220	Stacking crate with ventilation holes	Transport from off-farm packing house to supermarket; retail display
Supermarket B			
Supplier 1 Assorted fruits and vegetables	540 x 250 x 160	Stacking crate with ventilation holes	Transport from off-farm packing house to supermarket
– leafy vegetables	600 x 300 x 300	Stacking crate with ventilation holes	
– fruits and non-leafy vegetables	500 x 300 x 300	Stacking crate with ventilation holes	

Table 5. (continued)

Commodity	Dimensions (mm) (L x W x H)	Type of plastic crate	Application
Supermarket C			
Supplier 1 Fruits and non-leafy vegetables	520 x 365 x 320	Stacking crate with ventilation holes	Handling and transport from off-farm packing house to supermarket
Fruits	600 x 320 x 220	Stacking crate with ventilation holes	Retail display
Supermarket D			
Assorted fruits and vegetables	520 x 360 x 160	Display crate with ventilation holes	Retail display
Supermarket E			
Leafy and non-leafy vegetables	520 x 380 x 150	Display crate with ventilation holes	Retail display

5.3 Factors that drive the adoption of plastic crates for the bulk packaging of fresh produce

Increasing adoption of plastic crates for the bulk packaging of fresh produce in developing countries is stimulated by their reusability, their contribution to post-harvest loss reduction and the alleviation of human drudgery, buyer preferences and government support.

5.3.1 Reuseability

The rigidity and durability of plastic crates allows them to be repeatedly used over an extended period of time. The smooth surfaces of plastic crates facilitate the ease with which they can be cleaned after each use. The risk of pilferage should, however, be taken into account when considering investment in this type of bulk packaging.

5.3.2 Reduced post-harvest losses

An overriding factor that has enhanced the adoption of plastic crates for handling and transportation of fresh produce in horticultural supply chains is the significant reduction of quantitative and qualitative post-harvest losses. The rigidity of plastic crates and their smooth internal surfaces allow for the maximum protection of fresh produce.

Losses are significantly reduced during handling and transportation when using plastic crates as opposed to traditional packaging materials such as polyethylene bags. Results of handling trials for two varieties of eggplant transported in plastic crates and in polyethylene bags (PEB) on open trucks over a distance of 250 km of concrete road showed a reduction of compression damage from 52.7 percent to 32.0 percent and 37.4 percent to 23.3 percent for ‘Casino’ and ‘Black Ninja’ varieties respectively when transported in plastic crates (PHTRC, 2004). Crate dimensions are also of significance in reducing losses as a result of compression. A transport trial conducted by PHTRC (2004) which compared compression damage for eggplant packed in 10 kg capacity PEB and plastic crates of 10 kg and 13 kg capacity respectively, showed a reduction in compression damage from 54 percent for eggplants transported in polyethylene bags to 4.38 percent for eggplants transported in 13 kg crates and 2.83 percent for eggplants transported in 10 kg crates.

The use of bamboo baskets, elongated bags made of palm leaves, and wooden crates were compared with plastic crates for the handling and transport of tomatoes from the farm to the wholesale market over a distance of about 200 km of concrete road. Compression damage was reduced from 21.3 percent, 24.3 percent and 33.3 percent to 10.8 percent, respectively (PHTRC, 2004). Fruits packed in wooden crates showed the highest incidence of compression damage owing to the practice of over-packing prior to sealing to make up for weight loss on the way to the market.

A pilot project in Sri Lanka that introduced the use of plastic crates (Fernando, 2006) reported a reduction of post-harvest losses in vegetables from 30 percent to 5 percent during handling and marketing. The quality and safety of vegetables reaching the consumer were improved appreciably. In the case of fruits such as mangoes and avocados, the use of plastic crates for handling and transportation resulted in a reduction of losses from 30 percent to 6 percent (Fernando, 2006).

5.3.3 Alleviation of human drudgery

Given the high cost of transportation in developing countries, producers and marketers generally tend to maximize the loading capacities of vehicles by using traditional packaging materials such as bamboo baskets, wooden crates, sacks, etc. Eggplant producers in the Central and Southern Philippines generally make use of bamboo baskets with capacities ranging between 65 and 70 kg to as high as 100 kg. Given the weight of these containers, they run the risk of being dropped, or are generally thrown rather than lifted gently during handling and transportation, resulting in damage to the produce.

The weight of the packaging and convenience of transportation are important considerations when choosing a bulk package. In general, lightweight packaging is preferred. Plastic crates having capacities of up to 25 kg are generally preferred for the manual loading of produce. Plastic crates are designed for easy and convenient handling by a person of average build.

5.3.4 Buyer preferences

Institutional buyers in modern markets generally require that their fresh produce suppliers make use of plastic crates for bulk transportation because of the obvious advantage of minimizing quality deterioration and physical loss. Plastic crates also double as retail display crates in many supermarkets.

5.3.5 Government support

In order to link organized smallholder producers to urban markets through the establishment of strategically located village food terminals, the Government of the Philippines has introduced the use of plastic crates. This intervention demonstrates the advantage of using plastic crates and is intended to stimulate greater adoption of plastic crates by producers and marketers of fresh produce.

6. Hazards associated with the reuse of plastic crates for bulk packaging

Fresh produce can be contaminated at any point of the supply chain – during production as well as during its movement along the supply chain from the farm to the table – thereby posing risks to the consumer. A number of risk factors are associated with the reuse of plastic crates for the bulk packaging of fresh produce. These include microbiological contamination, post-harvest disease, exposure to physical hazards, chemical hazards, and insect infestation.

6.1 Microbiological contamination

Fresh produce can become contaminated by micro-organisms such as bacteria, viruses and parasites that can cause illness in humans. Micro-organisms can be introduced on to fresh produce as contaminants from the soil, dust and surroundings as well as through human contact as a result of poor hygienic handling. Other means of contamination are through poor production and handling practices such as the application of untreated manure and the use of contaminated irrigation and processing water (Hernandez-Brenes, 2002). Cross contamination of the contact surfaces of plastic crates used for bulk packaging during the handling and transportation of contaminated fresh produce is, therefore, a risk factor.

6.2 Post-harvest diseases

Fresh produce is subject to many kinds of decay and rots caused by fungi or bacteria. Post-harvest diseases may start before or after harvest. Wounds, cuts, or bruises caused during harvest are possible entry points for bacteria and fungi. Once infected, the disease can spread to healthy produce as well as to the contact surfaces of plastic crates.

Plastic crates can, therefore, encourage the development of post-harvest diseases. Their surfaces can become wet with condensate because of changes in temperature. Free water generated by the accumulation of condensate can run down the sides of the crates and wet the surface of the produce, providing perfect conditions for the development of post-harvest diseases.

6.3 Physical hazards

Physical hazards can be introduced into fresh produce when the plastic crate is damaged or broken during rough handling and transport. Plastic bits/pieces from damaged containers can also cause serious injuries to humans, such as cuts and choking.

6.4 Chemical hazards

The unrestricted use of toxic chemicals and pesticides during agricultural production in most developing countries can result in the chemical contamination of fresh produce. Contamination of plastic crates by residual quantities of chemicals can pose a chemical risk during the reuse of crates.

6.5 Insect infestation

Insect pests pose a serious problem during the production of fresh produce and must be controlled through the application of appropriate insecticides at the appropriate pre-harvest interval. Insect control as practiced by many farmers in developing countries may not, however, be adequate and produce can transfer insect contamination to plastic crates during handling and transport. Infested plastic crates can, therefore, pose the risk of insect infestation during the reuse of crates.

7. Mitigating hazards associated with the reuse of plastic crates

In order to alleviate the hazards associated with the reuse of plastic crates, it is critical that Good Manufacturing Practice (GMP) is followed when handling plastic crates. GMP is a set of fundamental principles of hygiene that should be followed with a view to ensuring the safety and wholesomeness of foods such fresh produce.

7.1 GMP for handling and storing plastic crates

GMPs that should be observed when using containers such as plastic crates for packaging include the following (Hernandez-Brenes, 2002):

- Damaged containers should be discarded when cleaning becomes difficult or when the damage is such that the container might break and bits/pieces could fall into the fresh produce.
- Containers used for transporting fresh produce should be cleaned and sanitized after each use.
- Containers that have been in direct contact with soil, mud, compost, chemical or faecal materials should be properly marked and should not enter the packing house facility at any time. A second set of containers can be used for fresh produce entering the packing facility.
- Containers for fresh produce should not be used to transport any other items such as tools, combustibles, pesticides or any other materials.
- Within the packing house, it is a good practice to use colour coded or labeled containers as a means of distinguishing produce that has been washed, from that which has not been washed, in order to avoid cross contamination.
- Pest control and monitoring of infestation should be considered during container inspections.
- Containers should be stored in an area that is clean, dry, and free from trash, insects, and animals.
- The ceiling of the storage area should be checked for leaks before storing the containers.
- The storage area should be well separated from all chemical agents and from other storage areas for chemicals or other hazardous materials.
- It is a good practice to store packaging containers on pallets in order to avoid their direct contact with the floor.

7.2 Protocols for cleaning and sanitizing plastic crates

Strict cleaning and sanitizing procedures must be followed in order to reduce the risk of contaminating fresh produce when plastic crates are reused. Only thoroughly cleaned and sanitized plastic crates should be used in fresh produce supply chains.

7.2.1 Cleaning procedures for plastic crates

Plastic crates can be cleaned using both physical and chemical methods (Hernandez-Brenes, 2002). Physical methods include scrubbing of crate surfaces whereas chemical methods make use of detergents, acids or alkalis to remove dirt, dust, product residues and other debris from surfaces. These methods may be used separately or in combination.

Detergents used in the washing of used plastic crates should be rapidly and completely soluble, exhibit good moistening action, good dispersion or suspension properties, good rinsing properties, germicidal action, and should be affordable in use.

Cleaning procedures alone cannot guarantee the reduction of micro-organisms. In order to reduce/eliminate micro-organisms, it is imperative that the surfaces of plastic crates are treated with disinfectants or sanitizers.

7.2.2 Sanitizing procedures

A **sanitizing agent or sanitizer** is an antimicrobial agent applied to destroy or reduce the number of micro-organisms of public health concern, without affecting produce quality and consumer safety. Cleaning and sanitizing are two separate yet related processes. Cleaning removes visible soil and/or food particles from crates and physically reduces their microbial load. In order to be effective, chemical sanitizers must be applied to crates that have been washed/cleaned.

Chlorine-based compounds, iodine compounds or iodophors, and quaternary ammonium compounds or quats are the sanitizers most commonly used to disinfect food contact surfaces. These compounds have different sanitizing characteristics, and offer both advantages and disadvantages in many applications (Marriot, 1997). The characteristics of these sanitizers are summarized in Table 6.

Chlorine is the most popular sanitizer used in the food industry. It is a widely distributed element not found in its free state, but exists primarily in combination with sodium, calcium, potassium, and magnesium. Commercially, sodium and calcium are generally combined with chlorine to produce hypochlorites that are more convenient to use than other forms of chlorine such as chlorine gas.

Table 6. Characteristics of common chemical sanitizers

Characteristics	Chlorine	Iodophors	Quats
Germicidal efficiency	Good	Kill vegetative cells	
Toxic			
Shelf strength	Yes	Yes	Yes
Diluted to use	No	Depends on wetting agent	Somewhat
Stability			
Shelf strength	Low	Varies with temperature	Excellent
Diluted to use	Varies with temperature	Varies with temperature	Excellent
Speed	Fast	Fast	Fast
Penetration	Poor	Good	Excellent
Film forming	None	None or little	Yes
Effect of organic soil	High	Moderate	Low
Water properties that affect action	Low pH and iron	High pH	Several
Ease of measurement	Excellent	Excellent	Excellent
Ease of use	Excellent	Excellent	High foam
Smell	Chlorine	Iodine	None
Taste	Chlorine	Iodine	None
Effect on skin	Some	None	None
Corrosive	Corrodes mild steel	Doesn't corrode stainless steel	No
Cost	low	Moderate	Moderate

Source: Marriot (1997)

Hypochlorites are preferred as sanitizers because of their rapid effect on a range of micro-organisms and their relatively low cost. When sodium hypochlorite is used in the sanitization of washed plastic crates, the chlorine concentrations in solution should be no less than 50 ppm and no greater than 200 ppm, according to USDA regulations. The dilution of bleach solutions to achieve chlorine concentrations ranging between 50 and 200 ppm is described in Table 7.

Table 7. Recommended method of diluting bleach to achieve different chlorine concentrations

Desired chlorine concentration (ppm)	Amount of chlorine bleach (5.25% sodium hypochlorite) needed (teaspoon)	Amount of water (litres)
50	1	17
100	2	17
200	4	17

Source: McKee (2004)

In order to assure their efficacy against bacteria, chlorine solutions must be used within a pH range of 5 to 6. The pH of the sanitizing solution should, therefore, be tested to ensure that it is less than 6. In situations where the pH of the solution is less than 4, chlorine gas, which is toxic, is released (McKee, 2004). Thus, strict adherence to the pH range of 5 to 6 is critical to assuring the efficacy and safety of chlorine sanitizers.

Chlorine must be diluted and applied within a temperature range of 40 to 49°C. Once applied, it is important that the chlorine solution has a contact time of one to five minutes with the crate.

7.3 Tools and equipment requirements

Appropriate tools and equipment are required for cleaning and sanitizing reusable plastic crates. If not properly maintained, these tools can serve as a major source of biological contamination. After use, cleaning tools and sanitizing equipment should be thoroughly rinsed and sanitized. Cleaning tools should be regularly replaced in order avoid the growth of micro-organisms on their surfaces.

7.3.1 Cleaning tools

An appropriate set of tools must be used for the thorough and effective cleaning of plastic crates. Tools commonly used for cleaning, include:

- Sponges
- Scrubs
- Scrapers
- Pressure water guns.

7.3.2 Sanitizing equipment

Spraying and dipping/soaking are the two most appropriate methods for the cleaning of plastic crates. Spraying with chlorinated water necessitates the use of a high pressure pump connected to water guns. The dipping procedure necessitates that cleaned plastic crates are dipped in tanks or tubs of chlorinated water at 43°C for at least two minutes. This latter procedure is practiced by an agribusiness firm in the Philippines (Figure 19). In practice, a thorough spray wash is generally more effective than a single dipping wash.

Figure 19. Sanitizing plastic crates by dipping



8. Physical management of returnable plastic crates in fresh produce supply chains

The adoption of returnable plastic crates has gained popularity for the bulk packaging of fresh produce because it generates operational benefit. However, the cost of these crates is significantly higher than that of disposable packages. There is consequently a need for proper physical management systems and practices for ensuring efficient and loss-free rotation of returnable plastic crates.

Management systems being applied in the Philippines, for example, include systems with return logistics, systems without return logistics, and firm-owned systems.

8.1 Management systems with return logistics

In the case of management systems that make use of return logistics, the plastic crates are owned by a service provider who could be a plastic crate manufacturer. The service provider is responsible for the return of the plastic crates after they have been emptied by the recipient, who stores them until a sufficient number has accumulated for cost-effective collection. The client always uses the same plastic crates and is responsible for monitoring the movement of the crates, their administration, cleaning, sanitizing, maintenance and storage. The client also sees to it that the number of containers is adequate. This system is being practiced by two farms supplying lettuce to fast-food chains in urban centres in the Philippines.

8.2 Management systems without return logistics

In systems without return logistics, the plastic crates are owned by entities, e.g. cooperatives, local government operators, terminal markets, that rent out the containers to traders. In situations where traders no longer require the containers, they are returned to the entities or owners. The trader is responsible for return logistics, cleaning, control, maintenance and storage. This system is followed by regular suppliers of fruits and vegetables to supermarket chains.

8.3 User-owned management systems

In systems of this type, the plastic crates are owned by the user who invests in order to purchase them. The user is responsible for return logistics, control, cleaning, sanitizing, maintenance and storage. Pilferage of crates can be as high as 20 percent during a single harvest season because of poor control measures.

9. Case study – lettuce supply chain in Southern Philippines

9.1 Background

In the highland town of Sumilao, Bukidnon in the Southern Philippines is located a 19 ha farm that produces lettuce for supplying food processors that serve large fast-food chains in Manila. Production is programmed in such a way that six tons of lettuce is harvested on a weekly basis, in order to fill two 20 ft refrigerated container vans to capacity. Figure 20 shows an area programmed to yield six tons of lettuce.

Figure 20. A plot of lettuce



9.2 Description of the supply chain

Lettuce is brought to the farm packing house for cleaning, sorting and air drying immediately after harvest. Harvested lettuce in the field is placed in green plastic crates with handles (Figure 21).

Clean and dry sorted lettuce is individually wrapped in brown paper prior to packing in yellow plastic crates (Figure 22). Plastic crates are then loaded in the pre-cooled 20 ft reefer van rented from a service provider, Cryo, Inc., with a loading capacity of three tons of lettuce. Two 20 ft reefer vans are used per shipment to Manila.

Figure 21. Harvested lettuce hauled from the field using green plastic crates



Figure 22. Plastic crates used for packing lettuce for transport



The loaded reefer vans are subsequently transported over a 12 hour journey to Cagayan de Oro City port. Shipping time from the farm packing house to the processor in Manila usually takes 48 hours. Processed lettuce is subsequently shipped to fast-food chains.

9.3 Adoption of plastic crates

The plastic crates are rented from a service provider who is also a manufacturer of plastic crates for its diverse group of agribusiness companies as well as for the food industry. The crates are 52 cm long, 35 cm wide and 27 cm high. The crates are stackable and nestable and are equipped with ventilation holes and rust-free handles for easy handling. Each plastic crate is rented from the service provider at a cost of 35 pesos (1 USD = 54 pesos) per “use”. One “use” constitutes the movement from the farm to Manila market.

9.4 Physical and hygienic management

Logistical arrangements between the lettuce farm and the service provider in so far as the return of the empty plastic crates is concerned is that the service provider holds responsibility for both the cost of transport and for the risk of pilferage of the empty crates.

As regards hygienic management, the lettuce farm is totally responsible for the cleaning and sanitizing of the rented crates. On harvesting a lettuce plot, the plastic crates assigned to be used as harvesting containers and for field hauling are used exclusively for that harvest. This policy is also followed for plastic crates used for transporting lettuce from the packing house to the market in Manila.

Cleaning and sanitizing of empty plastic crates is done by washing with water and detergent soap a day before use in order to allow for proper drying of the crates during storage in the packing house. The crates used during harvesting and hauling to packing houses are sanitized after every harvest, whereas those used for transport to market in Manila are sanitized after every shipment. The estimated cost of sanitizing crates is P2.50/crate.

9.5 Factors contributing to success in using returnable plastic crates

Given the high investment cost in acquiring the plastic crates, the rental scheme offered by the service provider is beneficial to both parties. Furthermore, the client is not subjected to the risk of pilferage of the crates during transport or when empty. The cost of transporting the empty crates back to the farm is also shouldered by the service provider.

With the use of plastic crates, a 5 to 10 percent reduction of post-harvest losses was realized over the entire lettuce supply chain when compared to the previous practice of using carton boxes for air transport.

Protocols followed for cleaning and sanitizing the reusable plastic crates are effective in preventing cross contaminations of post-harvest disease within the lettuce supply chain.

10. Conclusion

Maintaining the quality and protecting the safety of fresh produce supplies necessitates the coordinated effort of everyone involved in supply chains from the grower to the consumer. In the area of post-harvest handling and transportation, improvement in bulk packaging of fresh produce through the adoption of reusable plastic crates has contributed significantly to maintaining quality and reducing losses. Proper physical and hygienic management of plastic crates is equally important in order to safeguard against chemical, physical and microbiological risks.

This technical guide provides some basic principles and recommended practices for handlers and transporters to consider that will mitigate the various potential hazards associated with the reuse of plastic crates. It is important to follow strictly Good Manufacturing Practices (GMP) for handling and storage of plastic crates as well as protocols for cleaning and sanitizing them to ensure safety and wholesomeness of fresh produce as it moves through the chain from producer to consumer.

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