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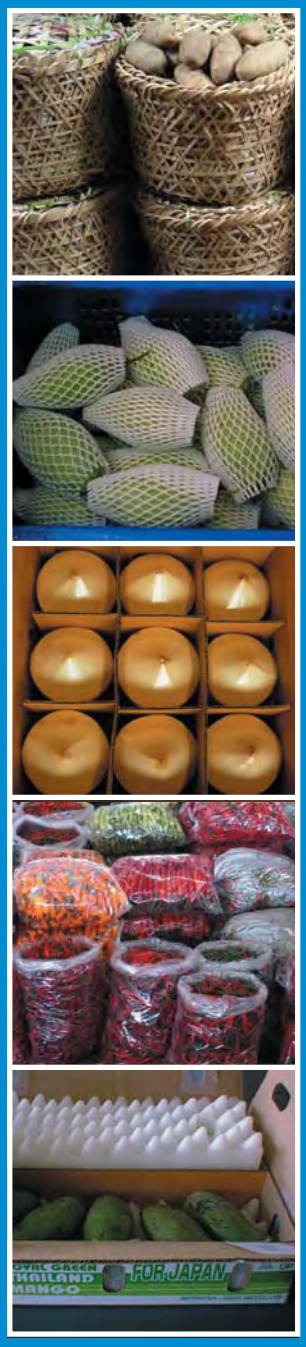

PACKAGING IN FRESH PRODUCE SUPPLY CHAINS IN SOUTHEAST ASIA

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Packaging in fresh produce supply chains in Southeast Asia

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FOREWORD

Packaging is very often critical to the success or failure of horticultural supply chains. In recent times, considerable emphasis has been placed on packaging in fresh produce supply chains in order to respond to changing consumer habits, market demand, trade requirements and the drive to reduce losses. Improved packaging can greatly contribute to improving efficiency in supply chain management and can increase returns for producers and retailers while delivering top quality fresh produce to consumers.

Bulk packaging of fresh produce in Southeast Asian countries ranges from traditional bamboo baskets and wooden crates to plastic crates and corrugated fibreboard boxes used for export. Retail packaging formats used vary widely in accordance with the nature of the retail outlet. Growing and changing consumer demands are, however, bringing about considerable change in retail packaging formats for fresh produce across the region.

This publication documents the results of surveys commissioned by FAO in three countries – the Philippines, Thailand and Viet Nam – to provide comprehensive up-to-date reviews on fresh produce packaging in the region's supply chains. Information presented in the publication is based on field surveys, interviews with supply chain stakeholders and experts, references from available sources as well as experiences of the various authors.

This publication provides the basis of FAO's future work in the area of capacity building on fresh produce packaging in the region. It is hoped that the information provided in this report will stimulate greater thought and action on measures to sustainably reduce losses across fresh produce chains in the region through improved packaging practices.

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ABBREVIATIONS AND ACRONYMS

ACCSQ	ASEAN Consultative Committee for Standards and Quality
ACFS	National Bureau of Agricultural Commodity and Food Standards
APEC	Asia-Pacific Economic Cooperation
BAFPS	Bureau of Agriculture and Fisheries Product Standards
BAR	Bureau of Agricultural Research (Philippines)
BAS	Bureau of Agricultural Statistics
BFAD	Bureau of Food and Drugs
BMC	box manufacturer's certificate
BPI	Bureau of Plant Industry
BRC	British Retail Consortium
CA	controlled atmosphere
CAT	Communications Authority of Thailand
CCF	corrugated common footprint
CEN	European Committee for Standardization (Comité Européen de Normalisation)
CF	common footprint
CFR	Code of Federal Regulations
CPLP	certified packaging laboratory professional
DA	Department of Agriculture
DOST	Department of Science and Technology
ECIB	European Chamber of International Business
EDI	electronic data interchange
EFTA	European Free Trade Association
EHWT	extended hot water treated
ENs	European Standards
EPAL	European Pallet Association
EPCIS	Electronic Product Code Information Services
EPS	expanded polystyrene
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FEFCO	European Federation of Corrugated Board Manufacturers (Fédération Européenne des Fabricants de Carton Ondule)
FTC	full telescopic container

FTD	full telescope design
FTHS	full telescope half slotted
GAP	Good Agricultural Practices
GDP	gross domestic product
GEM	Growth for Equity in Mindanao
GMA	Grocery Manufacturers' Association
GSMP	Global Standards Management Process
GTS	Global Traceability Standard
HACCP	Hazard Analysis and Critical Control Points
HDPE	high density polyethylene
IAF	International Accreditation Forum
IATCA	International Auditor and Training Certification Association
ICARD	Information Center for Agriculture and Rural Development
IEC	International Electro Technical Commission
IFPRI	International Food Policy Research Institute
ILAC	International Laboratory Conference
IPPC	International Plant Protection Convention
ISO	International Organization for Standardization
ISPM	International Standards for Phytosanitary Measures
ISTA	International Safe Transit Association
iTAP	Industrial Technology Assistance Program
LLDPE	linear low density polyethylene
LDPE	low density polyethylene
MAP	modified atmosphere packaging
MDF	medium density fibreboard
MTEC	National Metal and Materials Technology Center
NaOCl	sodium hypochlorite
NEDA-CAR	National Economic and Development Authority – Cordillera Autonomous Region
NLAQ	North Luzon Agribusiness Quadrangle
NMFC	National Motor Freight Classification
OSB	oriented-strand board
OTR	oxygen transmission rate
OVOP	One Village One Product
PASC	Pacific Area Standards Congress
PE	polyethylene
PET	polyethylene terephthalate

PHTRC	Postharvest Training and Research Center
PLA	poly lactic acid
PMO	produce marketing organization
PNRI	Philippine Nuclear Research Institute
POSSEC	Perishable One Stop Service Export Center
PP	polypropylene
ppm	part(s) per million
PRDC	Packaging Research and Development Center
PS	polystyrene
PVC	polyvinyl chloride
RFID	radio frequency identification
RO/RO	roll-on roll-off
RPC	reusable plastic container
RSC	regular slotted container
SC	subcommittee
SCSC	Standards and Conformance Subcommittee
SPS	Sanitary and Phytosanitary Standards
TC	technical committee
TISI	Thai Industrial Standards Institute
TISTR	Thailand Institute of Scientific and Technological Research
TPA	Thai Packaging Association
TPC	Thai Packaging Centre
UPLB	University of the Philippines-Los Baños
USAID	United States Agency for International Development
USFDA	United States Food and Drug Administration
USP	unique selling proposition
VHT	vapour heat treated
WG	working group
WHO	World Health Organization
WPP	woven polypropylene
WTO	World Trade Organization
WTO-SPS/TBT	WTO's Agreement on the Application of Sanitary and Phytosanitary Measures and Agreement on Technical Barriers to Trade
XCEP	Excellent Center for Eco-Product Development

Chapter I

Toward improved packaging practices for post-harvest loss reduction[1]

The past fifteen years have witnessed considerable growth and change in fruit and vegetable chains across Asia and the Pacific region. These changes have been accompanied by an evolution of packaging trends to respond to consumer and market demand in both local and export markets. These trends have also been largely influenced by the cost and availability of packaging to meet the need of various target markets.

Packaging plays an important role in maintaining the quality of fruits and vegetables as they move through the supply chain. Packaging protects produce from compression and abrasion damage during handling and transportation, and from exposure to chemical, physical and microbiological risks that could compromise their safety. Packaging facilitates the transportability of produce, while extending its shelf-life. Packaging alone cannot, however, address produce quality and safety. Other factors such as the maturity index of the produce at harvest, temperature control, washing and storage conditions of the produce, time to market, the retail system and consumer needs and preferences all play a critical role.

Across the ASEAN region, traditional packaging materials such as baskets and wooden crates are currently being replaced by corrugated boxes and returnable plastic crates for the bulk packaging of produce destined for high-end local markets, and institutions, while corrugated boxes are used primarily for export markets. Concurrently, plastic bags have begun to replace these forms of bulk packaging in the repackaging of produce at wholesale markets, owing to their lower cost, ready availability and ease of handling. The latter shift is of concern from both practical and environmental perspectives in that plastic bags do not allow for adequate ventilation, often compromising the shelf-life of produce under ambient conditions, offer little protection to produce against mechanical injury during handling, and are not biodegradable.

Growth of supermarkets in the region and growing consumer demand for quality, convenience and portion control has led to growth in retail packaging and, in some cases, branding of fresh produce for sale in high-end supermarkets. Retail packaging is also of interest from the retailer perspective in enhancing the visual appeal of produce on display in these establishments.

FAO's current initiatives to address post-harvest loss reduction in horticultural supply chains across the region bring in a specific focus on promoting the use and adoption of environmentally

[1] Rosa S. Rolle, FAO Regional Office for Asia and the Pacific

sustainable practices. Through capacity building activities and initiatives, FAO continues to place emphasis on the *reduce-reuse-recycle* concept of preserving the environment, in the marketing chains for fresh produce and promotes the proper use of recyclable bulk packaging materials such as reusable plastic crates to minimize losses during transportation. Given the changing trends in fruit and vegetable retail, emphasis is also placed on the appropriate use of consumer packaging. FAO continues to develop and disseminate pertinent technical support materials in the form of bulletins, technical guides and via Web-based communication.

The adoption of sustainable bulk packaging practices in horticultural supply chains, such as the use of reusable plastic crates will hinge greatly on awareness raising and training and education of supply chain stakeholders. Governments of the region can facilitate the adoption of good packaging practice in horticultural supply chains by providing an enabling environment that is supportive of the implementation of sustainable post-harvest practices. This could take the form of incentives to supply chain stakeholders that promote the adoption of recyclable plastic crates, for example, and the provision of facilities for the recycling and hygienic maintenance of these crates in wet markets. The private sector and particularly packaging companies can also play a role in providing services such as crate leasing arrangements. Academic and research institutions must, in the interim, continue to pursue research on the adaptation of traditional packaging materials, to enhance their suitability for the bulk packaging of fresh produce.

This publication documents surveys commissioned by FAO in three countries – the Philippines, Thailand and Viet Nam – on the use of packaging in fresh produce supply chains. It is hoped that the information provided in this report stimulates greater thinking and action on measures to sustainably reduce losses in fresh produce chains in the region, through improved packaging practices.

Chapter II
Basic principles of fresh produce packaging

1. Packaging

Packaging is defined as a term for material used for containment, protection, handling, delivering and presenting goods from the producer to the consumer or user, as well as preserving the product (European Parliament and Council, 1994/62/EC). Packaging is also regarded as an efficient system for delivering products to consumers. The packaging system includes various operations starting from conversion of packaging materials into packages, filling the packages with products before transporting them to the marketplace, consumption of packaged products and disposal of packaging waste.

The Packaging Institute International defines packaging as the enclosure of products, items or packages in container forms to perform one or more of the following functions: containment, protection, preservation, communication, utility and performance.

Packaging plays a significant role in delivering fresh produce to the consumer through distribution systems. Proper packaging reduces damage and loss, maintains quality, and protects produce against contamination risks throughout the supply chain. In addition, packaging plays a key role as a marketing tool, which is an important part of consumer decision-making. Packaging effectively serves an important role at every step of the supply chain.

2. Importance of packaging

Growing consumer demand for fresh produce has led to increased competitiveness in the fresh produce business, with quality and safety as major concerns. Consumers are increasingly searching for fresh produce with improved characteristics in terms of freshness, appearance, taste and flavour. Moreover, in today's fast-paced society, consumers are looking for additional benefits and convenience.

Packaging is used in moving fresh produce from farm to fork. It is the key solution in delivering produce of good quality to consumers. Packaging also adds value to fresh produce. Basic functions of packaging for any product including fresh produce are containment, protection and preservation (Box 1). Additional functions such as communication and convenience are becoming increasingly important in meeting consumer requirements. Packaging materials must also be designed to minimize environmental impacts. Advances in packaging design offer solutions to address these needs.

Primary functions of packaging for fresh produce include:

- *Containment:* Produce often comes in a number of discrete units of which distribution and marketing are difficult without packaging.
- *Protection:* Packaging of produce offers protection from post-harvest damage such as wilting, ripening and bruising.
- *Communication:* Packaging provides a medium for communicating information about the packaged produce between supply chain actors. By different means of communication, packaging can help promote and motivate the buying decision of consumers.
- *Convenience and use:* Pre-packaging provides consumers with convenience in consumption. A popular example of a convenience food is a pre-cut salad mix product, in which vegetables are cleaned, cut to size and are ready to eat, thus helping save on food preparation time.

3. Characteristics of fresh produce

Fresh produce is a living entity. Even after harvest, fresh produce continues its metabolic activity and undergoes physiological changes. These changes occur in three phases as growth, maturation and senescence. Ripening generally occurs during the later stages of fruit maturation to the first stages of senescence. Fruits generally undergo marked changes during ripening, leading to the development of desirable quality attributes – appearance, odour, flavour, and taste – that appeal to consumers.

Two types of fruit can be differentiated on the basis of respiratory patterns and ethylene production during ripening. A sharp increase in respiration and ethylene production occurs in "climacteric fruits" on the onset of ripening. This is not, however, the case in "non-climacteric fruits". Tropical climacteric fruits include mango, durian, mangosteen, papaya, etc., while non-climacteric fruits include pineapple, cantaloupe melon, water melon, litchi, longan, pomelo, etc.

Major factors in maintaining the quality of fresh produce at harvest and in the post-harvest state, include maturity at harvest, harvesting practices and post-harvest practices. Maturity indices are used to determine appropriate stages of produce maturity for harvesting. While mature produce can fully develop some characteristics such as size, colour, flavour and taste, immature produce may not fully develop such characteristics to meet consumer requirements. Produce harvested at a more mature stage is often susceptible to physical damage, disease and decay.

Proper harvesting and post-harvest handling practices reduce damage and minimize quality loss.

4. Packaging requirements for fresh produce

Packaging must be appropriately designed to maintain the quality and prolong the shelf-life of fresh produce. Fresh produce packaging must:

- be resistant to low temperature storage;
- be resistant to water damage resulting from produce cooling;

- be semi-moisture-proof to minimize weight loss and shrinkage of produce during marketing;
- be strong enough to protect produce from mechanical damage during distribution;
- be able to hold produce in place to prevent abrasion or impact of adjacent produce within the package;
- permit ventilation to dissipate heat resulting from produce respiration;
- have good gas permeability to avoid the risk of metabolic processes which may occur in the absence of oxygen (anaerobiosis), except in the case of modified atmosphere packaging, of which a degree of gas barrier may be essential;
- be biologically and chemically safe as food contact materials;
- be compatible with handling and transport equipment – facilitating the use of new modes of transportation, e.g. air transportation of light fibreboard boxes designed in rectangular shapes for efficient area utilization;
- provide convenience to consumers during marketing and consumption;
- be easily disposable, reusable or recycled.

5. Benefits of fresh produce packaging to consumers

Fresh produce packaging offers a number of benefits to the consumer:

- it reduces waste due to rotting or bruising;
- it extends the shelf-life of fresh produce – this is enhanced by low temperature storage and controlled atmosphere or modified atmosphere packaging;
- it enhances produce appeal – appearance and freshness to consumers;
- it increases convenience to consumers and decreases time required for shopping;
- through branding and proper labelling, it provides consumer confidence in produce quality;
- it increases the availability of produce to consumers, owing to the ability to ship produce from remote production areas to consumers worldwide.

6. Packaging formats for fresh produce

Fresh produce is packaged in either bulk or retail packaging formats.

Bulk packaging is used to facilitate the delivery of large volumes/quantities of fresh produce throughout a supply chain. Bulk packaging protects produce from physical damage and facilitates efficiency in handling and distribution. It is used for handling and transporting fresh produce for various purposes in the supply chain, including for harvesting, storage, wholesaling and also retailing. Design features of bulk packaging include strength, stackability, ease of handling and space utilization.

Retail packaging is a means of preparing fresh produce in unitized (small package) formats for retail markets by pre-packing produce in various forms. Retail packaging facilitates the delivery of individual units of produce for sale to the consumer. The main purpose of retail packaging is to meet consumer requirements for convenience.

The function of retail packaging goes beyond basic containment and protection. Retail packaging also facilitates communication as well as convenience and use. Printing and graphics are an important consideration in the design of retail packaging as a marketing tool for branding and consumer attraction. Retail packages are ready to be displayed in refrigerated cabinets at supermarkets.

7. Packing of fresh produce

Packing is primarily concerned with providing protection from the hazards of handling and distribution. Packing operations are generally conducted in packing house facilities that may be operated by middlemen, distributors, large retailers or exporters.

Fresh produce is susceptible to mechanical damage during handling and transportation. Damage may result from shock, vibration and compression. Shock usually results from drop and impact. Vibration may occur continuously during transportation, but the intensity of the vibration may vary with the mode of transportation. Compression damage occurs primarily during handling and storage.

Various types of cushioning materials are used along with distribution packages to reduce damage and loss due to mechanical injury during handling and transportation. Sheets of newspaper or shredded newsprint are commonly used as a lining material in bamboo and plastic crates (Photo 2.1), and in corrugated boxes. Leaves are also used as a lining material inside bulk containers. Plastic foam netting is commonly used for wrapping individual fruits before filling in corrugated boxes (Photo 2.2) and partitions and pads made of corrugated board are used to accommodate fruits in layers (Photo 2.3).

7.1 Methods of packing produce

- ***Random pack or jumble pack (Photo 2.1)***

This packing pattern refers to filling or packing of produce into containers randomly either by hand or via a filling machine. The quantity is usually based on weight rather than count. This is the most common method of produce packing as it is simple and low in cost. It, however, has the lowest density, which generally causes the greatest degree of produce damage during handling and transportation. Besides, it is the least attractive and uniform pattern. Therefore, this is not commonly used for the packaging of expensive, premium quality produce destined for high-end markets.

Photo 2.1 Random pack or jumble pack pattern

- ***Pattern packing or place packing (Photo 2.2)***

In pattern packing, produce is generally placed by hand in a pattern, in the package. Pattern packing generally results in higher density packing as compared to random packing. Pattern packs are less vulnerable to produce damage, are more uniform and are more appealing in appearance. Pattern packing is generally used for relatively expensive, premium quality produce for high-end or export markets.

Pattern pack

Photo 2.2 Pattern packing or place packing

- ***Tray or cell packing (Photo 2.3)***

Produce is placed in an individual compartment of a tray or cell stacked in a shipping container. Tray or cell packing offers protection of produce from stacking pressure as well as from impact with each other. However, with its loose packing density and headspace in each compartment, produce could be damaged due to vibration during transportation. Trays are generally made from moulded pulp paper or plastic. Cells are usually formed from corrugated board. Produce should be of uniform size in order to fit properly in moulded tray compartments. The tray pack pattern has become increasingly common for produce packing as it is a simple and convenient system, with an appealing appearance.

Photo 2.3 Tray pack pattern

Chapter III

Packaging in fresh produce supply chains in the Philippines[2]

1. Introduction

Changing consumer and market demand, trade requirements and the need to reduce losses in horticultural supply chains dictate that greater attention is given to the proper use of packaging in horticultural supply chains in the region. The objective of this study was to review the status of packaging in horticultural supply chains in the Philippines.

To appreciate and understand the agricultural sector in the Philippines, various published articles were referred to. Documented research and studies gave meaningful insights into the current situation of the fresh fruit and vegetable supply, the overall performance of the fruit and vegetable sector, areas requiring improvement, post-harvest practices and growth prospects for the sector. This background provided a good overall understanding of current handling and packaging practices. Visits were made to several provincial wet markets and supermarkets, major "*bagsakan*" or trading posts and a number of growers, retail vendors, traders, handlers and truckers were interviewed to validate prior knowledge.

A number of resource persons from different institutions including: the University of the Philippines-Los Baños (UPLB) – Postharvest and Seed Science Division, Packaging Research and Development Center (PRDC) of the Department of Science and Technology, Department of Trade and Industry (Philippine Trade Training Center and Bureau of Export Trade Promotions, National Economic and Development Authority – Cordillera Autonomous Region (NEDA-CAR) in Baguio, Municipal Agriculture Office in La Trinidad, DTI-Region 10 Regional Office, and San Miguel Yamamura Packaging Group, contributed useful information in the preparation of this report.

Statistics were obtained from the Web sites of the Bureau of Agricultural Statistics (BAS) and the Bureau of Agricultural Research (BAR) of the Department of Agriculture.

This study on the "Status of packaging in fresh fruit and vegetable chains in the Philippines" surveyed the following:

- trends in fresh produce (including fresh cut) horticultural supply chains;
- marketing channels for fresh horticultural produce;

[2] Aniceto Abner S. Villahermosa, Packaging Consultant, Philippines

- types, cost, accessibility and availability of packaging materials used in the supply chain and marketing channels;
- in-country programmes to promote the use of packaging in horticultural supply chains;
- regulations that govern the use of packaging within the country and in regional and international export markets;
- traceability issues and packaging;
- gaps that prevail in the fresh produce supply chain.

2. Fruit and vegetable consumption trends

Fruits and vegetables in the Philippines are primarily procured in wet markets. However, with increasing income and with improved purchasing power, produce is increasingly being purchased in supermarkets. Buying decisions of supermarket shoppers are based on the composite influence of price, convenience, safety, packaging, branding and produce quality. Now visibly evident in Metro Manila, the popularity of supermarkets will likely continue to evolve in key urbanizing cities and municipalities nationwide.

The fresh fruit and vegetable sector is challenged to proactively respond to the following consumer trends and to find growth opportunities in the process.

- **Growing sophistication which brings about a greater emphasis on quality, safety and overall wholesomeness of food.**

Changing lifestyles brought about by rapid urbanization, increased purchasing power and more women in the workforce are creating a market of consumers willing to pay for safe, high-quality value-added products. Health and wellness concerns are also overriding factors in food trends. Families will improve eating habits by turning to natural and healthy foods. Fresh fruits and vegetables fit snugly into this trend not only as nutrient sources but also as alternative healthy snack foods.

"Organic", "naturally-grown", "traditionally-grown", "pesticide-free" and similar taglines or unique selling propositions (USPs) will likely be keywords in the market promotion of fresh fruits and vegetables.

- **Increasing number of smaller families and single households**

Trends point toward a growing demand for single-portions and preference for produce packaged in convenient formats. Solo papayas are, for example, preferred over larger sized papayas on export markets. Similarly, smaller varieties of pineapples such as the Queen pineapple produced, in Camarines Norte (Bicol Region in Luzon) may find wide acceptance in markets nationwide.

- **Continuing tug-of-war between value and price**

A good understanding of customer demands and market segmentation will play a critical role in developing market niches for value-added products. With limited disposable income, consumers

will stretch their financial resources in every possible way. They will trade down to lower-priced brands and eat out less. On every possible occasion, they will, however, treat themselves by indulging in small yet affordable luxuries. They will hold on to favourite brands as long as they can. Consumers want to control how they live and how they spend.

Malls and supermarkets are actively balancing value and low cost with the average consumer in mind. The coined word "malling" means many things other than buying. Supermarkets nurture a "feel-good" atmosphere for meeting friends, enjoying recreation or even just letting time pass. Commonly seen in malls and supermarkets are families spending bonding moments together.

Photo 3.1 Supermarket shopping scenes in the Philippines

Consumers will demand more value for money in the form of high quality produce, assured safety and consistent customer service. To obtain their money's worth, consumers like to be informed more about products they buy, where they are sourced and how they are processed. Package labels and branding are wide-reaching media that are used to communicate relevant messages and information that consumers want to know.

- **Increasing desire for new flavours and variety**

All trends pose both threats and opportunities at the business level. One threat comes from the growing volume of fresh produce imports into the Philippines. Many consumers perceive imported fruits as being of better quality than those that are locally produced. When offered at lower prices in visually appealing packages, Filipino consumers will not hesitate to purchase imported fresh produce.

Imported temperate fruits such as apples, pears, peaches, persimmons, plums, citrus, cherries, litchis from China, Republic of Korea and Taiwan Province of China stand out visually on display shelves in supermarkets and in wet markets across the country. Imports from Thailand such as longan and sweet tamarind packed in paperboard folding boxes also stand out. Photo 3.2 shows examples of fruit imports sold in wet markets in Metro Manila and in the provinces.

Opportunities also come from the growing global demand for the year-round availability of a range of high quality fresh produce items. New markets may be found in countries where Filipino populations exist. These markets can be effective in promoting ethnic or indigenous fruits to mainstream populations of Filipinos. The large number of overseas Filipino workers also brings the need for more choices.

Photo 3.2 Fruit imports sold in wet markets in Metro Manila

- **Brand consciousness of consumers**

Brands that can communicate what they really stand for and show how they can make life easier will earn consumers' trust and loyalty. It should be noted that a brand simplifies the buying process and stays long in the memory of the consumer. It also differentiates suppliers from competition.

- **Growing appreciation for social consciousness and responsibility**

Consumers procure produce from companies that demonstrate concern for their manpower, ecological protection and social commitment. Food processors source their raw materials from domestic growers as their contribution to community development. Nestle has, for example, entered into agreements with Philippine coffee growers not only because this is logistically advantageous but also to improve livelihoods in rural areas. Supermarkets are promoting reusable "green bags" for packaging as their share in solid waste reduction and overall environmental responsibility.

3. Fresh fruits and vegetables produced in the Philippines

Fruits and vegetables are the most dynamic agricultural commodities traded globally. International trade in fruits and vegetables has been growing at a steady pace for over two decades, and has grown by as much as 30 percent since 1990 (Rudyard, 2008).

The Philippines ranked among the world's top 30 exporters of fruits and vegetables (fresh fruits, processed fruits and vegetables, and fruit and vegetable juices) according to a 2004 ERS report. Its foreign trade partners include Iran, United Arab Emirates, Republic of Korea, Singapore, Hong Kong Special Administrative Region, United States of America, Germany, Malaysia, New Zealand, Canada and Japan. These foreign trade markets, particularly Japan, are major export destinations of the country's top fresh tropical fruits, particularly banana, pineapple, mango and papaya.

The large Japanese fruit and vegetable market is an important trade partner not only for Asian countries but also to the rest of the world. Together with the United States, Philippine fresh tropical fruit exports to Japan (mainly banana, followed by pineapple and mango) comprised at least 50 percent of total imports (Dyck and Ito, 2004) into that country.

In 2008, the Philippine crop subsector, which accounts for 47.7 percent of total agricultural production, showed 4.0 percent growth over that in 2007. Palay and corn registered output

increases at 3.5 percent and 2.8 percent respectively. Higher production outputs were obtained for pineapple (9.6 percent), banana (6.1 percent) and sugar cane (22.6 percent). The crop subsector accounted for close to 48 percent of total agricultural production grossing ₱635 billion (at current prices) and grew about 24 percent over 2007 (Bureau of Agricultural Research).

The Philippine agricultural sector accounts for about 20 percent of the country's gross domestic product (GDP) and employs about one-third of the population. It is the bedrock of the rural economy. Of the five identified Super Regions, major agribusiness development will be focused on: (1) North Luzon Agribusiness Quadrangle (NLAQ) and (2) Agribusiness Mindanao.

Top 5 fruits produced

During the period January to June 2008, the Bureau of Statistics (BAS) reported increases in area planted over 2007 at 12.64 percent for pineapple, 3.1 percent for mango, 2.93 percent for calamansi and 1.8 percent for banana.

The top five fruits produced in the Philippines are:

- Banana — Generally priority crop in most regions
- Pineapple — Generally priority crop in most regions
- Mango — High domestic demand. Luzon accounts for 49 percent; exports account for 2-3 percent of world market demand.
- Calamansi — Processed into juice drinks and concentrates.
- Papaya — Capital intensive; primarily large-scale concentrated in Mindanao particularly in South Cotabato; also grown on a large scale in Southern Luzon particularly in Cavite.

Banana Pineapple Mango Calamansi Papaya

Photo 3.3 Top five fruits produced in the Philippines

Main exports of the Philippines include bananas (Cavendish) and pineapples which are exported by multinational companies such as Del Monte Philippines and Dole Philippines. Vapour heat treated (VHT) mangoes are exported to Japan by companies such as Diamond Starr Agro Products, Hi-Las Marketing, Marsman Drysdale and Dole. Extended hot water treated mangoes (EHWT) are exported to Hong Kong and China by Phil Harvest Agro Marketing Corp., Mabuhay 2000 Enterprise, Fruitful Harvest, Wenatchee Marketing, Sucrex, Flying Horse and Eden Marketing. Dried mangoes are exported by Profoods, Hi-Las, 7-D, AEO and Cebu Legacy.

Top 5 vegetables produced

Two main categories of vegetables are produced in the country:

- Highland or temperate — Salad vegetables, e.g. lettuce, tomato, carrots, cucumbers. Other major crops are cabbage, Chinese cabbage, cauliflower, broccoli, potato
- Lowland — Eggplant, squash, okra, bitter gourd, string beans, garlic

Some of the highland or temperate vegetables are also grown in the lowlands in limited quantities. Benguet is the major source of temperate vegetables.

The top five vegetables produced are eggplant, tomato, cabbage, onion and bitter gourd.

Eggplant | Tomato | Cabbage | Onion | Bitter gourd

Photo 3.4 Top five vegetables produced in the Philippines

Issues and concerns

Post-harvest losses

Post-harvest losses across fruit and vegetable marketing chains vary between 20 and 40 percent in the Philippines and are a major bottleneck that must be addressed. These high levels of post harvest losses result largely from inefficiencies in handling, transportation, harvesting, packaging and storage operations.

The more complex, multilayered or fragmented the marketing system, the higher the levels of losses. A reduction in losses would increase the availability of marketable volumes and thereby increase the affordability of produce. Proper post-harvest handling practices, cold chain systems, improved logistics and appropriate transport and packaging systems for fresh fruits and vegetables will contribute greatly to reducing losses and to expanding market reach.

Cost of transportation

Charges for the transportation of fresh produce in the Philippines are based on the number of containers, rather than on the basis of the weight of the produce. For this reason, large containers are used for the transportation of fresh produce. This, however, results in losses owing to compression. Large wooden crates are, for example, used for the shipment of papayas from Mindanao, and large and overfilled *kaing*/bamboo baskets and woven polypropylene (WPP) sacks are used for shipping eggplants from Iloilo (a province in Visayas).

Moreover, fresh produce is often treated as "low priority cargo" in air freight and probably even during sea shipments. Low priority is given to the shipment of fresh produce when compared to tuna (air shipment) and livestock (sea shipment).

Distance to market

Fresh produce farms are generally located in very remote locations and are relatively distant from each other. Transportation of produce to markets, therefore, necessitates high handling and transport costs and incurs spoilage and losses. In Luzon and Visayas, vegetable farming is characterized by smallholdings which are further subdivided into tiny parcels of land planted with various types and varieties. The situation is somewhat different in Mindanao where parcels are bigger and are owned by fewer landowners.

Because fruits are generally perennial crops, harvest for the coming season is, in general, pre-allocated to traders at lower than prevailing market price. This is due to the fact that wholesalers and traders have paid way ahead of time by providing farm inputs like fertilizers and pesticides.

Fresh produce supply chains

A schematic of commodity flows for fresh fruits and vegetables in supply chains in the Philippines is shown in Figure 3.1. Fresh produce all over the country passes either through wholesale vegetable markets or through trading posts where buyers bargain for the lowest price. Numerous small farmers compete for buyers at arm's length transactions and very volatile daily prices (Concepcion and Montiflor, 2003).

The centre of the supply chain for temperate and lowland vegetables is the wet market which serves as the primary retailer for both the consumer and institutional markets such as supermarkets, fast-food chains, restaurants and hotels.

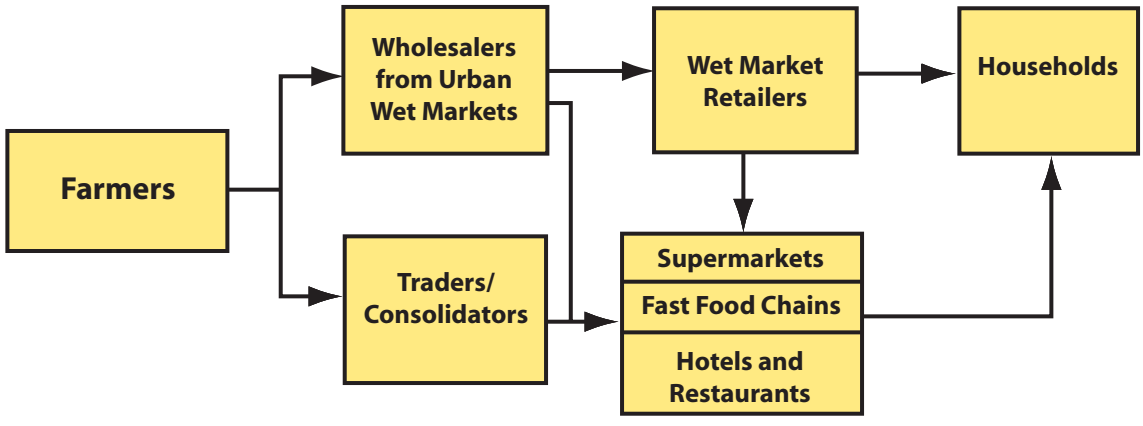


Figure 3.1 Schematic of commodity flows for fresh fruits and vegetables in supply chains

Harvested produce is, in general, either loosely packed onto vehicles, or is packed into large *kaings* which are loaded into jeeps and trucks for transportation. On arrival at the trading post, produce is sorted, weighed and packed into plastic bags, woven polypropylene sacks or reused corrugated boxes as specified by traders, consolidators, wholesalers.

Photo 3.5 Packing and packaging of fresh produce for transportation to wholesale markets

The produce is subsequently loaded onto large trucks for delivery to Divisoria (the mecca of value shopping in Manila) and Balintawak (a fresh produce trading centre located in Quezon city) in Metro Manila and other trading posts and wet markets in lowland provinces, including those in Visayas and Mindanao. On arrival in Manila markets, bulk-packaged produce in large bamboo baskets is repacked into smaller packaging units for retail in other wet markets in Metro Manila and nearby provinces. Once purchased, fresh produce always ends up in plastic bags or is packed into baskets by consumers.

Photo 3.6 Repackaging of fresh produce at wholesale markets for sale to retailers

Vegetables destined for remote areas go through several wholesalers before reaching wet markets. Most farmers are not concerned where or to whom their produce is ultimately sold.

Key players in fruit and vegetable supply chains

Wholesalers, consolidators and traders are key players in fresh fruit and vegetable supply chains. Their main focus is on maximizing profit by providing consistent and reliable supplies of produce. Consolidators and traders who procure produce for institutional markets are becoming increasingly active in trading posts which are generally located in close proximity to wet markets. In some cases, these consolidators and traders sell to institutional markets and procure produce directly from retailers and wholesalers in wet markets.

Farmers/growers and consolidators are increasingly developing closer relationships for the supply of complete lines of vegetables that are demanded by institutional buyers. Supermarkets deal with a very limited number of consolidators for their produce supplies. One or two consolidators

specialize in vegetables and the same number for fruits. Thus, consolidators also source from different farm areas to assure continuous supplies.

In situations where supermarkets make direct purchases, they exercise tight control over the placement and packaging of produce. The cost of shrinkage due to water loss and product spoilage is borne by the supermarket. In some cases, supermarkets lease out space to a vegetable supplier who in turn takes care of the assortment of produce, packaging, stocking, display and all other merchandising activities. Standards and other operating parameters are also imposed by supermarkets.

Grower cooperatives and cluster farming associations currently trade alongside private wholesalers and consolidators. Large growers of fruits from Mindanao have established their own trading areas or booths in Divisoria or Balintawak.

Transportation systems used in fruit and vegetable supply chains

Carts, trolleys, tricycles, jeeps, trucks and vans are used for the collection, handling and delivery of fresh produce to wet markets and trading centres. In remote farming areas, carabaos and horses are the major sources of fresh produce transportation. Fresh produce handling will likely remain a manual operation.

Photo 3.7 Transportation systems used for moving produce to wholesale markets

Shipments from Visayas and Mindanao are now made convenient by roll-on roll-off (RO/RO) vessels that connect Luzon, Panay, Guimaras, Negros Oriental and Mindanao through the so-called strong Philippines nautical highway. As a supply chain solution, RO/RO allows loading and unloading of self-driven vehicles onto the vessels. Gains are in the form of short timeframes between the farm and market, resulting in reduced handling and produce losses. Relatively limited quantities of fresh produce are shipped by air freight.

4. Packaging systems for fresh produce

Bulk packaging

Bulk packaging used for fresh produce transportation includes corrugated boxes, wood crates, bamboo crates or "kaings" and "bayong" (woven baskets). The most widely-used forms of bulk packaging in supply chains in the Philippines are plastic bags, wooden crates, corrugated boxes, sacks and plastic crates. These are now described in terms of their use, price and availability.

Indigenous bulk packaging materials

Basic features • are generally "*kaings*" made from bamboo and rattan, 20-50 kg capacity; • used for harvesting/collecting; transporting and bulk selling; • used in wet markets and roadside stalls in provinces.	*Examples of current usage* • as collection/harvest containers; • for collecting tomatoes for processing; • for the collection of "saba" bananas for processing by fast-food chains; • as display/sale pack for mangoes and small-sized fruits.
Supply and Prices • supply increasingly difficult and are becoming scarce; • no known company supplier; are handcrafted where a concentration of growers exists; • prices ranging from ₱20 to ₱80 a piece depending on size and material; large rattan *kaings* cost ₱120–₱150/piece.	*Prospects* • being replaced by LDPE bags; • suitable for deliveries over short distances; • used as gift packs for fruits such as mangoes

Kaings used for harvest, collection, handling and road-side vending

Photo 3.8 Bulk packaging materials from indigenous materials in use

Wood boxes and crates

Basic features	*Examples of current usage*
• good mechanical protection, good stacking height, weight-to-strength ratio, resilient, good ventilation; • some crates labelled with supplier codes; • untreated boxes can be contaminated with pests and insects; • after-use-value for firewood or for repair of broken box parts.	• long-distance shipment of heavy fruits such as pomelo, watermelons, durian, mangosteen, lanzones, and bananas in large volumes; • shipment of tomatoes from Mindanao; • exports to nearby countries like Hong Kong, Malaysia and Taiwan; • reused as retail stands or for firewood.
Supply and prices	*Prospects*
• supplied by individuals and from community enterprises; • no known company supplier; • growers fabricate to meet own requirements; • wood is increasingly becoming a scarce resource; • prices range from ₱15 to ₱40 a piece.	• will likely continue to be used for transportation of heavy fruits; • wood crates for mangoes may be replaced with corrugated boxes for domestic shipments; • use declining in export markets owing to importer regulations.


As display stand


Watermelon


Lanzones


Mangosteen


Banana


Tomato

Photo 3.9 Wood crates used as packaging options for fresh produce

Wood crates having a capacity of 70 kg that make use of reused corrugated board (₱4.00/kg) as liners/side panels in the packaging of solo papaya;
Growers source wood and assemble crates. Crates cost ₱35/piece. Solo papayas are repacked at trading centres into LDPE bags with newspaper wrap in accordance with buyer specifications.

Woven polypropylene (WPP) sacks

Basic features • poor protection from compression; • capacity of 50 kg; • are often overfilled; • can easily be returned for re-use; • commonly seen in trading centers; • difficult to clean and allow build up of decay	*Examples of current usage* • used for produce items such as potatoes, root crops, and small fruits; • used as bulk overwraps for leafy vegetables; • used for the short-distance land delivery of green mangoes, green papayas calamansi (Philippine lemon) and unripe avocados, etc.
Supply and prices • easy to source from local converting companies; • reused sacks are commonly used; • cost about ₱10/piece.	*Prospects* • will remain with "overloaders" in provincial areas or for short-distance land deliveries; • may be substituted with plastic bags for orders weighing less than 20 kg; • usage will decrease since transparent bags are, in general, preferred by traders.


Green mango


Unloading from jeep for wet market delivery


At La Trinidad Trading Post


Leafy vegetable


Avocado


Cassava

Photo 3.10 Use of woven sacks in fresh produce packaging

Raschel bags

Basic features	*Examples of current usage*
• strong, good ventilation; • referred to as "red bags" in trading centers.	• for the packaging of onions and garlic • for the packaging of calamansi.
Supply and prices	*Prospects*
• domestic supply; • price about ₱12/piece.	• packaging of onions and garlic; • packaging of calamansi.


Called "red bags" for onions


Calamansi

Photo 3.11 Use of raschel bags in the bulk packaging of fresh produce

Traders and vendors in Divisoria associate violet sacks with imported garlic and red sacks with imported onions. This practice illustrates the power of colour as brand equity.

Plastic bags

Basic features	*Examples of current usage*
• poor compression, difficult to clean, allows build up of decay; • good barrier against water; • capacities ranging from 10 kg to 50 kg; • shipping bags are made of LDPE and have poor ability to facilitate exchange of moisture and gases; • shopping bags are made of HDPE.	• used mainly for vegetables such as carrots, potatoes, root crops; • LDPE bags are the predominant packaging material for vegetable deliveries from Benguet and nearby provinces to Divisoria; • used for shipping, repacking and retail/ "take-home" purchase.
Supply and prices	*Prospects*
• easy to source from many converters in Metro Manila; • easy to deliver, freight-efficient; • can be sourced in wet markets from vendors/ packaging traders; • prices: shipper/big @₱2.30–₱5.60/piece retail/shopping @₱0.20–₱0.50/piece	• will be more dominant even for provincial deliveries; • are a preferred form of packaging for traders/ repackers; • may introduce branded deliveries.

Photo 3.12 Use of plastic bags in the bulk packaging of fresh produce

Multipacked okra in LDPE plastic bags in Divisoria

Okra multipacked in plastic netting for export to Japan

Photo 3.13 Packaging formats for okras destinged for local and export markets

Corrugated shipping boxes

Basic features	*Examples of current usage*
• shipping boxes can be customized; • resistant to moisture; this resistance is improved by wax and other chemical coatings; • easily printed and doubles as shelf display, bins, dispensers, carriers, etc.; • made of kraft linerboards and mediums.	• large commercial volume for fruits particularly for exports – bananas, mangoes and pineapple; • suitable for high-value vegetables for export; • reused for fruits and vegetables.
Supply and prices	*Prospects*
• sources concentrated in Metro Manila, Cebu and Davao; • reused box costs ₱5–₱15/box (depending on condition and location); • new box prices range from ₱20 to ₱50/piece depending on structure and volume order.	• substitute for wood crates (pomelos) for delivery to supermarkets; • growth hindered by relatively high price, volume orders, availability; • airlines require corrugated boxes rather than wood crates; • as gift packs for fruits.

Mango for export to Hong Kong

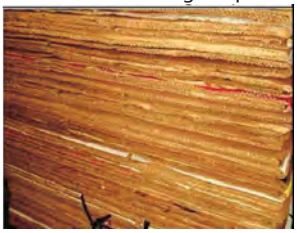
Bin at trading center in Baguio

Banana for export

VHT box for mango export

Del Monte box reused for mangosteen

Banana box reused to ship mangoes from Mindanao



Used boxes for resale

Photo 3.14 Use of corrugated shipping boxes in the bulk packaging of fresh produce

Regular slotted containers (RSC) and full telescopic containers (FTC) are two of the most popular shipping carton structures. RSC is most simple and the lowest-cost box style. However, the RSC has relatively low stacking strength when compared to the FTC which actually consists of one box inside another. In some instances Bliss box is constructed with three different pieces for maximum stacking strength. Corrugated fibreboard containers are shipped to the packer in the flat form and are assembled at the packing house.

18.41 kg (40 lb) FTC; Bottom box is double-walled. Top cover is top white linerboard. Mandatory label information such as the batch code and handling instructions are included on the label.

4.7 kg and 7.2 kg FTC; Bottom box for 7.2 kg is double-walled while for 4.7 kg is single-walled. Side panels include USP claims such as "fresh and sweet" and "natural health".

Photo 3.15 Boxes used in the packaging of bananas showing special features of design and labeling

17 kg; 200-test, partitioned, wet-strength boxes, with ventilation holes covered with nylon mesh, with or without foam padding for the packaging of vapour heat treated mangoes.

Photo 3.16 Boxes used in the packaging of mangoes, highlighting special features




single-wall printed white linerboard covers for boxes; double-wall bottom box; box (a)

brand/logo USP claim instructions batch code (b)

Photo 3.17 Boxes used in the packaging of pineapples, highlighting special features of labelling and branding

Plastic crates

Basic features	*Examples of current usage*
• commonly produced using HDPE or polypropylene (PP); • best for closed returnable system • hygienic and easy to clean; • usually nestable and stackable; • long reusable life/highly recyclable; • often times recommended by post-harvest studies.	• widely-used container in pack houses and processing plants; • high-value vegetable deliveries to supermarkets, hotels, restaurants; • retail display trays; • deliveries to consolidation centres.
Supply and prices	*Prospects*
• stock crates are retailed; • proprietary crates require mould payment at about ₱1 million; Minimum order volume at 5 000 pieces; • use of recycled material lowers price; • price range:₱250–₱300/piece.	• limited use as containers for fruits and vegetables; • crates are offered on lease by the San Miguel Cooperation.

Photo 3.18 Use of plastic crates for the bulk packaging of produce

Successes achieved with the use of plastic crates for bulk packaging

The horticulture community in the Philippines has done its part in training, research and development nationwide. Despite its limited resources both in terms of manpower and finances, the community has published various articles on increasing yield, improving varieties, developing pest-resistant plants and improving post-harvest practices for specific fruits and vegetables. Packaging innovations, however, continue to lag behind innovations in fresh produce supply chains. Reasons for this lag include continuing resistance to innovations, rigid or self-serving attitudes among supply chain players, lack of market information and insensitivity to changing consumer preferences. These problems are compounded by the inadequacy of farm-to-market roads and unavailability of cold storage facilities.

The resistance to adopting innovations among farmers is not without reason. Farmers are competent in production rather than in marketing. Farmers/growers expect the cost of packaging innovations to be borne by traders and consolidators who they perceive to be deriving the largest percentage of profit.

San Miguel Packaging Specialists Inc. (now known as San Miguel Yamamura Packaging Group), in 1995, presented its leasing crate arrangement programme to producers and distributors nationwide as part of its Total Packaging Solution strategy. This marketing strategy was based on the high initial costs of the purchase of plastic crates coupled with the fact that plastic crates are the most economical shipping container over the long run for closed distribution systems.

Farmers interviewed in Benguet during this survey, were not interested in plastic crates because of their high cost. Fully aware of high losses, farmers were pleased with the use of *kaings* and plastic bags which they could overload to maximize space during transportation and delivery.

Photo 3.19 Packaging and transport systems used in traditional fresh produce supply chains

A lettuce grower of Mount Moriah Farms in Bukidnon, Cotabato in Mindanao, recognized the need for the use of plastic crates to maintain produce quality during shipping.

Photo 3.20 Packaging and transport systems used in a modern supply chain for lettuce

Mount Moriah Farms, therefore, entered into the leasing of crates (with an option to purchase) with San Miguel, a packaging company. The former paid on a per-trip basis, while San Miguel retrieved the crates in Metro Manila and shipped them back to Bukidnon. The arrangements worked perfectly despite the fact that the supply chain was not really a "closed" system. Today, Mount Moriah is well accepted as a reliable lettuce supplier for Metro Manila fast-food chains. The company now owns 10 000 plastic crates. It has also partnered with consolidators for supplying supermarkets.

NorMinVeggies (Northern Mindanao Vegetable Producers' Association)

NorMinVeggies (Northern Mindanao Vegetable Producers' Association), a "cluster farming system" is another success story. Originally comprising small farmers to supply local wet markets, the cluster now ships about 50 metric tonnes of high-value, semi-temperate vegetables weekly to major fast-food chains, supermarkets and hotels in Cebu and other cities in the country. The cluster was closely assisted by the Department of Agriculture and USAID's Growth with Equity in Mindanao (GEM) Program. In conformance to Good Agricultural Practices (GAP), NorMinVeggies makes use of plastic crates in its supply chains to assure delivery of quality produce.

Retail Packaging

Retail packaging in wet markets

Retail packaging in wet markets is largely done by vendors. Plastic bags are packed with pre-weighed quantities of small-sized produce such as tomatoes and calamansi. Rubber bands are used in unitizing selected produce items such as string beans and petsay (pak choi). Pre-cut vegetable mixes are packed in plastic bags while pre-sliced fruits are packaged either in plastic bags or in cling-film overwrapped styrofoam trays.

Photo 3.21 Retail packaging formats used in wet markets in the Philippines

Photo 3.22 Retail sale and packaging of fresh produce in wet markets in the Philippines

Photo 3.23 Green bags used for the packaging of sweet Japanese corn in Laguna

Retail packaging in supermarkets

Retail packaging is done on-site in most supermarkets to assure fresh produce quality. While still in the process of setting standards and strengthening their supply networks, supermarkets in the Philippines are likely to delegate retail packaging to their consolidators in the coming years. Manually perforated plastic bags (mainly low density polyethylene) are used for the multipacking of vegetables and fruits. Eggplants, bitter gourds and cucumbers are sold in packs of three or six. Lettuce, cabbages, string beans, bananas, tomatoes and other seasonal fruits are cling-film wrapped with or without styrofoam trays. Pre-cut salad mixes and pre-sliced fruits are commonly packed in film overwrapped styrofoam trays. Branded salad mixes in printed flexible packs are slowly being introduced on supermarket shelves but volumes are still very limited.

Photo 3.24 Branded salad mixes packaged in printed flexible packaging

Retail packaging for export

By and large, packing houses have yet to consider retail packaging in the true sense of the word. The labelling or tagging of individual fruits with stickers is, however, gaining popularity. With the exception of clear cling film, all materials for retail packaging are produced by converters based in Metro Manila and are distributed nationwide by wholesalers and vendors in trading centres, supermarkets and wet markets.

With the exception of okras shipped to Japan, relatively little is done on retail packaging for export. Retail packages of okras destined for the Japanese market consist of plastic nets (imported from Japan) as multipacks with label headers made from paper. The plastic nets are, however, imported from Japan.

Photo 3.25 Retail packages of okras for export

Thermoformed plastic trays, clamshells and cups

Basic features	*Examples of current usage*
• made primarily out of polystyrene; other materials are polypropylene (PP) and polyvinyl chloride (PVC); • expanded polystyrene (EPS), usually referred to as styrofoam, is popular; • relatively easy to source; • retailed by packaging traders and supermarkets.	• on-site retail packaging of pre-cut vegetables and sliced fruits in trays which are cling-film overwrapped seen mostly in supermarkets; • domestic interest remains lukewarm as retail/ individual fruits packaging.
Supply and prices	*Prospects*
• easy to source in retail volumes; • at least 3 major suppliers in Metro Manila; • proprietary design mould payment @ ₱50 000/set; • price range: ₱1.50–₱2.00 for cups; ₱2.00–₱3.50 for trays; for EPS trays depending on size.	• use will grow with fresh-cuts; • perfect use as convenience packs for niche markets; • a good option for fresh strawberries and export mangoes.

Usually made of polystyrene in clear clamshell, trays or expanded also called "Styrofoam" white or colored trays

Photo 3.26 Plastic trays and clamshells used for the retail packaging of fresh and fresh-cut fruits and vegetables in the Philippines

Paper and paperboard

Basic features	*Examples of current usage*
• common paper stocks used are sulphate, sulphite, grease-proof, glassine, tissue, chipboard, clay-coated boards. • surface treatment to improve properties includes waxing, lamination, varnishing.	• as labels, tags, folding cartons; • better used in the processed food sector.
Supply and prices	*Prospects*
• few large companies but numerous medium, small and specialty ones; • minimum volume orders vary from small to large depending on suppliers; • box prices (₱10–₱15/piece) depending on type of material, size, surface treatment, print quality, etc.; • sticker labels: ₱0.25–₱0.75/piece.	• no application as shipping packages for fresh fruits and vegetables; • can be used as carriers for light-weight loads.

Some years ago, a company was trying to introduce moulded pulps (right) for domestic applications. One of the target markets was fresh produce particularly strawberries. This packaging format was not adopted owing to the high price.

Photo 3.27 Moulded pulp trays with potential use in the packaging of strawberries

Limited growth in retail packaging will likely take place in the future. This growth will hinge greatly on how rapidly supermarkets increase from their current share of 5 percent of fresh produce total sales. The National Capital Region will likely be the main source of growth for retail-packaged fresh produce sales.

Cushioning/wrappers/liners

Partitions and liners are often used in order to protect produce from shock and vibration within the package. Cushioning materials used in fresh produce packaging for the domestic market include leaves, rice stacks, newspaper and plastic bags.

Photo 3.28 Cushioning materials used for the packaging of fresh produce for the domestic market

Manila paper, tissue paper, foam, kraft liners and paperboard partitions are used to immobilize produce destined for export.

Photo 3.29 Cushioning materials used for the packaging of fresh produce for the export market

Labelling

Produce labelling is not practically feasible particularly in wet markets owing to current retail and display practices. In some cases, suppliers stick labels on individual fruits or fruit bunches or pack vegetables in labelled plastic bags, thereby mobilizing packaging as a marketing tool. Labelling of this type is also common in supermarkets. Shipping packages such as plastic bags, woven polypropylene (WPP) sacks and wood crates are rarely labelled. Corrugated boxes are the only form of bulk packaging that is properly labelled.

Photo 3.30 Presence and absence of labels on different types of bulk packaging

Minimum labelling requirements for consumer food products in the Philippines are summarised in the Table below.

Per Consumer Act and BFAD (Bureau of Food and Drugs)	*Example: fresh broccoli as recommended by BPRE*	*Example: Guimaras mango for export to United States and Australia*
• product name • net content declaration • ingredient list • name and address of manufacturer, packer or distributor • country of origin • expiry/best before (for selected products) • brand name, trademark	• name of product • grade • name and address of grower or supplier • net weight (kg) • pesticide residues (per Codex) • country of origin	• name of product • net weight • name of grower, barangay, municipality (using codes) • box number • date of packing • name of PQS signing officer

Exporters must comply with labelling laws of importing countries for additional mandatory information such as chemical residues and pest infestation. Handling, stacking and storage instructions must also be printed on corrugated boxes for shipping. Many importing countries also require that bar codes are printed on shipping containers.

Below is a good example of a well-labelled shipping box for Cavendish banana exports from the Philippines.

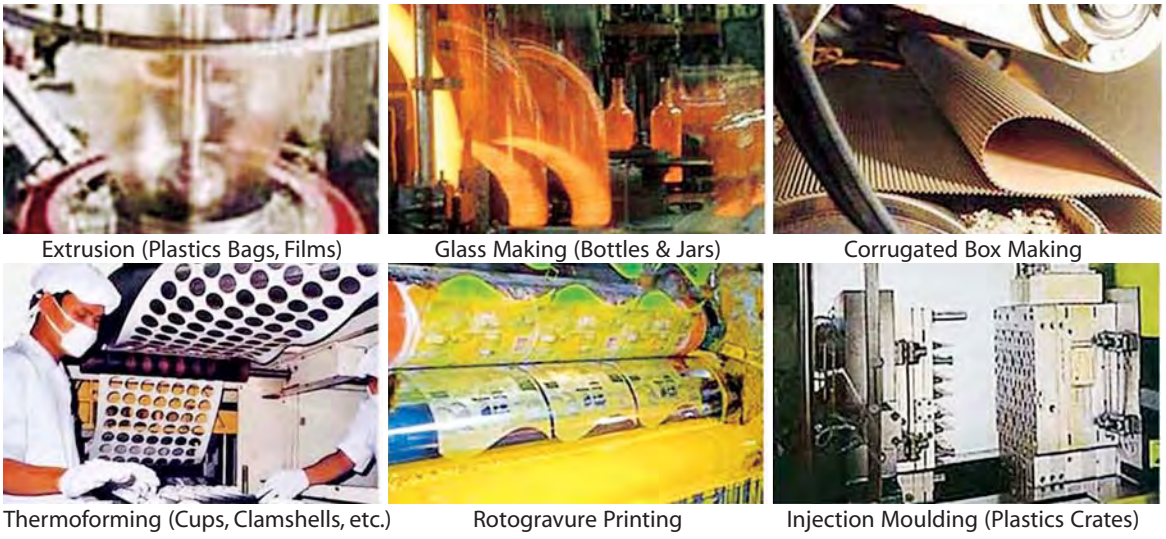
Brand | Producer name | Collective information | Instructions | Batch code

Photo 3.31 Details of labelling on a shipping box for Cavendish banana exports

Sources of packaging materials in the Philippines

The Philippine packaging industry supplies major packaging materials such as glass containers, metal cans, closures, plastic bags, flexible packages (which are made of single materials consisting of combinations of paper, films, and foil), plastic crates, trays, bowls, cups and pallets, corrugated boxes, paper, paperboard, woven polypropylene (WPP) and raschel sacks.

Packaging converting plants are largely concentrated in the Metro Manila area. Few are located in nearby provinces of Laguna, Cavite and Batangas. Despite the number of packaging facilities in Metro Cebu, packaging users in the Visayas continue to source their packaging requirements from Metro Manila. In Mindanao, corrugated box makers primarily supply requirements for the packaging of banana and pineapple exports.



Extrusion (Plastics Bags, Films) | Glass Making (Bottles & Jars) | Corrugated Box Making

Thermoforming (Cups, Clamshells, etc.) | Rotogravure Printing | Injection Moulding (Plastics Crates)

Photo 3.32 Packaging materials produced in the Philippines

About 60 percent of the materials used in the production of packaging materials, such as plastic resins, paper and paperboard, pigments, glues and other additives and converting machinery and equipment are imported. Some packaging materials such as glass, metal cans, flexibles, plastic nettings, plastic bottles, tubes and jars are sourced from overseas markets despite the availability of local supplies. Reasons for this include lower price, more variety and consistency of supply.

The Philippine packaging industry was valued at roughly ₱100 billion (US$2 billion) or about 1.15 percent of national gross national product in 2008. Its largest industry client is the food sector which consumes about half of its output. Other major industry clients are the beverage, pharmaceutical and personal care sectors.

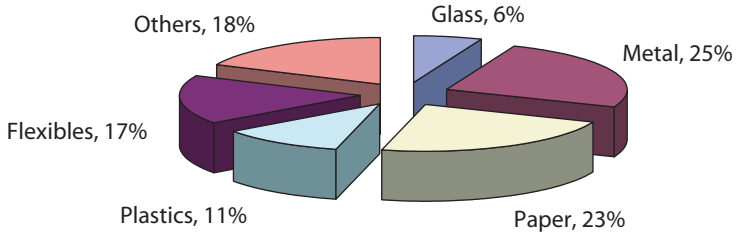


Figure 3.2 Philippine packaging market (2008)

Best estimates on packaging mix show metal packaging claiming 25 percent share of the industry output, followed by paper-based packaging at 23 percent. Large clients of metal-based packaging are processors of fish and meats, dietetic products, paints, beverages and beer and soft drinks. In recent years, domestic paper-based packaging users pursued cost reductions through down gauging or the use of lower-weight paper and plastics.

Flexible packaging materials, plastics and glass follow at 18 percent, 11 percent and 6 percent respectively. Consistent with global trends, flexible packaging films are the fastest growing segment with bags, pouches and sachets. Plastic bags are widely used for fresh produce packaging. Rigid plastic packaging dominates in the personal care industry and as shipping crates for beer and soft drinks. Collectively, other packaging materials account for 17 percent, including indigenous packaging materials such as *kaings*, wood crates, sacks and reused materials.

Glass containers remain unchanged as packaging for beer, alcoholic spirits and heat-processed fruit and vegetable preserves. Fruit juices and flavoured drinks are retailed in various packaging formats such as glass bottles, plastic bottles and flexible stand-up pouches. Bottled water is the domain of polyethylene terephthalate (PET) bottles.

Few large packaging converters dominate the packaging material sectors. Converting plants are located mainly in Metro Manila which accounts for about 65 percent of the consumer market. Where there is a concentration of demand, converting facilities follow. Large volume demands of Del Monte, Dole and other large exporters of pineapple and bananas in Mindanao have resulted in the establishment of in-house or commercial corrugated box making facilities. Box makers serving Mindanao are Mindanao Corrugated (a San Miguel), Davao Packaging Corporation and Steniel Manufacturing.

Photo 3.33 Different types of packaging produced in the Philippines

Leaders in the different packaging material sectors in the Philippines are:

- Plastic crates – Mainly plastics: San Miguel Yamamura (San Miguel), Plastimer Corporation, Plastech
- Flexibles – Leading plastics bag suppliers:

  For fresh produce are GoldTop Plastics, Asian Plastics Center (Calypso) and Pagoda Plastics;

  For processed goods, Rightpak Intl (San Miguel), Flexo Manufacturing, Bonpack Gilvan, Daibochi, Imports (for fast-moving consumer goods)
- Corrugated boxes – San Miguel Yamamura, Mega Pack, Malinta Packaging, Valenzuela Packaging, Cavite Packaging, *Serving the Mindanao box requirements* are Mindanao Corrugated (San Miguel), Davao Packaging Corporation (DAPACOR) and Steniel Manufacturing.
- Paper/paperboards – Printwell; other numerous suppliers of labels and folding carton boxes as the segment is highly fragmented.
- Glass containers – San Miguel Yamamura, ABI, Imports
- Metal containers – Oriental, Century, PhilCan

There are no known listed suppliers of *kaings* (made of bamboo or rattan) and wood crates. These are locally sourced where there is a concentration of fresh fruits and vegetables for sale. *Kaings* are generally supplied by farmers/growers, traders and enterprising individuals.

Packaging supply issues and concerns

Some of the nagging complaints from packaging users include:

High cost: The cost of packaging is a major constraint cited by small enterprises whose volume demands are often below economies of scale. Having strength in price negotiations, large packaging buyers always get the best terms and can resort to importation when local prices are unacceptable. Still, the high cost of packaging remains an issue.

Non-availability of supply: There are basically two hurdles to accessing fresh produce packaging in the Philippines. One is the minimum volume order required to justify production. The other is the logistic delivery of goods. As most converters are heavily concentrated within the Metro Manila area, shipments must fill a truck or van to make delivery economical.

Furthermore, some packaging users have experienced difficulties even in asking for price quotations. Presumably, when the volume is not interesting, the response of the packaging supplier is lukewarm.

Key complaints of packaging suppliers:

Packaging buyers are "too focused": It is understandable that packaging buyers will source from suppliers offering the lowest price. Low price does not necessarily mean cost-effectiveness. Quality performance by reducing damage and spoilage must also come into the formula for computing total overall costs. Consistency of quality, reliability of supply and customer service must also be factored into the supply selection process.

Limited market demand: This is the response of packaging suppliers to packaging users' complaints about non-availability of supply. In the past, there were efforts by packaging suppliers to put up supply satellites by themselves or through trading companies in strategic provinces. Success was achieved on a very limited scale.

High cost of research and development: While a few large packaging companies venture into joint packaging development projects with their select clients, initiatives of this type are more an exception than a rule with small producers. Without guarantees of volume and protection, interest in packaging research remains low. Many experiences of packaging suppliers in the past have been painful. After spending on research, prototype preparation and field testing, packaging suppliers are left empty handed after the first order because the packaging buyers source from other suppliers owing to low price.

The problems and concerns expressed by both packaging buyers and suppliers are not easy to understand and accept. This is one wide gap that needs creative solutions and cooperative implementation.

Against this realistic scenario, it is interesting to know that the packaging industry sees the fresh fruit and vegetable sector as an opportunity for growth.

Likely future packaging scenarios in the Philippines

- *Plastic bags* will dominate as shipping, repacking and retail packages for domestic shipments in view of their low cost, freight efficiency and widespread availability. As plastic bags begin to be used as substitutes for woven polypropylene (WPP) sacks, their demand will likely continue to increase.
- *Corrugated boxes* will find growth with increasing exports and as replacements for wood crates for high-volume and long-distance domestic shipments of fruits such as tomatoes, watermelons and green papayas.
- *Plastic crates* have yet to be accepted as economic shipping containers to augment their current share in the packaging of high-value vegetables and in processing plants. Growth of plastic crate packaging will likely continue with developments in the cold chain and with the adoption of GAP by farmers/growers.
- *Wood crates* will be primarily used for the long-distance shipment of heavy fruits, and for tomatoes, where the supply of corrugated boxes is not accessible.
- *Kaings* will continue to be used. Their use will, however, be limited to packaging for short-distance delivery to wet markets and roadside vendors and as harvest/collection containers.

- *Mixed loads* will dominantly consist of plastic bags, reused corrugated boxes and wood crates.

- *Retail packaging* will remain at a very low level both for domestic and export markets. Most retail packaging will be done at/or for supermarkets.

Regulations that directly or indirectly influence packaging

The "Consumer Act of the Philippines" (RA 7374) seeks to protect the general interest and health and welfare of consumers. This Act is implemented by the Department of Health which is also tasked with the establishment of standards and quality measures for food and with the adoption of measures to ensure a pure and safe food supply. In accordance with this Act, provincial, municipal and city governments shall regulate the preparation and sale of fresh fruits and vegetables and other foodstuffs for public consumption.

The use of packaging for transportation and marketing of fresh fruits and vegetables for domestic consumption in the Philippines is currently not regulated. Attempts have, however, been made in the past to ban the use of plastic shopping bags and expanded polystyrene (or better known as Styrofoam) disposable cups, clamshells and trays. The Provinical Council of Lanao Norte (Reg. 10 Mindanao), for example, passed a resolution on 17 February 2009 requesting its 22 municipalities to research, develop, promote and use indigenous materials available in its localities for packaging. The resolution intends to regulate, if not prohibit, the use of plastic bags (Mindanao Current, February 2009).

In-country programmes to promote use of packaging in horticultural chains

Fresh fruits and vegetables are produced in the Philippines on small and scattered farms. The primary aim of production is to sell produce to the wet markets the earliest time possible. Fresh fruits and vegetables are, therefore, shipped in packaging materials that are readily available. The farmer's day is over once his produce is purchased by a wholesaler, consolidator or trader at a "bagsakan" or trading post. The wholesaler sorts, weighs and packs ordered quantities and loads the produce onto trucks. The journey begins and trading begins at another *bagsakan*. Produce purchased by vendor-retailers end up in the bags and baskets of consumers.

In its simplest form, fresh produce marketing is a "daily" activity. Tomorrow is a repeat of today. Consumers are able to identify quality. Consumers will often pay a higher price for added value. In the consumers' mind, the tug of war between low cost and value is heating up. Striking the correct balance is one challenge which needs active response from stakeholders in fresh produce supply chains.

The task begins with the perceived high losses which are estimated to range between 20 percent and 40 percent. A reduction in losses would increase the availability of marketable volumes and thereby increase the affordability of produce. The next step is to upgrade produce quality. Home-grown fruits when displayed alongside imported fruits, suffer from poor overall visual appeal. Proper post-harvest handling practices, cool/cold delivery systems and appropriate packaging and transport systems will contribute greatly to expanding market reach.

These twin tasks can be addressed mutually by rationalizing the roles of packaging in the supply chain beyond its delivery and shipping functions. Packaging must address issues in consumer-based marketing to perk up consumption by communicating relevant information through labelling, branding and industry promotion. The need to make consumers feel good and safe cannot be overemphasized.

Many initiatives have been pursued by governments assisting agencies, cooperatives, industry clusters and foreign-funded institutions. Documented and published studies and reports on specific fruits and vegetables recommend the planting of high-yielding varieties, upgrading post-harvest practices, extending produce marketable life, establishing market linkages and developing appropriate packaging.

Jointly with farmers and suppliers, extension workers have tested and implemented recommendations on model farms and packing houses prior to commercial or full-scale implementation. Some recommendations have been adopted. Others go to the reference archives. Nevertheless, extension workers just keep on going even if rewards come after several modifications and re-testing. Patience seems to be their common virtue.

Research and development studies on fruits and vegetables are largely concentrated on high-value crops, particularly those intended for export. Mangoes, bananas, and pineapples have received attention from both the government and private enterprises. Those fruits and vegetables which contribute to the livelihoods of many small farmers nationwide are, however, often neglected. More importantly, they are the ones needing most assistance from the government and assistance institutions.

Agencies associated with fresh produce packaging

This section briefly describes studies, programmes and projects extended by government agencies, academic and private institutions in the Philippines.

Postharvest and Seed Science Division, University of the Philippines-Los Baños

Formerly known as the Postharvest Training and Research Center (PHTRC), UP-Los Baños in Laguna, the division has been active in post-harvest training and development of specific fruits and vegetables intended for domestic markets. The institution boasts post-harvest technologists and practitioners who are highly academically trained (most with doctoral degrees) and well-experienced in the practical application of post-harvest technology. It has published research studies, training materials and textbooks. Recommendations on appropriate packaging form part of these post-harvest handling projects. UP-PHTRC has developed ethylene gas absorbers for fruits, vegetables, cut flowers and ornamentals.

Department of Agriculture (DA)

The Department of Agriculture (DA) conducts various projects primarily aimed at increasing production. Much of its research and many of its projects involve agricultural applied science, building infrastructure such as cold storage facilities, expanding market outlets and overall policy-making.

National Mango Research and Development Center

As part of the Bureau of Plant Industry (BPI), the National Mango Research and Development Center in Jordan Guimaras took the lead role in the collaborative development of mangoes for export to the United States.

Packaging Research and Development Center (PRDC)

The Department of Science and Technology (DOST), through its Packaging Research and Development Center (PDRC), is currently pursuing packaging development for specific fruits. DOST is equipped with facilities for shelf-life testing, package design and toll packing.

PRDC is the packaging development resource in the Philippines for small and medium enterprises. Its aim is to develop generic packaging for a wide range of produce. In the process, PRDC is developing pseudo-standards which could become official packaging standards in the long term.

Growth for Equity in Mindanao (GEM)

Other assistance agencies are focused on strengthening the competitive positions of small farmers by organizing associations, industry clusters and consolidating supply to enable them to negotiate sales as a group. Funded by USAID, GEM has reported successes in development projects which benefited farmers involved in mango, durian, banana, mangosteen, rambutan and lanzones. Challenging Luzon produce suppliers, Mindanao is now making its presence felt in the supply not only of fruits but vegetables as well. Plastic crates are now more visible in the area as collecting, distribution and shipping containers.

Trucking and freight community

The trucking and freight community is also contributing to the movement of fresh produce. For example, half-load container shipment and refrigerated vans are being promoted to enhance trade among suppliers nationwide. RO/RO facilities are overcoming hurdles by facilitating land and sea travel with minimum handling.

Packaging industry

While efforts are being made by the packaging supply sector, more needs to be done to overcome issues of economies of scale. Suppliers of packaging are largely concentrated in Metro Manila. More needs to be done to make packaging, other than plastic bags which are freight efficient and low cost, more conveniently available to end users. San Miguel Yamamura continues to promote its leasing arrangements for plastic crates to the fresh produce supply chain. Corrugated box makers serving fruit exporters are working on new cost-saving structures that include the production of boxes which double as display and shippers as well as the conversion of shipping boxes to look

like retail packages. In general terms, however, the packaging supply sector must proactively initiate new packaging ideas and innovations to smooth the rough edges of the supply chain.

5. Conclusion

The development of packaging is an evolutionary process that responds to changing lifestyles and consumer preferences. The objective of packaging development for fruits and vegetables is to come up with packaging materials and packaging systems that will: (1) protect product quality effectively so as to avoid loss and spoilage; (2) market products efficiently; and (3) source materials economically.

Given the perishable nature of fruits and vegetables, stakeholders in fruit and vegetable supply chains must collectively pursue packaging programmes, to reduce spoilage and losses and to enhance the value of produce.

The fresh fruit and vegetable sector in the Philippines must transform itself from being production-based to being market-driven. At the retail level, consumers do not only buy low-priced produce. Their purchase motivators are many and include quality, convenience, safety, hygiene, branding and ecological friendliness, among others. Consumers must be confident of the safety and quality of the goods they procure.

The selection of retail packaging is truly dictated by the dynamics of the marketplace. Package converters cannot dictate material usage to the buyers of packaging. They can, however, influence the selection of packaging by making packaging materials available.

In the Philippines, there is a need to narrow the gap between package supply and current demand particularly in rural areas. But the greater challenge is to introduce packaging that not only conforms to mandatory regulations but also helps increase fresh fruit and vegetable consumption. In this regard, packaging converters must be sensitive to emerging consumer and industry trends to enable themselves to proactively introduce new and innovative packaging for transport and retail. They should not limit themselves to order taking. Instead, packaging converters should take an active role in strengthening the supply chain.

Economies of scale continue to constrain packaging converters, trucking and shipping companies in responding efficiently at low cost. Moreover, the lack of labelling and produce branding leaves retailers and consumers fully reliant on sensory attributes as quality measures. This practice slows down the buying process.

Plastic bags are the most widely accepted shipping containers for vegetables in the country. Wood crates will likely be dominant for large-volume, long-distance deliveries of heavy fruits and for tomatoes. As the packaging choice for the export of mangoes, pineapple and bananas, corrugated boxes will find new markets for the domestic shipment of pomelos, mangoes and other high-value or novelty fruits. Plastic crates will be the choice for deliveries to supermarkets, processing plants and fast-food chains using cool/cold facilities. Growers/suppliers aligning with GAP will also continue to make use of plastic crates.

As to the supply chain players, they have yet to appreciate and understand what consumer marketing is. Hopefully, the influences of supermarkets in terms of clean and hygienic practices and packaging will impact on wet markets which will continue to account for more than 90 percent of fresh fruit and vegetable sales.

Resource persons

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- Janet S. Balicdang, Processing and Packaging Center, La Trinidad, Benguet
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- Liz Tagaylo, Senior Trade and Industry Development Specialist, Regional Office-Region 10 Department of Trade and Industry, Cagayan De Oro, Misamis Oriental
- Genesis Lucenda, photographer, Quezon City, Metro Manila
- Wholesalers, traders, handlers, truckers in La Trinidad, Divisoria, Balintawak and wet markets in Cagayan De Oro (Misamis Oriental), Tagbilaran City (Bohol), San Jose (Antique), Legaspi (Albay), Imus (Cavite)

Chapter IV
Packaging in fresh produce supply chains in Thailand[3]

1. Introduction

Packaging is very often critical to the success or failure of a horticultural supply chain. Changing consumer habits, market demand, trade requirements and the drive to reduce losses have resulted in major advances in the use of packaging in horticultural supply chains in recent times. These advances focus on ease of handling, ease of distribution, loss reduction, preservation of quality, promotion of safety, and can even modify purchasing habits of consumers. Improved packaging technology can greatly contribute to improving the efficiency of supply chain management and increase returns for producers and retailers while delivering top quality fresh produce to the consumer.

This report focuses on Thailand's use of packaging in supply chains for fresh produce, current practices and the adoption of new technology. The aim of this study is to provide a comprehensive survey of the status of packaging for fresh produce in horticultural supply chains. The content of this report is based on field surveys, interviews with supply chain stakeholders and experts, references from available sources as well as the author's experiences.

1.1 Fresh produce supply chains

A supply chain is defined as the movement of materials involving activities, information, and resources from a source to an end consumer. Supply chain management refers to the coordination and alignment of activities and processes of materials, financial and information flows. Supply chain management aims to minimize waste and achieve cost reductions while maximizing overall value. Packaging is important at every step in the supply chain, from farm to shelf.

Fresh produce supply chains are concerned with produce of a short shelf-life and which are highly susceptible to temperature extremes that greatly impact on quality. Proper packaging systems considerably help to reduce damage and maintain produce quality while facilitating the ease of distribution of produce.

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Fresh produce supply chains include a number of stakeholders and vary in accordance with location as well as produce type. Several different supply chain models exist for the marketing of fresh produce in Thailand (Figure 4.1).

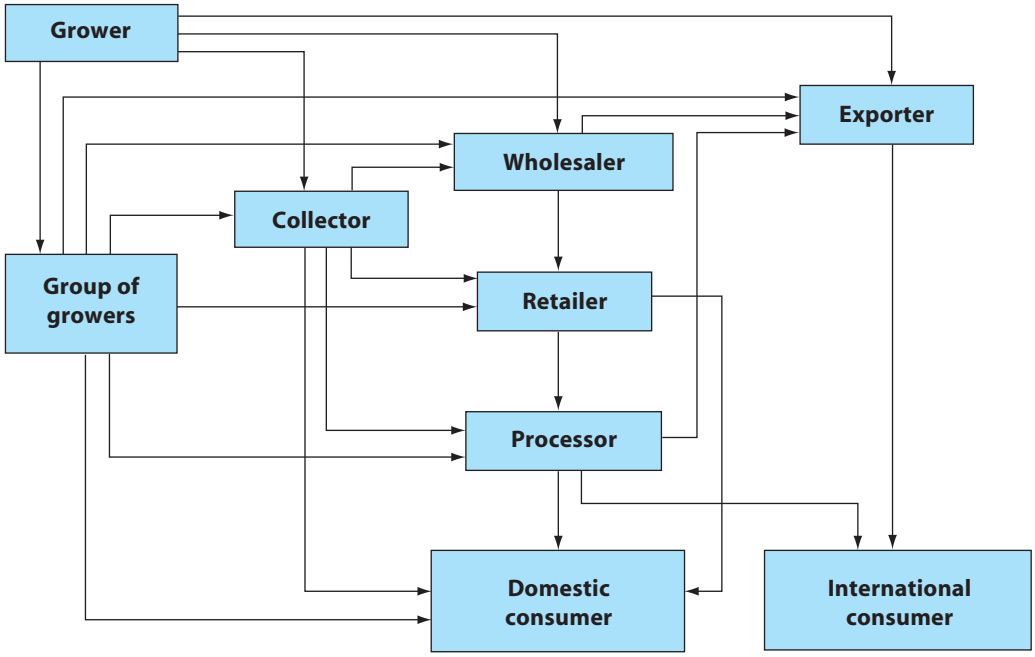


Figure 4.1 Supply chains for fresh produce in Thailand

Stakeholders in fresh produce supply chains include growers, middlemen, wholesalers, retailers and consumers. The roles and functions of these stakeholders are now described.

Group of growers or farmers

Individual growers in Thailand may own or rent small tracts of land for growing produce. Groups of growers or contractors may also come together to form a union, in order to benefit collectively rather than individually. Growers' unions are very popular in Thailand. They are generally location specific and in some cases can be crop specific.

Growers' unions range in size from the "muban" formed at the village level, which is the smallest growers' union, to the "tambon" formed at the subdistrict level, the "amphoe" formed at the district level and the "changwat" which is the largest union formed at the provincial level. The main objective of growers' unions is to represent all of their members. Growers' unions are, in general, managed by a committee selected from members by members. In addition to representing their members, growers' unions serve many different functions including but not limited to collection, wholesaling, retailing and in many cases processing of produce. However, most growers' unions in Thailand function as collectors and may be contacted or contracted by other parties including exporters.

A contractor may form a group of growers that could consist of any of the parties involved in the supply chain (collector, wholesaler, retailer or exporter, or even processor). Agreements between contractors and growers (or a group of growers) can be made either verbally or in the form of written signed documents.

Advantages of group formation by growers include: reduced cost of agricultural supplies; increased negotiating power; and increased access to agricultural technology and practices. Contractors benefit by being able to manage and assure the quality and quantity of fresh produce available for marketing, as well as the agricultural practices applied from production through to post-harvest.

Collector

Produce is transferred from the grower to the next stakeholder in the chain who may be a collector, middleman, broker, distributor or packer. These stakeholders share a similar function in collecting harvested produce from each grower or group of growers to deliver or distribute to the next set of stakeholders in the chain. In addition to collecting and delivering fresh produce, a collector may perform other functions such as storing, cleaning, packing, distributing, selling, marketing, exporting or processing.

Wholesaler

The wholesaler receives fresh produce directly from the grower or collector and for the most part, receives the fresh produce in bulk packaging. The main function of a wholesaler is to sell fresh produce in large quantities to retailers, consumers or exporters. In Thailand, a wholesaler may also be a collector, retailer, exporter or processor. Wholesale outlets are the wholesale markets located in each city, while the main wholesale markets are located at different areas throughout Bangkok. Many wholesalers have their own packing houses and these facilities have become increasingly important in preparing fresh produce for both domestic and international markets.

Retailer

Fresh produce is sold to the end user – the consumer – at different places that change over time in response to changes in consumer behaviour. There are various types of retailers offering fresh produce in Thailand. These are now described:

- ***Superstore, super-centre, hypermarket and warehouse membership club***

These stores combine a supermarket and a department store in a large retail facility, offering a wide variety of food and non-food merchandise. Fresh produce is displayed in the fresh food or fresh produce section of the store. Fresh produce in such superstores is generally displayed in open cabinets at temperatures ranging between 4°C and 12°C. The different types of fresh produce are

stored as close as possible to their optimum temperatures. In general, fresh vegetables are stored at temperatures below 4°C while temperate fruits such as apples, pears, grapes, strawberries as well as fresh-cut fruits are stored at 4°C. Tubers and most tropical fruits such as mangoes, pineapples, papayas and subtropical fruits such as guavas, tangerines and longans are stored at room temperature, which is generally set around 25°C. It should be noted that while optimum temperatures of many tropical fruits are 12–15°C, they are stored at 25°C. At higher temperatures, fruits deteriorate very rapidly, hence having a shorter shelf-life. Superstore types in Thailand are listed below:[4]

Name	Country of origin	Number of stores (2005)
Tesco Lotus	United Kingdom	140
Casino Big-C	France	43
Makro	The Netherlands	29
Carrefour	France	22

- ***Supermarket, grocery store***

Supermarkets or grocery stores in Thailand as of 2002 are listed below:

Name*	Country of origin	Number	Web site
Tops	The Netherlands	48	www.tops.co.th
FoodLion	Belgium	37	tescolotus.com
Jusco	Japan	10	N/A
FoodLand	Thailand	8	www.foodland.co.th
Villa Market	Thailand	8	www.villamarket.com

- ***Fresh market vendors***

In years past, fresh produce in Thailand was generally sold in fresh markets located within each community for convenience. Presently, the fresh market is no longer a major retailer of fresh produce for most consumers in Bangkok or larger cities, given that superstores and supermarkets offer a wider range of goods and activities with a greater level of convenience. Some consumers still, however, prefer and remain loyal to the fresh market for reasons such as affordability of fresh produce and the ability to procure smaller more appropriately proportioned quantities than can be procured at the superstore or

[4] http://www.siamfuture.com

supermarket. However, primary concerns at the fresh market include poor hygiene of the premises and safety of the fresh produce. Another important issue of concern at fresh markets is that the fresh produce is commonly maintained under ambient temperature conditions which negatively impacts on its quality and shelf-life.

- ***Street vendor***

Another retail outlet for fresh produce is the street vendor. Fresh produce is displayed by street vendors either on a cart, or on a mat spread on the street. The seller is a grower or small retailer who buys fresh produce from a wholesaler or another grower. The sale of produce out of pickup vans has also gained popularity in recent years as fresh produce can be sold at more than one location by the same vendor.

Exporter

Exporters obtain fresh produce from different sources including growers, groups of growers, collectors, wholesalers and distributors. Packaging requirements of exporters are primarily dependent on market requirements. Standards, regulations and certification are increasingly required by exporters to assure the safety of food. Fresh produce exports from Thailand go mainly to wholesale markets in destination countries. It may either be sold in bulk or repacked for retail markets. Some exporters may have direct contacts with retailers.

1.1.1 Processor

Processors obtain fresh produce from various sources such as growers, wholesalers or other processors. Fruits and vegetables are processed in order to preserve them and to increase their shelf-life. Fresh produce can be processed by canning, freezing, drying and juicing. Fresh produce can also be marketed in the form of fresh-cuts.

1.1.2 Consumer

Consumer requirements for fresh produce vary in accordance with location, income grouping and age. The recent past has witnessed a trend of increasing consumer demand for fresh fruits and vegetables in Thailand owing to increased awareness and recognition by consumers of the health benefit of consuming fresh fruit. Consumers in high-end domestic markets and in export markets are very concerned about the safety and quality of the produce they procure. This is not the case for consumers in domestic wholesale or fresh markets, where the quality of the fresh produce and the packaging requirements may be compromised, but the price is affordable to most. Bulk packaging is mainly required at wholesale markets.

1.2 Export markets for fresh produce produced in Thailand

Thailand is recognized among the leading producers and exporters of fresh produce in the world. Approximately 80 percent of fresh produce outputs of Thailand are sold on the domestic market. The remaining 20 percent is sold on the international market. The top ten international export markets for fresh produce outputs from Thailand are presented in Table 4.1.

Table 4.1 Top ten countries by export value for fresh fruits from Thailand (2006–2008)

Rank	Export countries	Export values (million baht)		
		2006	2007	2008
1	United States	13 305	13 781	14 598
2	China	3 894	4 587	5 269
3	Netherlands	3 903	3 163	3 760
4	Japan	2 489	2 504	3 242
5	Hong Kong	1 652	2 397	2 489
6	Germany	1 688	1 844	2 103
7	Canada	1 172	1 309	1 653
8	Russia	1 514	1 753	1 557
9	Indonesia	1 294	1 367	1 319
10	France	1 091	924	1 261
11	Others	14 517	14 857	18 249
	Total	**46 518**	**48 486**	**55 499**

Source: *Office of Agricultural Economics, Thailand*

Fresh produce is marketed in various forms including as whole fresh fruit, as fresh cuts, and as processed products – canned, bottled and dried. Survey data shows that fresh produce sections in supermarkets in 2009 averaged around 20 percent of total displayed area, when compared to 5 percent in 2004.

Distribution practices in fresh produce supply chains in Thailand

Good supply chain management aims to minimize waste and achieve cost reductions while maximizing overall value.

Produce is transported from a grower/packer/distributor to a wholesaler, retailer or exporter usually by truck. Packed or unpacked produce is loaded onto the truck either with or without pallets. Different truck types are used depending on the target markets and quantities of fresh produce. The most common trucks used in Thailand in transporting produce are two-axel and three-axel trucks. Produce is generally transported under ambient conditions. Large distributors, retailers and exporters, however, generally make use of refrigerated trucks for produce distribution. There are no standardized truck sizes in Thailand.

Fresh produce is distributed in Thailand using varied packaging formats and a range of different packaging systems. These are now described:

- Unpacked produce loaded on to a truck

  Fresh fruits such as pineapple, pomelo, durian and rambutan are often loaded in a "loose format" directly onto trucks without any packaging (Plate 4.1). On arrival at the central or wholesale market, they are transferred by purchasers into bulk containers such as plastic crates, bamboo baskets or plastic bags. The selection of produce by purchasers can result in injury from impact or cuts leading to wastage. Damaged produce is sold at a substantially lower price than high quality produce, and is sold in low-end markets.

Photo 4.1 Loading of unpacked produce onto trucks

- Packed produce loaded on a truck

  Produce is packed in various types and sizes of packages prior to loading on to trucks (Plate 4.2). Different packaging systems and truck types are used in accordance with the destination markets. Retail packages of produce are placed in bulk packaging. Fresh produce is generally manually handled. Various types of handling equipment are shown in Plate 4.3.

Photo 4.2 Loading of packaged produce onto trucks

Photo 4.3 Equipment commonly used for fresh produce handling in Thailand

Transportation systems used for fresh produce marketing

Six-wheel trucks are the most commonly used type of vehicle for the transportation for fresh produce in Thailand. A majority of trucks are not refrigerated owing to high cost. Trucks can travel via either fixed or non-fixed routes.

Trucks used for the transportation of fresh produce are owned by different parties in the supply chain as follows:

- *truck transportation companies,* e.g. Nim See Seng, a major shipping and logistics service provider in Thailand which offers truck transportation service for delivering goods, including agricultural commodities within Thailand and neighbouring countries;
- *packers/distributors/retailers,* e.g. The Royal Projects Foundation; large retailers such as Tesco Lotus, Carrefour, Tops Supermarket, etc.;
- *exporters*, e.g. KC Fresh, Siam Export Mart, Swift, etc.;
- *export shippers and freight forwarders.*

In general, small trucks loaded with packaged produce deliver produce to central or wholesale markets. The central market for agricultural goods of Thailand is "Talaad Thai" located in the north of Bangkok. Other main wholesale markets in Bangkok are "Pak Klong Talad" located in the west of Bangkok, "Talad Si Moom Muang" located in the north of Bangkok, and "Talad Mahanak" located in the south of Bangkok. Produce is generally scheduled to arrive at markets in the evening or early morning, depending on the distance between the grower/packer/distributor and the central/wholesale markets. This serves to avoid high temperatures that cause excessive weight loss of produce during the day. Central/wholesale markets operate on a 24-hour basis. Wholesale purchasers often procure their produce in the late evening or early morning.

In situations where produce is packaged ("on-farm packaging") prior to delivery to wholesale markets, it is unloaded on arrival at the market, stacked and then sold as packaged produce without breaking down into smaller units. This form of produce marketing provides convenience to both sellers and buyers. Pre-packaging reduces waste in the supply chain, owing to reduced handling of produce by purchasers.

Produce from central/wholesale markets is sold to small retail markets such as vendors in fresh markets or in four-wheel pickup trucks who run around or park in residential areas around Bangkok. Produce items that are regularly used as cooking ingredients such as chillies, green beans and lemons may be divided into small units packaged in common polyethylene (PE) or polypropylene (PP) bags in quantities suitable for household usage. Some small grocery-type bags are hung around the pickup truck offering consumers the freedom to select the produce. Some types of produce are weighed in accordance with consumer needs. This "local" style has become one of the popular ways for everyday selling/buying of produce in Thailand.

Large retailers with grocery/supermarket sections set up their own distribution centres in the suburbs of Bangkok to pre-package all fresh and perishable foods for their multidivisions in Bangkok. Produce is packed in reusable plastic crates and is sent from the distribution centre to supermarket consignees. Some types of produce may be packed on sight at the grocery store.

Produce that is destined for export is packed either at a packing houses or distribution centres and is loaded on to trucks for transportation to the shipping port or airport. Produce destined for export can be pre-packaged in retail packaging, before being placed in a shipping container (corrugated or foam box) or packed directly in a shipping container for repacking at the destination market. Trucks used can be of any type and may be either refrigerated or unrefrigerated.

Temperature plays a significant role in maintaining produce quality. Temperature management in supply chains in tropical countries such as Thailand is a key solution to improving quality and prolonging the shelf-life of produce. While maintaining temperature from farm to shelf is costly, efforts must be made to identify efficient systems and to apply good practice in post-harvest management in order to reduce cost.

Factors contributing to losses during transportation in Thai supply chains

Some of the current practices of packaging for fresh produce in a supply chain in Thailand, which contribute to high percentages of produce damage and loss, may be summarized as follows (Plates 4.4 to 4.6):

- Packing too many layers of produce which results in high percentages of damage and reduces produce quality (Plate 4.4).
- Loading different sizes of boxes/crates on to trucks results in poor stacking and reduced logistical efficiency while increasing cost (Plate 4.4).
- Packing without proper cushioning or accessory materials which results in substantial damage (Plate 4.5).
- Use of improper packaging which results in a high percentage of damage and shortens the shelf-life of produce (Plate 4.6).
- Transporting produce in unrefrigerated trucks, or storing produce under unrefrigerated conditions or at too low temperature shortens the shelf-life of produce.

Use of foam boxes for packaging

High compression, high damage due to excessive packaging

Photo 4.4 Some current practices in fresh produce packaging that could cause produce damage

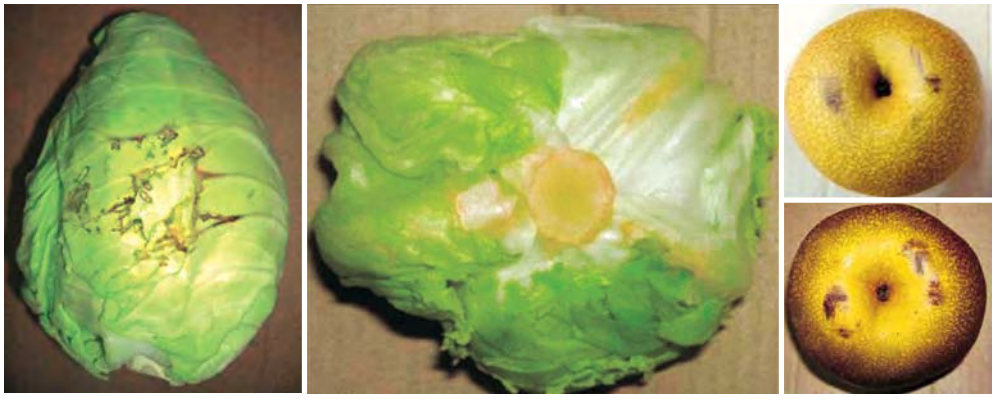


Photo 4.5 Produce damage resulting from improper packaging/cushioning during transportation

Photo 4.6 Improper packaging of mango resulting in shrinkage due to water loss (right); CO_2 accumulation of baby corn in a commonly available PE bag (left)

Factors that could compromise safety include:

- The use of unclean, non-hygienic reusable plastic crate/basket can transfer contamination to produce, and shorten its shelf-life of produce.
- Packing, storing, selling, handling and distributing produce using unclean equipment, in an unclean environment can compromise safety and shorten shelf-life.

2. Materials and formats for fresh produce packaging

Fresh produce in Thailand ranges from the delicate mangoes to the armoured durian. Each item of fresh produce has its own specific characteristics, and thus has specific packaging requirements. A variety of options are available for the packaging of fresh produce.

2.1 Bulk packaging

Design features of bulk packages include strength, stackability, ease of handling and space utilization. Several types of fresh produce bulk packaging are used in Thailand. These include plastic crates, corrugated fibreboard boxes and bamboo baskets. Results of the current survey show that that plastic crates are by far the most widely used form of bulk packaging (Figure 4.2).

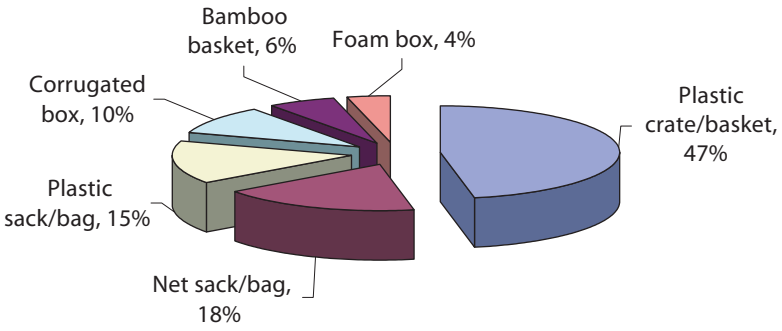


Figure 4.2 Survey data on the use of different types of bulk packaging for fresh produce in wholesale markets in Thailand

Trapezoid plastic crates equipped with steel handles are the most commonly used types of plastic crates in Thailand. Their trapezoid shape allows empty crates to be stored in nested stacks. Large retailers and exporters also make use of round and rectangular nestable plastic crates for the bulk packaging of fresh produce. Solid plastic boxes are used for some produce types but their use in not common. Plastic bags/pouches/sacks are popularly used as packaging for fresh produce, given the convenience they offer in handling and sale. Woven/net plastic sacks are used for produce types that require high levels of ventilation.

Corrugated boxes are commonly used for the packaging of fresh produce destined for export. Solid fibreboard trays and boxes are less popularly uses as a bulk packaging option in Thailand when compared to corrugated boxes owing to their comparably higher cost than corrugated boxes. The use of solid fibreboard trays and boxes is generally limited to filling orders from international markets in Europe and North America. Such packing materials are generally imported. Other types of bulk packaging materials used include bamboo baskets and foam boxes, which will be discussed in detail later in this Chapter.

2.1.1 Plastic crates/baskets

Different types of plastic crates are available for use in bulk packaging. Plastics can be formed into rigid, semi-rigid and flexible containers. Although rigid plastic containers are not as strong as wooden boxes or baskets, they are lighter in weight and are less costly. Moreover, plastic packages are resistant to water and moisture, and can be easily cleaned and sanitized which are important criteria for being selected for produce packaging.

Reusable/returnable plastic crates are commonly used for bulk packaging worldwide. Their role has significantly increased in fresh produce distribution in the United States and across Europe. In Thailand and in most countries in the Southeast Asian region, plastic crates have been used in fresh produce packaging for many decades. They are commonly used for delivery from farm to retail. Plastic crates perform a variety of functions ranging from collection, storage, transportation, distribution to display of individual packed produce.

Plastic crates are generally classified as "reusable plastic containers" or "RPC". Reusability is one of the main advantages of plastic crates over fibreboard containers. Pooling systems have become

a key role in managing efficient supply chains. However, in most cases, management of plastic crates in Thailand is not yet based on a true pooling system as occurs in the United States or in Europe.

Several suppliers of plastic crates for fresh produce exist in Thailand. Users include growers, packers, shippers, distributors, wholesalers and retailers, all of whom generally purchase their own plastic crates. Privately owned plastic containers are generally marked to discourage loss or theft. The use of crate deposit systems is also widespread across Thailand. Deposits are refunded upon safe return of the plastic crates to the supplier. Other agreements can be made between parties in order to help prevent package loss, which is a major problem in the Thai agribusiness.

A closed-loop system is generally used for the management of plastic crates in supply chains in Thailand. These systems generally include no more than three participating parties. The most common arrangement is for a distributor/middleman to provide plastic crates to his growers/ shippers. Empty crates are delivered to the farm for packing of harvested produce. Packed crates are transported to a packing-house or storage and distribution facility. Harvested produce packed in plastic crates is then sold domestically at central markets, where small/medium retailers or wholesalers around the area come to purchase fresh produce. The empty crates are then recovered from the market by the crate supplier.

Large retailers generally have their own distribution systems to achieve optimal efficiency and minimize cost. Distribution centres of large retailers are located around the country usually on major routes in order to facilitate efficient logistics. Plastic crates are managed on the basis of a pooling system. A deposit strategy is also applied to promote quick rotation and to prevent loss of the crates. Inventory control of plastic crates is efficiently managed to facilitate the flow of fresh produce in the supply chain. Loose or packed produce is generally delivered, in plastic crates, from a distribution centre to retailers or supermarkets. Some types of fresh produce may be delivered in other types of bulk packaging.

Trapezoid-shaped plastic crates

Trapezoid shaped crates are non-collapsible crates generally made of high density polyethylene (HDPE) or polypropylene (PP) and are equipped with steel handles attached to the crate mouth (Plate 4.7) which facilitates stacking. Packed crates are stacked by placing the steel handles on the slot located at the edge of the crate mouth. Empty crates are stacked by fitting the narrow base into the wide mouth of the crate. Trapezoid-shaped plastic crates are the most widely used bulk packaging containers for shipping produce across Thailand. They are used for packing a range of produce types. While many sizes of trapezoid crates are available, a majority of those used in Thailand have a high depth ratio which allows for the stacking of empty crates. Given their high depth design, trapezoid crates are commonly packed with many layers of produce to fill up the crate, resulting in a high level of damage and loss.

Photo 4.7 Trapezoid-shaped plastic crates commonly used in Thailand

Rectangular plastic crates/boxes

Straight walled rectangular crates (Photo 4.8) are commonly used for the bulk packaging of fresh produce, while solid boxes (Photo 4.9) are used for the packaging of selected produce items. Rectangular crates come in a variety of sizes and designs. Most have handle holes in the body panels. Stacking is done through interlocking tabs with matching receptacles or matching slots along the edges of adjoining crates. Rectangular-shaped plastic crates are gaining popularity as an alternative to trapezoid shaped crates. The key advantage of rectangular plastic crates over trapezoidal plastic crates is greater space efficiency for storage and distribution. Variable depths with fixed length dimensions allow standardization, high produce payload and fewer packing layers, resulting in lower damage and loss. Non-collapsible rectangular-shaped plastic crates are generally used in Thailand, unlike in the United States and European markets.

Photo 4.8 Rectangular plastic crates used in Thailand

Photo 4.9 Rectangular solid boxes used in Thailand

Round plastic crates

Plastic crates made of polypropylene (PP) or high density polyethylene (HDPE) that are round in shape are also used in the bulk packing of fresh produce in Thailand (Photo 4.10). The characteristics and uses of these crates are similar to those of traditional bamboo baskets. The stackability and space utilization of round plastic crates is inferior to that of trapezoid/rectangular plastic baskets. Despite this limitation, they continue to be used by small/medium distributors for the harvesting and shipment of bananas, pomelos, papayas and oranges, especially at wholesale markets.

Photo 4.10 Round plastic crates used in Thailand

Key considerations on the use of plastic crates

Low temperature is a key issue in maintaining the quality of fresh produce. Ventilation of bulk packaging systems is, therefore, an important factor affecting the final quality of fresh produce. Ventilation involves two important post-harvest practices: pre-cooling and storage. Pre-cooling should be done within the shortest time possible after harvest. Pre-cooling is, however, seldom done in Thailand because of the cost involved. Many growers/shippers also do not realize the significant impact of pre-cooling on the keeping quality and marketability of fresh produce.

Plastic crates offer pre-cooling advantages over corrugated boxes. Studies conducted at Kasetsart University, on the rates of pre-cooling mangoes, papayas and pineapples in different shipping containers, showed that reusable plastic containers provided markedly faster pre-cooling rates (7/8) when compared to corrugated boxes of all tropical produce studied. However, air movement over produce during the pre-cooling process could enhance water loss. Ventilation is a trade-off between cooling and heat removal against water loss, which should be considered when selecting bulk containers for packaging and distribution of fresh produce.

Cleaning and sanitizing plays a critical role in assuring the hygiene and safety of reusable containers like plastic crates. After each use, plastic crates are generally cleaned and sanitized at the distribution centres of large retailers. Approved sanitizers such as sodium hypochlorite, chlorine dioxide, various peroxides and ozone are used to reduce the microbial load on plastic crates. Small shippers/distributors may not, however, be aware of the importance of cleaning the crates. Packing of fresh produce in unwashed/unclean reusable plastic poses a risk of cross-contamination. Where single-use containers like corrugated boxes and plastic bags are reused, packers show greater concern for incoming packages that are clean.

2.1.2 Plastic bags/sacks

Plastic bags or sacks are the other form of plastic packaging commonly used for all types of fresh produce. Plastic bags (Photo 4.11) are used for both bulk and retail packaging. They can be made of various sizes and types of films, but the most widely used types for produce packaging are polyethylene (PE) or polypropylene (PP) films. Woven plastic or net sacks are commonly used for produce that requires a high level of ventilation (Photo 4.12). The strength of the woven sacks and net are dependent on the materials used and the spacing of the woven mesh.

Plastic bags/sacks are not reusable and are used as bulk packaging for transporting produce from farms to wholesale markets. They are also used as bulk units for sale. For small produce items such as Thai peppers, e.g. *kheenoo and cheefa*, plastic bags/sacks provide convenience in handling. When used for such applications, strength is of minor concern, given that the bags contain only 10–15 kilograms of produce. In some cases, perforation is required in order to dissipate heat, moisture and gas from the package.

Woven sacks are generally used as bulk packaging for limes, potatoes and onions. Commonly packed bags are horizontally stacked on top of each other. Produce packed in plastic bags and in woven sacks should, therefore, have a high level of resistance to mechanical damage.

Photo 4.11 Plastic bags/sacks used as bulk packaging for fruits and vegetable in Thailand

Photo 4.12 Woven or net sacks used for produce requiring high ventilation

2.1.3 Paper cases/boxes/trays

Paper containers are classified as single-use containers, as opposed to plastic crates which are reusable. Paper containers have a number of advantages over plastic crates. Paper containers offer various options of display and can serve as an effective point-of-purchase marketing tool. They can be custom designed to serve specific needs and enhance produce value. Customized designs of paper containers are, therefore, available for produce packaging to perform different functions. These customized designs might, for example, include various holes, handles and designs for convenience and use.

Survey data show that corrugated boxes are the second most commonly used bulk container for in-land packaging and distribution of fresh produce in Thailand and many other countries in the region. They are, however, the most common shipping container for exporting fresh produce much like in several other countries worldwide. Corrugated boxes are probably the most commonly used shipping containers and provide the most economical solution for shipping.

Photo 4.13 shows different types of corrugated containers used in fresh produce packaging in Thailand (domestic, export and import). Boxes used for export usually require certification in compliance with existing standards, specified by freight organizations, industries or standard organizations. The certification systems seek to control and assure the quality specification and performance of the boxes.

Standardized containers have been developed for efficient logistics. Corrugated common footprints have been developed in the United States by The Fiberboard Box Association. Similarly, the European Federation of Corrugated Board Manufacturers (FEFCO) has developed the common footprint standard and common footprint (CF) stamps for identifying trays that meet FEFCO specifications. With their uniform dimensions and tab and receptacle system, standardized common footprint containers have efficient and safe stacking as well as inter-stacking features which are absent from conventional corrugated containers. Standardized common footprint containers also protect produce located in the bottom layers of a pallet from top load

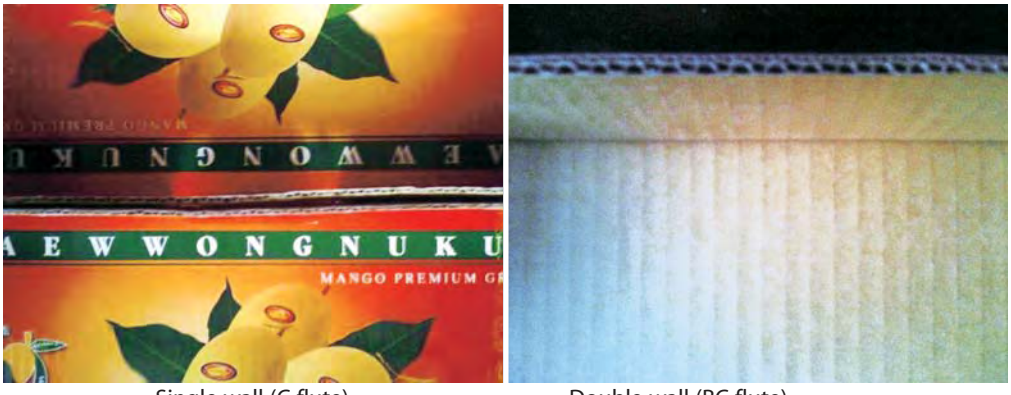
Regular slotted container (RSC) (top) and telescope boxes (bottom)

Photo 4.13 Various types and designs of corrugated boxes and trays

compression, which otherwise occurs with the use of conventional corrugated systems. Common footprint is a global standard, which allows containers from various growers/shippers worldwide to stack safely and efficiently. In addition, it can save space during storage and distribution. These standards offer mixed load shipments for efficient global logistics.

Conventional corrugated containers are widely used in Thailand for exporting fresh produce. The most commonly used type is the regular slotted container (RSC), which is generally used for a range of produce items. Full telescope design (FTD) and full telescope half slotted (FTHS) boxes are also used for fresh produce packaging. The FTD is made from two scored and slotted blank containers, while FTHS boxes are made from two half-slotted containers. The corrugated fibreboard or combined board consists of a linerboard and a medium sheet, which varies in flute profiles. The most common flute configuration used for fresh produce packaging in Thailand is the C-flute and BC-flute for single-wall and double-wall corrugated boards, respectively (Photo 4.14). Standardized produce trays or common footprint containers are often used for international shipping. In most cases, boxes or trays for shipping the produce are provided by the customer.

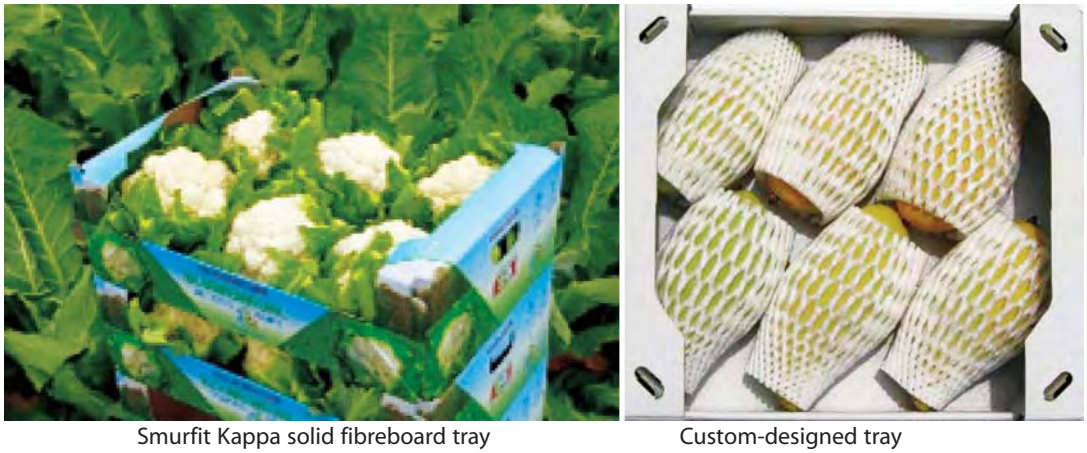
Another type of paper container commonly used for fresh produce packaging is the solid fibreboard box. Various designs and sizes of fibreboard boxes are shown in Photo 4.15. These boxes are formed by gluing or laminating two or more plies of paperboard sheets together. The solid fibreboard box has a higher manufacturing cost when compared to a similar corrugated box.



Single wall (C flute) Double wall (BC flute)

Photo 4.14 Common corrugated flutes in fresh produce boxes

Typically, solid fibreboard boxes are more durable than are corrugated boxes, and are thus reused in some cases. International companies have recently introduced solid fibreboard containers for produce packaging in Thailand. They have, however, received relatively little attention from growers/shippers/distributors/retailers. This lack of attention is mainly due to a significant initial cost difference between solid fibreboard and corrugated containers.



Smurfit Kappa solid fibreboard tray Custom-designed tray

Photo 4.15 Solid fibreboard trays

Key considerations on the use of paper boxes

Ventilation is a drawback with the use of paper boxes as compared to plastic crates. Trays outfitted with an open top can, however, be used to overcome this problem. Corrugated and solid fibreboard boxes for fresh produce incorporate holes or slots in their design for enhanced ventilation and pre-cooling benefits.

Paper containers are well suited for the packaging of produce, given their strength and cushioning properties. They are lightweight and rectangular in shape, thereby allowing stable stacking and efficient space utilization during shipment. They are superior to other containers in the communication function of packaging by having the area of 4–5 panels of the box readily available

for printing produce information. Empty cases are collapsible and are bundled in flat forms which save inventory space. Side panels may be perforated to form handles and to create holes for transfer of moisture and heat.

Uncoated paper containers are, however, moisture sensitive and may lose their strength if wet. They therefore require extra care against moisture and water during use. Corrugated boxes are designed to be single-use containers given that the integrity of the box is greatly reduced during shipment. The moisture barrier properties of paper containers can be improved by coating, waxing, and laminating of the paper surface with polymers. Coated paper, however, produces waste that is not environmentally friendly.

While produce distributors in Thailand are aware of the advantages of using paper-based packaging in transportation, not everyone can afford to purchase paper-based packaging materials. A number of case types are, therefore, currently being used in Thailand for the packaging of fresh produce.

Made-to-order boxes

These boxes are tailor-made for the shipment of high-value fruits and vegetables such as fresh ginger, bell peppers and mushrooms. Graphics on the boxes are specifically designed for each type of produce. The boxes are often made of double-walled corrugated board to enhance protection of produce.

Out-of-specification boxes

These boxes are rejected from the manufacturing plant owing to their failure to conform to specifications. The mechanical strength of these boxes is comparable to that of new, made-to-order boxes. Nevertheless, the graphic designs of these boxes do not always correspond to their contents. They may be used on the domestic market for direct shipment from a producer to known consignees. Their use is prohibited for export shipments, owing to incorrect labelling information.

Used boxes

Corrugated boxes obtained from supermarkets, e.g. boxes used to contain other products such as detergent, toiletries, canned foods or fresh produce are also widely used for the bulk packaging of fresh produce for domestic wholesale markets.

A number of rules, regulations and guidelines have been developed by relevant organizations for the use of paper-based materials in packaging. The main rules and regulations applied to shipping containers are:

- Pictorial markings

  Pictorial markings are recommended particularly when shipping abroad. Handling instructions are presented in the form of pictures to avoid language barriers. Pictorial markings commonly recognized include "*fragile/handle with care*", "*this side up*" and "*keep dry*". References pertinent to pictorial markings can be found in International Standard Organisation (ISO 780), American Society for Testing and Materials (ASTM

D 5445), and National Motor Freight Classification (NMFC Item 682-A). Standards and regulations related to the packaging of fresh produce are described later in this report.

- Box manufacturer's certificates

  Box Manufacturer's Certificates (BMCs) are recommended markings which indicate that box manufacturing meets the requirements stated by carrier rules for shipping products as defined in Item 222 of the NMFC and in Rule 41 of the Unified Facilities Criteria (UFC).

- Quality and safety certification

  Markings may also indicate quality or safety certifications. In Thailand, the "Q Mark" (Plate 3.20) or "Q Premium" is accredited by the National Bureau of Agricultural Commodity and Food Standards (ACFS). The "Q Mark" certifies produce at 2 levels: (1) produce level, which indicates that the produce meets quality and safety standards under Good Agricultural Practice (GAP) and the Code of Conduct (COC); and (2) system level – GAP, Good Manufacturing Practice (GMP), Hazard Analysis and Critical Control Point (HACCP) and COC. "Q Mark" product certification may be included on the label, the container, the package or on the produce itself.

Photo 4.16 Pictorial markings and the "Q Mark" on mango boxes destined for export from Thailand

2.1.4 Wooden containers and bamboo baskets

Wooden containers are very rarely used for the packaging of fresh produce in Thailand. Traditional bamboo baskets are, however, very widely used for the packaging of fresh produce. The use of bamboo baskets for the bulk packaging of fresh produce is a tradition in Thai society. Bamboo baskets are produced in numerous forms, each with its own name and tailored for a specific use. Many patterns are incorporated during weaving to allow for the packaging of specific produce items. The density of the weaving pattern – loose vs dense – can vary according to produce type.

These baskets are considered traditional handicraft products of Thailand and of many other countries in Asia. They can also be categorized in accordance with their shapes and forms as described below.

Bamboo baskets are referred to in Thailand as "*khengs*". They are of two main types: wide-mouth trapezoid baskets (Photo 4.17) and rectangular and cylindrical (Photo 4.18) forms. The wide-mouth *kheng* equipped with two handles is the most popular form of bamboo basket used for the packaging of fresh produce in Thailand and in Asia. It is currently widely used for the transportation of produce from growers to wholesale markets or fresh markets by small and medium growers, shippers, distributors, and for fresh produce items that are not highly susceptible to mechanical damage or which are inexpensive. Rectangular shaped bamboo baskets are traditionally used for the packaging of leafy vegetables, longan and garlic. These *khengs* are generally referred to as "vegetable *khengs*", "longan *khengs*" and "garlic *khengs*" respectively.

Photo 4.17 Wide-mouth trapezoid shaped bamboo basket (*kheng*) commonly used in Thailand and in Asia

Khengs vary in size as shown in Photos 4.17 and 4.18. Empty baskets weigh approximately 250–4,650 grams (11–240 m^3) and are nested for convenience and use in storage and shipment. They have a capacity of 10–100 kilograms of produce.

Thick bamboo strips with unpeeled outer rinds are used to supply extra strength to the baskets. The baskets are equipped with two handles at the mouth made of either wood or plastic rope. Bamboo covers tied to the body of the basket are often used to cover the top of the basket. In some cases, bamboo baskets are covered with the leaves of packed produce. *Khengs* are generally used as reusable shipping containers between farms and wholesale markets.

Photo 4.18 Rectangular cylinder shaped bamboo basket

"*Chaloms*" are loosely woven cylindrical bamboo baskets (Photo 4.19), and are in some cases referred to as *khengs*. Various weaving patterns are used in the production of *chaloms*. Tightly woven or dense *chalom* baskets are used for the packaging of fruits and vegetables of small size such as longans and litchis. Loosely woven *chalom* baskets, on the other hand, are used for the packaging of many vegetables including leafy vegetables, vegetable heads such as cabbage, and tubers such as onions.

Photo 4.19 Loosely woven bamboo basket (*chalom*)

Chaloms can be covered using range of different options:

- bamboo strips bunched together at the top of the basket;
- bamboo handles made to merge bamboo strips at the top of the basket together;
- use of rope to nest open-top of the baskets;
- use of bamboo lids to cover the open top of the basket.

Studies conducted at Kasetsart University show that fresh produce packaged in bamboo baskets typically suffers greater physical damage when compared to produce packaged in plastic crates of similar packing volume. Cuts or abrasions are often caused by bamboo strips. Moreover, bamboo baskets are not stackable. A wooden shaft can be used to facilitate the stacking of bamboo baskets for loading (Photo 4.20). Nevertheless, in some cases bamboo baskets are stacked directly on top of each other, with no separator in between, which results in bruising.

Photo 4.20 Stacking of bamboo baskets using wooden shafts

With the many advantages of plastic crates and paperboard boxes over bamboo baskets in terms of strength, stacking, ease of handling and space efficiency, the use of bamboo baskets for fresh produce packaging in Thailand has declined tremendously. Bamboo baskets are still used for the bulk packaging of some root, tuber and bulb crops such as garlic, red onions and onions, which are lightweight and require a high level of ventilation during storage. Surveys conducted within the framework of this study at wholesale markets reveal that bamboo baskets account for 6 percent of fresh produce packaging. Plastic crates offer several advantages over bamboo baskets and, as a result, the use of bamboo baskets has declined substantially during the past decade.

2.1.5 Foam containers

Another type of bulk container commonly used in the packaging of fresh produce in Thailand for both domestic and export markets is the foam box (Photo 4.21). Foam boxes used in fresh produce packaging are typically made from polystyrene (PS). According to data obtained during this survey, a number of shippers/ distributors in Thailand make use of foam boxes for the export of fresh produce because of their superior thermal insulation and the physical protection they offer. Foam boxes are the best insulators among bulk containers. They are generally packed with gel ice to keep produce temperatures low during long-distance flights. Experience at Kasetsart University has shown comparably less produce damage with foam box packing as compared to corrugated box packing.

Photo 4.21 Foam boxes closed with the use of tape

Surprisingly, survey findings confirmed by further communications, reveal that several produce packers do not make appropriate use of foam boxes. While produce should be cooled to its optimum temperature prior to packing, several distributors pack warm produce in foam boxes and then transfer the boxes to cold room storage. In addition, several foam boxes contain holes resulting in the loss of insulation. From the standpoint of protection, technical data do not show that foam boxes are stronger or more durable than corrugated boxes.

2.1.6 Bundling of produce

Bundling is a simple method of holding produce items together by tying them with rope, tape or rubber bands. Asparagus and leafy vegetables are commonly wrapped with kraft or newsprint, plastic or banana leaf before tying. Bundled produce can either be packed in plastic crates for shipping or sold as individual bulk units (Photo 4.22).

Photo 4.22 Vegetable bundling with twine and with and without wrapping at wholesale markets

While the bundling of vegetables for retail packaging is a widespread practice, bundling can also be used for the bulk packaging of produce. Vegetable bundling is more common than is fruit bundling. Nevertheless, the bundling of fruit stalks has recently become popular with consumers owing to its visual appeal in retail.

2.1.7 Accessories and cushioning materials

Packaging accessories can help in protecting fresh produce from physical damage during shipping and storage. These include foam nets (Photo 4.23), moulded pulp or plastic trays (Photo 4.24), paperboard partitions (Photo 4.25), bubble wrap sheets or bags (Photo 4.26), individual plastic wrapping bags (Photo 4.27), shredded paper or newsprint liners (Photo 4.28), and sponge (Photo 4.29). Foam nets are the most commonly used packaging accessory in Thailand. Studies conducted at Kasetsart University show that foam netting significantly reduces mechanical damage by 20–60 percent for selected tropical produce items. Some of these cushioning materials, e.g. foam nets may also be used during the retail display and sale of produce.

Photo 4.23 Foam net cushions

Photo 4.24 Moulded pulp and plastic trays

Photo 4.25 Paperboard partitions

Photo 4.26 Bubble wrap

Photo 4.27 Individual plastic wrapping bag

Photo 4.28 Shredded paper and newsprint liners

Photo 4.29 Use of sponge as a cover and a liner in boxes

Single-layer packing in a container significantly reduces the percentage of bruised fruits. The packing of more than one layer of fruits into plastic crates is one of the major causes of produce damage in fresh produce supply chains in Thailand. Growers/shippers/distributors, however, generally follow recommended container standards or customers' orders for international markets, which usually require only 1–2 layers to be packed.

2.1.8 Comparison of types of bulk packaging

Table 4.2 summarizes the relative advantages and disadvantages of the various types of bulk packaging used for fresh produce in Thailand. The user must identify major factors and then rank their importance in order to design a suitable packaging system. Primary factors to be considered include produce type, distribution environment, packaging characteristics and marketing requirements. Several important characteristics of bulk packaging must be considered in making decisions on the selection of the package type for fresh produce. These characteristics serve different functions and purposes such as strength for protection, stackability for proper handling and distribution, ventilation for maintaining quality and shelf-life and printability for information

and branding, etc. Proper design should also take account of ergonomics and the environment as well as the cost involved at all steps. All of these are important factors in the decision-making process.

Table 4.2 A qualitative comparative analysis among primary shipping containers used for fresh produce packaging in Thailand (bulk packaging)

Relative factor	Plastic crate	Corrugated box	Bamboo basket	Foam box	Plastic bag
Raw material	Petroleum-based	Natural source	Renewable source	Petroleum-based	Petroleum-based
Reusability	Excellent	Poor	Good	Good	Poor
Strength	Excellent	Good	Moderate	Good	Poor
Stackability	Excellent	Moderate-excellent	Poor	Good	Poor
Handling	Good-excellent	Good-excellent	Poor	Good	Poor
Space utilization	Moderate-excellent	Good-excellent	Poor	Good-excellent	Moderate
Weight	Heavy	Moderate	Moderate	Light	Light
Moisture resistance	Excellent	Poor-moderate	Moderate	Excellent	Excellent
Ventilation	Good-excellent	Poor-good (hole)	Moderate-good	Poor	Poor-good (hole)
Graphic design	N/A	Excellent	N/A	N/A	Good
Cost of package	High	Moderate	Low	Moderate	Low

2.2 Retail packaging

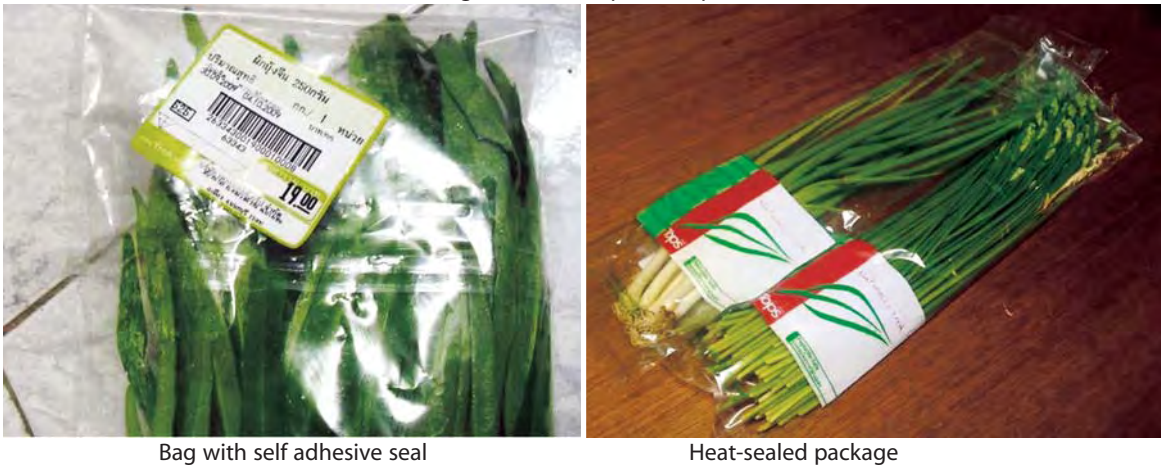
Retail packaging for fresh produce is available in a range of formats. The selection and use of retail packaging in fresh produce supply chains involves consideration of consumer behaviour and social marketing. The selection of a particular type of retail packaging varies according to the target market for the produce. Individual units of packaging are designed to suit specific portions for consumption – usually for an individual household – before the produce deteriorates. Commonly used retail packaging formats for fresh produce in Thailand can be categorized as: bags or pouches, trays, boxes, cases, cartons and netting or banding.

2.2.1 Bags, pouches and film wrap

Bags or pouches are generally produced from plastic and paper. The most commonly used form of retail packaging for fresh produce in Thailand is the plastic bag or pouch. Plastic bags and pouches can be used for almost all types of produce and for almost all purposes. In most cases, clear films are used for retail packaging in order to allow consumers to see the produce inside the package, given that appearance is a key quality criterion for the selection of produce by consumers.

Bags used for fresh produce packaging in Thailand are commonly made from polyethylene (PE), polypropylene (PP) or polyvinyl chloride (PVC). PE and PP bags (Photo 4.30) can be easily manufactured at low cost, but lack clarity. Polyvinyl chloride bags (Photo 4.31) are clear but are not considered to be environmentally friendly. Some bags are made from bubble wrapping materials to protect produce from physical damage.

Bags closed with plastic tape



Bag with self adhesive seal

Heat-sealed package

Photo 4.30 Produce packed in polyethylene (PE) and polypropylene (PP) bags that are sealed using different methods

Fresh produce continues to respire after harvest and therefore has a limited shelf-life. Modified atmosphere packaging (MAP) is a commercially successful technique for prolonging the shelf-life of many fruits and vegetables. Flexible pouches are commonly used to establish modified atmospheres in packaged produce. The main factors that govern MAP design include produce respiration, film permeability and temperature. Commonly available plastics such as PE and PP are not suitable for the creation of optimum modified atmospheres for most produce items. Many supermarkets have recently adopted the use of PVC bags for the retail packaging of fresh produce. In addition to its clarity, PVC has high gas permeability, which is well suited for MAP of many fruits.

Photo 4.31 Fruits in polyvinyl chloride (PVC) bags

Materials of high gas permeability or breathable materials have continually been researched, and are used globally in the fresh produce industry. The use of MAP for the packaging of fresh-cut lettuce is shown in Photo 4.32. Gas-permeable films are generally imported into Thailand for use in the packaging of produce for export. They are also used in the packaging of produce for high-end local markets owing to their high cost.

Photo 4.32 Leafy vegetables packaged in high gas-permeable or "breathable" bags

Films of high permeability, developed by Thai researchers at the National Metal and Materials Technology Center (MTEC) and Kasetsart University's Department of Packaging and Materials Technology, have now been commercialized in Thailand. The films are suitable for various types of fresh produce including tropical produce. The low cost of these films has broadened their use in packaging for both domestic and export markets.

A wide range of films with varied gas transmission rates have successfully been developed for use in the packaging of a variety of produce items. Many companies have adopted the use of these films for fresh produce packaging for domestic consumption and for export. Films of high gas permeability can extend the shelf-life of many fruits and vegetables by a factor of two to five, when compared to commonly available films. Table 4.3 shows the survey results for oxygen transmission rates (OTR) of the packaging films used in fresh produce packaging in Thailand.

Table 4.3 Oxygen transmission rates of various packaging films used in fresh produce bags/pouches in Thailand

Film	Oxygen transmission rate (cm^{-3} m^{-1} day^{-1})
Low density polyethylene (PE)	3 000–4 000
Polypropylene (PP)	3 000–5 000
Polyvinyl chloride (PVC)	12 000–14 000
High gas-permeable film (MTEC-1)	6 000–8 000
High gas-permeable film (MTEC-2)	10 000–15 000
High gas-permeable film (MTEC-3)	18 000–20 000
Imported breathable film	8 000–15 000

Wrapping of fresh produce in plastic films is another form of retail packaging commonly used in Thailand (Photo 4.33). Film wrapping is a convenient and simple method of packaging, usually done by hand. It is widely used for the packaging of fruits and vegetable heads. Film wrapping improves produce appearance, hence promoting retail sale. Commonly available film wraps include PE, LLDPE (linear low density polyethylene) and PVC.

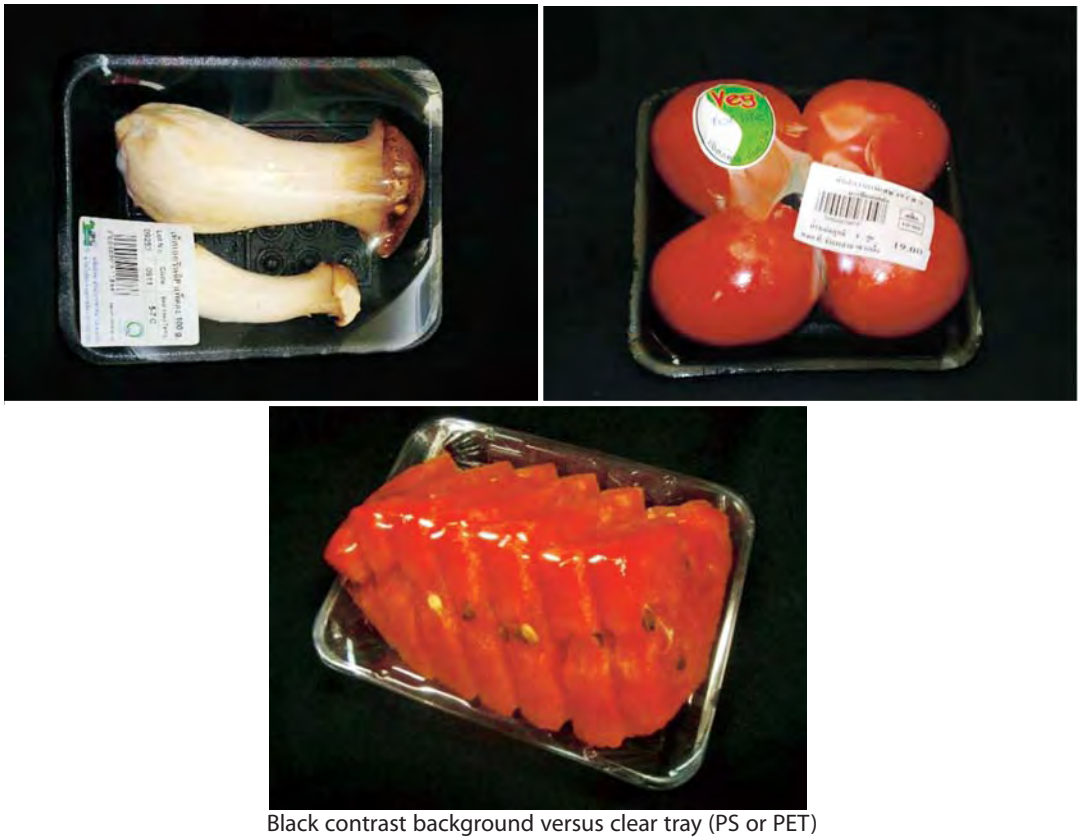
Photo 4.33 Film wrapped produce with and without foam net

Individual wrapping of produce items prevents produce contamination. In addition, because of the low level of film thickness, film wrapping allows for high gas transmission rates thus preventing the anaerobic respiration of produce that occurs in common PP and PE bags which generally require holes to facilitate respiration. Film wraps may be used along with foam net cushions for improved protection during handling and distribution.

2.2.2 Trays

The semi rigidity of trays offers key benefits including protection and convenience for ready-to-eat or ready-to-serve purposes. Trays are usually made from plastic, plastic foam, pulp or paper by a thermoforming process. Plastic trays that are commonly used for fresh produce packaging are made from PE, PP, PET and PS. While popular in the North American and European markets owing to its clarity, PET it is not widely used in Thailand owing to its high cost.

Trays can be custom designed for specific applications into a variety of sizes and shapes: rectangular, square and round. Different methods can be used for closure of the packages, such as overwrapping with film (Photo 4.34), heat-sealed film lids or heat-sealed bags (Photo 4.35). In the past, trays were closed with wire staples or tape. Wire staples, however, pose a risk to consumers and are no longer used as large retailers are now aware of the risks. The use of tape for sealing is still common in retail markets.



Black contrast background versus clear tray (PS or PET)

Photo 4.34 Plastic tray overwrapped with film

Photo 4.35 Tray in heat-sealed bag with attractive printed packaging

Overwrapping is the most common type of produce packaging used in Thailand. The most commonly used overwrap films include PE, LLDPE and PVC. Heat sealing is not as common as overwrapping because it is more costly and complex. Tray heat sealing requires heat sealable materials and additional items of equipment. In recent times, black coloured trays have been introduced to the retail packaging of produce, in order to enhance product appeal to consumers.

Clamshell packaging (Photo 4.36) is popularly used in North America, Europe and in some countries in Asia. It is used for a few select items of produce such as rocket salad and fresh-cut produce in high-end supermarkets in Thailand. Clamshell packaging consists of a hinged base and top that interlock. Thermoformed clamshell packaging may be designed to feature individual cups for fruit in order to enhance protection during distribution (Photo 4.37).

Foam trays continue to be widely used in Thailand despite the fact that they are not considered environmentally friendly (Photo 4.38). Their widespread use is largely due to their low cost when compared to other packaging materials. The use of foam trays in supermarkets and superstores has, however, markedly declined since 2009. Plastic foam trays have been slowly replaced with

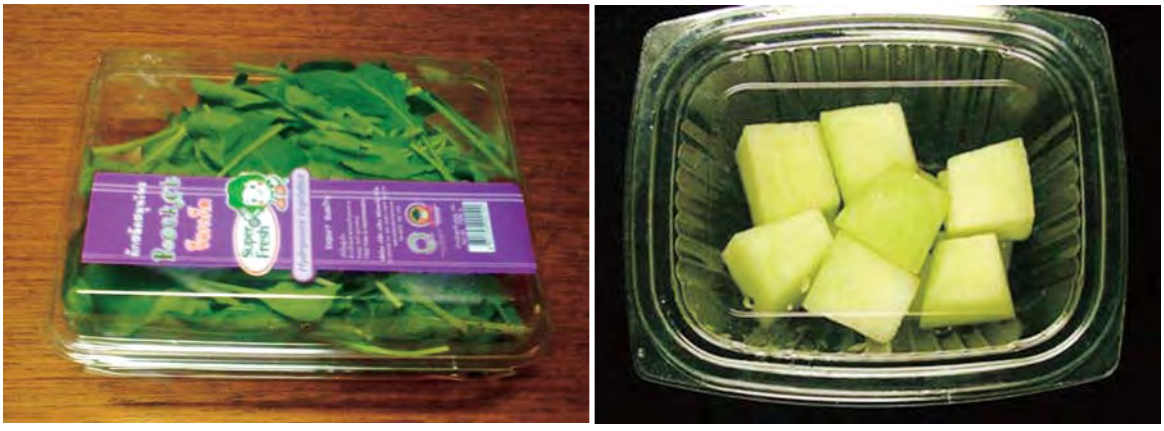


Photo 4.36 Clamshell tray with hinge interlock

Photo 4.37 Thermoformed tray featuring individual cups for protecting fruit

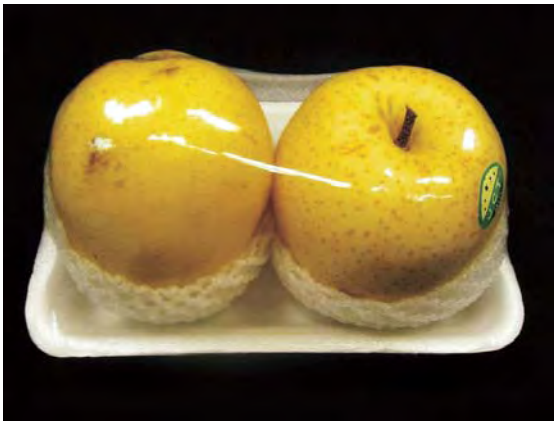


Photo 4.38 Foam tray overwrapped with film for retail

paper trays or mould pulp trays in the past few years owing to increasing consumer awareness of environmental issues in Thailand. The increased demand for paper trays has resulted in a reduction in their prices. Foam and paper trays are generally closed using film overwrapping.

Biodegradable trays are currently receiving a great deal of attention for fresh produce applications. Biodegradable polylactic acid (PLA) trays are not widely used in Thailand owing to their high cost and limited applications. Trays produced from renewable resources such as starch and sugar cane pulp have recently gained increased attention for various food applications. In recent years, sugar cane pulp trays in particular, have been widely used in Thailand for food and fresh produce packaging applications. A coating is usually applied to these biodegradable trays to improve their moisture barrier properties.

2.2.3 Boxes, cases and cartons

Retail boxes are produced using either paperboard or plastic, the former being more common. Due to the moisture sensitivity of paperboard it must be coated or laminated with a polymer in order to improve its moisture barrier properties.

Retail paperboard boxes are primarily of a full telescope design (FTD). The retail box is used primarily for specialty items – items that are expensive or delicate – such as gift packs for strawberries, cherries and mandarin oranges (tangerines). Graphics on retail packages play a key role in the marketing of the product. Retail boxes of packed produce may contain a clear film window for produce display and visibility.

2.2.4 Net bags

The main advantages of packing produce in nets are ventilation and display. Produce items such as onions and garlic are generally packaged in net bags. Plastic netting is lightweight making it ideal for packing light weight or small units of produce. Plastic foam nets can also be used for cushioning. Plastic netting serves as a popular form of retail packaging for fruits such as tangerines and oranges (Photo 4.39).

Photo 4.39 Net bags for fruits and vegetables displayed at retail outlets

2.2.5 Bundling

Plastic bands and plastic-covered wire ties are most commonly used to unitize leafy vegetables such as cilantro, parsley and green onions. Vegetable bundles are generally displayed in chilling cabinets in supermarkets where they are routinely sprayed with water to minimize water loss and to refresh the produce. Produce can be bundled in different ways. The most common examples of fruit bundling in Thailand include: tying rambutan and longan stalks with rubber bands; and using bundling tape to bind a whole banana bunch. Bundled fruits are generally displayed in baskets at both low- and high-end retail markets. Different applications of bundling are shown in Photo 4.40.

Photo 4.40 Bundled produce at retail markets

2.2.6 Comparisons between types of retail packaging

As previously described, there are both advantages and disadvantages to using any particular type of retail packaging format for fresh produce. Retail packaging formats can be classified as flexible, semi rigid and rigid. For fresh produce packaging applications, flexible packaging is generally referred to as a bag/pouch, while semi-rigid packaging is referred to as a tray/box.

Primary advantages of trays/boxes over the bags/pouches are:

- rigidity
- strength
- load stability
- convenience for serving

In terms of materials used, trays and boxes are generally categorized as plastic and paper packaging. The main advantages of plastic over paper are:

- moisture resistance;
- wide range of permeability;
- modified atmosphere packaging can be established;
- level of ventilation can be adjusted by poking holes into the plastic;
- secure closing for safety (heat sealing, film overwrapping).

A packaging system is composed of fresh produce and one or more packaging types (primary, secondary, tertiary and quaternary) as previously described. Findings of this survey indicate that different packaging systems are used for different types of fresh produce in Thailand. Survey results of the retail packaging formats of the top ten fruits and vegetables with the highest export values from Thailand in 2009 are summarized in Table 4.4 and Table 4.5 respectively.

Table 4.4 Retail packaging formats of the top ten Thai fruits in export value in 2009

No.	Fruit	Volume (tonne)	Value (million baht)	Common retail packaging (supermarket/superstore)
1	Pineapple	803 576	25 989.586	Basket/crate display (with or without foam net)
2	Longan	286 328	5 051.021	Basket/crate display (without foam net) Plastic bag (perforated) Plastic bag (non-perforated)
3	Durian	222 559	3 824.230	Basket/crate display (without foam net)
4	Mango	36 334	1 428.740	Basket/crate display (with or without foam net) Tray with film overwrapping
5	Mangosteen	44 268	743.954	Basket/crate display (without foam net) Plastic bag (perforated) Plastic bag (non-perforated) Tray with film overwrapping
6	Tangerine	28 718	590.608	Basket/crate display (with or without foam net) Net sack/bag Plastic bag (non-perforated) Tray packed in net bag
7	Banana	22 904	402.854	Basket/crate display (without foam net) Plastic bag (perforated) Plastic bag (non-perforated) Bubble wrapping bag Tray with film overwrapping
8	Litchi	13 491	513.590	Basket/crate display (without foam net) Plastic bag (perforated) Plastic bag (non-perforated)

Table 4.4 *(continued)*

No.	Fruit	Volume (tonne)	Value (million baht)	Common retail packaging (supermarket/superstore)
9	Rambutan	6 886	126.842	Basket/crate display (without foam net) Plastic bag (perforated) Plastic bag (non-perforated) Tray with film overwrapping Bundling tape/rubber band
10	Papaya	3 458	111.885	Basket/crate display (with or without foam net) Film overwrapping

Table 4.5 Retail packaging formats of the top ten Thai vegetables in export value in 2009

No.	Vegetable	Volume (tonne)	Value (million baht)	Common retail packaging (supermarket/superstore)
1	Sweet corn	356 481.483	5 191.311	Tray with film overwrapping Plastic bag (perforated) Plastic bag (non-perforated) Film overwrapping
2	Baby corn	48 614.891	1 556.926	Tray with film overwrapping Plastic bag (perforated) Plastic bag (non-perforated)
3	Onion	39 346.635	390.089	Basket/crate display Net sack/bag Plastic bag (perforated) Tray with film overwrapping
4	Ginger	39 136.549	865.732	Basket/crate display Tray with film overwrapping
5	Chilli	24 757.244	1 278.415	Tray with film overwrapping Plastic bag (perforated)
6	Red onion	21 944.370	158.265	Basket/crate display Net sack/bag Tray with film overwrapping
7	Asparagus	13 604.885	804.392	Bundling tape Tray with film overwrapping Plastic bag (perforated) Plastic bag (non-perforated)
8	Tomato	8 865.915	316.411	Tray with film overwrapping Plastic bag (perforated) Plastic clamshell tray
9	Garlic	2 800.653	26.126	Basket/crate display Net sack/bag Plastic bag (perforated)
10	Pepper	2 447.100	82.895	Tray with film overwrapping Plastic bag (non-perforated)

2.3 Unitizing/palletizing

A unit load refers to a combination of small units/packages into one unit for efficient handling, storage and distribution. Unitizing usually involves placing shipping containers on a pallet. Pallets play an important role in unitizing, distributing and protecting produce. Pallets are primarily made of wood, although some are made from plastic, paper and metal. Various types and sizes of pallets (Photo 4.41) exist. No global standardized pallet size has been established although there have been attempts to do so. Pallet pooling and exchange systems have been developed to facilitate efficient logistics. Pallet pooling is growing and expanding in many regions in response to global trading.

Photo 4.41 Stacking packaged produce with and without pallets

Pallets commonly used across the globe are described in the next section.

North American pallets

The most commonly used pallet in North America is that used by the Grocery Manufacturers' Association (GMA). The dimension of the pallet is 48 in × 40 in.

Euro pallets

The most widely used pallets in Europe are the "Euro pallets," which are certified and inspected by the European Pallet Association (EPAL). The most common sizes of Euro pallets are listed below with their dimensions:

- EURO (800 mm × 1 200 mm)
- EURO 2 (1 200 mm × 1 000 mm)
- EURO 3 (1 000 mm × 1 200 mm)
- EURO 6 (800 mm × 600 mm)

Asian pallets

The most widely used pallets in Asia measure 1 100 mm × 1 100 mm and 800 mm × 1 200 mm.

ISO pallets

In ISO 6780: 2003, specifications are given for the principal dimensions and tolerances of flat pallets of any entry types and materials used for intercontinental materials handling.

Palletizing for local fresh produce distribution is not common in Thailand. Unpacked or packed produce is usually loaded on to transport vehicles without pallets. Large retailers in Thailand make use of pallets for some of their local fresh produce distribution. Exporters, freight forwarders or shippers generally make use of pallets. Requirements or standards for pallets depend on the destination markets.

2.4 Model of the packaging and distribution system for fresh produce in a supply chain: the case of mangoes in Thailand

Different fruits and vegetables behave differently and therefore require different packaging and distribution systems. Nevertheless, packaging concepts are the same. This model highlights important roles of packaging along with good post-harvest practices in maintaining quality and safety of fruits and vegetables in general. Steps below propose the packaging and distribution systems of mango (cv. Nam Dok Mai) as a case study.

Harvest

- Carefully harvest mangoes at the correct stage of maturity for the destination market.

Packing and post-harvest treatment

- Grade and/or sort mangoes according to the requirements of the destination market.
- Clean mangoes in 200 ppm NaOCl for five minutes. Select the proper shipping container according to the needs of the destination market.
- Pack mangoes carefully and properly in the shipping containers (1–2 layer pack with foam net cushions) under clean/hygienic conditions.
- Use clean/washed/sanitized reusable plastic containers (RPC) or clean corrugated boxes.
- Apply proper post-harvest practices for mangoes (e.g. pre-cooling, hot water treatment, vapour heat treatment, irradiation).
- Tag, stamp or label mangoes or packages if needed.

Loading and transporting

- Carefully load shipping containers and securely stack onto refrigerated trucks.
- Refrigerated truck is controlled at optimum temperature for mangoes (12–13°C).
- A pallet load is recommended for large volume.
- Transport mango load to distribution centre/wholesalers/retail outlets, then to the airport or seaport for export.

Recommended bulk packaging options for mangoes

- Reusable plastic containers (RPCs) are recommended for domestic markets. The recommended external dimensions are approximately 300 mm × 400 mm × 200 mm. The internal height is approximately 192 mm. This RPC features the standard 600 mm × 400 mm Euro footprint and can accommodate about 20 mangoes in a two-layer pack.
- Corrugated containers are recommended for shipping to export markets. The inside dimensions of these corrugated containers are similar to those of the recommended RPCs. One-layer packing is recommended. Holes are required on all side panels of the box to allow for air ventilation. The corrugated common footprint (CCF) is preferred for secure stacking and efficient logistics. Plastic bags should be used to prevent weight loss. In general, high gas-permeable or breathable film should be used either as individual packs or liner bags to extend shelf-life especially if shipped by sea. For export to Japan, holes in boxes should be covered with nets to prevent fruit fly contamination after vapour heat treatment.

Pallet configurations

The recommended containers can be stacked on to most common global pallets (48 in × 40 in, 1 000 mm × 1 200 mm, 800 mm × 1 200 mm) as shown in Figure 3.3. It is recommended that nine layers are stacked for RPCs and ten layers for corrugated containers due to the higher weight of RPCs than that of paper containers.

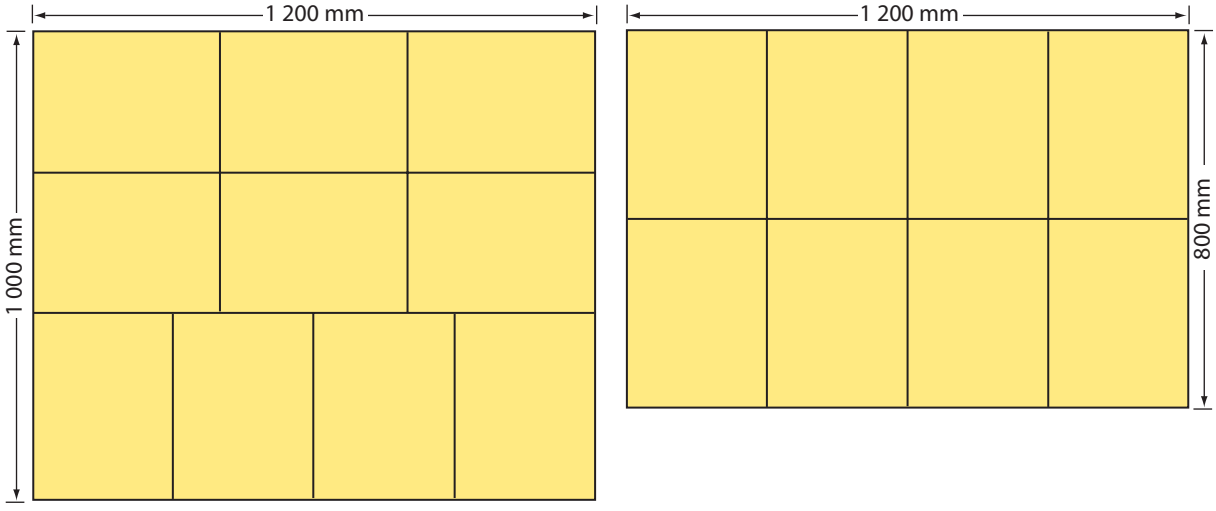


Figure 4.3 Pallet configurations for packaged mangoes

3. Standards and regulations for fresh produce packaging in Thailand

The Thai Industrial Standards Institute (TISI) is a government organization established as a national standards body of Thailand under the Ministry of Industry, pursuant to the Industrial Products Standards Act B.E. 2511 (1968). The TISI's activities on standardization include national standards development, participation in the international standards development, product certification, standards information service, and standardization promotion. The primary objectives of TISI are consumer protection, environmental protection and natural resource preservation. In general, national standards have been established in accordance with international standards.

At the international level, TISI is a member of ISO and the International Electro Technical Commission (IEC). TISI also participates in the FAO/WHO Food Standards Programme (CODEX) as a representative of Thailand as well as in the activities of other organizations related to accreditation including the International Accreditation Forum (IAF), the International Auditor and Training Certification Association (IATCA) and the International Laboratory Conference (ILAC).

Where regional standardization is concerned, TISI is a member of the ASEAN Consultative Committee for Standards and Quality (ACCSQ) and represents Thailand in the Standards and Conformance Subcommittee (SCSC) under the Asia-Pacific Economic Cooperation (APEC) and the Pacific Area Standards Congress (PASC).

Regarding agricultural commodities, the National Bureau of Agricultural Commodity and Food Standards (ACFS), which is a governmental agency under the Ministry of Agriculture and Cooperatives, has come into play. The primary role of ACFS is to set up and enforce agricultural and food standards along the supply chain with the goal of ensuring the safety of food and agricultural commodities produced in Thailand. The Bureau acts as a focal point for the WTO's Agreement on the Application of Sanitary and Phytosanitary Measures and Agreements on Technical Barriers to Trade WTO-SPS/TBT, Codex and the International Plant Protection Convention (IPPC) and provides accreditation of certification bodies of agricultural commodities and foods.

3.1 Standards and regulations related to packaging for fresh produce in Thailand

Regulations and standards involving packaging for fresh produce are listed by standard numbers as shown in Table 4.6.

Plastic crates for the packaging of fruits and vegetables

The most relevant standard for the bulk packaging of fresh produce is TIS 2373-2551: Plastic Crate for Vegetables and Fruits. This standard is based on the following standards as guideline references:

- JIS Z 1655-1993 Plastic returnable containers
- ASTM D 5276-98 Standard test method for drop test of loaded containers by free fall
- TIS 589-2528 (1985) Transport packages: designation
- TIS 656-2529 (1986) Methods of analysis for plastic products used for food contact

Table 4.6 Thai standards related to the packaging of fresh produce

Standard number	Subject	Scope
TIS 587-2528 (1985)	Freight containers: designation	Size, dimensions for distribution, labelling
TIS 588-2528 (1985)	Wooden flat pallets	Design, size, dimensions, quality, labelling, sampling plan and standard test method
TIS 589-2528 (1985)	Transport packages: designation	Dimensions and tolerances on dimensions, number of packages on each row and combination arranged to interlock
TIS 656-2529 (1986)	Methods of analysis for plastic products used for food contact	Methods of analysis for food contact plastic materials
TIS 729-2530 (1987)	Sacks manufactured from woven plastic tape yarn	Design, dimension, materials, test methods
TIS 1027-2534 (1991)	Plastic bags for food	Shape, dimension, material quality, packaging, labelling, packing, sampling, standard test method; Includes one-layer PE or PP film
TIS 925-2533 (1990)	Slip sheets	Design, dimensions, quality, labelling, sampling, standard test method
TIS 1311-2538 (1995)	Heat shrinkable film	Type, size, quality, packing, labelling, sampling plan, standard test method; Includes only PE, PVC roll films.
TIS 1698-2541 (1998)	Codex general standard for the labelling of prepackaged foods	Labelling standard and related aspects.
TIS 2108-2544 (2001)	Nylon utensils for food	Type, quality, packing, labelling, sampling, standard test method
TIS 2373-2551 (2008)	Plastic crate for vegetables and fruits	This standard covers plastic crates made from PE, PP or other materials with equal or higher quality than that specified in this standard for fruits and vegetables.
TIS 1136-2536 (1993)	Cling film	Type, size, material quality, packing, labelling, sampling, standard test method; PVS, PE for food

The details for this standard are summarized below:

Type, dimension and tolerances of plastic containers

According to this standard, plastic containers are divided into two categories as follows:

- General transportation (G)

  This type of plastic container is used for general transportation with stacking height capabilities of approximately 1.5 m. It is categorized by usage of crate and solid plastic containers. Dimensions are specified by manufacturers with tolerances of not more than ±0.7 percent.

- Shipping or airfreight (S)

  This type of plastic container is used for stacking height needs up to approximately 4 m including pallets. It is categorized by usage of crate and solid plastic containers. Dimensions are in accordance with TIS 589 Table 2 with tolerances of not more than ±0.7 percent.

Required characteristics

Plastic containers cannot have any cracks, cuts or defects from manufacturing. They cannot be compromised in any way. Container edges and handles cannot be sharp and if the handles are made of metal they must not have any rust. Plastic containers must have no flaws or imperfections due to manufacturing or uneven coloration.

Plastic containers must be tolerant to compression, shock, drop and packing weight with no defects, cuts, or deformities after the corresponding tests. Compression tests of three stacked plastic containers are performed on a compression tester using compression forces as described in the standard. Shock strength is tested by dropping a metal ball from a three-metre height for three times onto the middle of the plastic crate while being positioned upside down on a concrete, stone or metal plate flat surface. Drop tests are done by hanging a plastic container at the heights listed in the standard allowing a free fall drop onto its corner, edge and bottom.

Other standards related to packaging of fresh produce in Thailand should be referred to ACFS including "Q Mark" as previously described along with the paper containers.[5]

4. Cost of packaging

According to the basic distribution packaging concept, costs associated with packaging include a packaging cost and a damage cost. "Over packaging" increases packaging/product cost, while "under packaging" may result in damage and loss, which could lead to excessive additional costs. Therefore, packaging solutions are generally based on optimization of the two costs. The cost of packaging may be referred to as a direct cost, while the cost of damage may be referred to as an indirect cost. Direct costs comprise material and labour costs, which are directly attributed to the packaging applied. Indirect cost is not directly caused by the packaging used. It is frequently referred to as overhead cost, which includes all costs of running the packaging operation.

Packaging is used at all steps in the fruit and vegetable supply chain. The cost of packaging is composed of package manufacturing, the packaging process, and distribution. Packaging costs can be affected by various factors. These include, for example, the type and form of materials, production process and production volume. Packaging is generally a volume-based industry. High-volume production (or customer orders) will lower the unit cost (i.e. cost of each package). Results of a survey conducted on the cost of packaging in Thailand, compiled by the authors, are shown in Tables 4.7 to 4.9. The costs shown are based on retail prices. Costs may be reduced by increasing purchase quantity or by contracts/agreements.

5

Table 4.7 Cost of bulk packaging for fresh produce commonly used in Thailand

Type	Dimension (mm)	Cost (baht/piece)
Plastic crate (with steel handles)	385 × 600 × 300	180/265
	485 × 560 × 300	325
	490 × 605 × 320	370
	365 × 590 × 330	160/250
	410 × 510 × 280	265
	420 × 520 × 333	270
	365 × 575 × 335	165/250
	365 × 580 × 320	250/290
	500 × 620 × 310	520
Plastic crate (with embedded handles)	375 × 570 × 310	250
	370 × 555 × 305	150
	365 × 580 × 320	220
	370 × 555 × 305	160/240
	350 × 530 × 230	200
	375 × 565 × 160	220
	370 × 555 × 300	180
	360 × 480 × 95	115
	357 × 505 × 313	254
Plastic crate (with cover)	586 × 578 × 315	575
	360 × 485 × 250	115
	375 × 502 × 210	90/115
	360 × 490 × 168	60/75
	185 × 275 × 108	35
	220 × 350 × 107	32
Plastic solid box (with embedded handles)	275 × 405 × 130	135
	255 × 330 × 120	105
	335 × 485 × 185	180
Plastic crate (collapsible)	350 × 490 × 250	224
Plastic basket (round)	Ø540 × 360	95
	Ø570 × 410	120
	Ø530 × 530	95
	Ø520 × 350	115
	Ø650 × 450	190
	Ø590 × 410	160
	Ø650 × 450	170
Corrugated box (new)	255 × 380 × 75	7.70
	300 × 400 × 100	14
	300 × 400 × 200	12.75–13.50
	300 × 450 × 230	9–22
	350 × 450 × 200	21–26
	300 × 475 × 240	15.50
	300 × 480 × 235	18

Table 4.7 *(continued)*

Type	Dimension (mm)	Cost (baht/piece)
	300 × 500 × 100	15–19
	300 × 500 × 240	15
	284 × 525 × 360	15
Corrugated box (used)	Vary	3.50–5
Out-of-spec box	Vary	15–16
Bamboo basket (round)	Ø700 × 580	20–30/150–180
Thaitambon.com/market	Ø685 × Ø490 × 570	15–20/120–150
	Ø470 × 420	12–20/32–35
	Ø445 × 310	10–12/32–35
	Ø400 × 350 (height)	9–10/20–25
	Ø300 × 240 (height)	5–6/20–25
	Ø230 × 160 (height)	4–5/20–25
Bamboo basket (cylinder)	Ø600 × 450 (height)	150–180
	Ø400 × 350 (height)	120–150
Foam box	460 × 600 × 320	80
	352 × 478 × 355	70
	470 × 395 × 355	70
	346 × 475 × 337	75
	298 × 390 × 342	60
	257 × 375 × 320	45

Table 4.8 Cost of retail packaging for fresh produce commonly used in Thailand

Type	Dimension (mm)	Cost (baht/piece)
Plastic bag (PE, PP)	100 × 280	125–140/ kg
	250 × 400	125–140/ kg
	300 × 450	125–140/ kg
	380 × 630	125–140/ kg
	500 × 760	125–140/ kg
PP/PET/PLA	122 × 184 × 28	1.23/1.40/2.10
	124 × 272 × 28	2.15/2.20/3.20
	140 × 175 × 28	1.35/1.50/2.00
	166 × 226 × 28	2.40/2.50/3.40
	299 × 304 × 28	4.77/5.50/6.70
	144 × 203 × 16	1.60/1.60/2.60
	178 × 275 × 28	2.80/2.80/4.00
	178 × 178 × 30	1.73/1.80/2.70
	130 × 198 × 30	1.60/1.76/2.60
	144 × 203 × 30	1.80/1.90/3.70
	212 × 212 × 20	2.80/2.90/4.40
	85 × 139 × 20	0.65/0.80/1.20
	120 × 120 × 20	0.79/0.90/1.30

Table 4.8 *(continued)*

Type	Dimension (mm)	Cost (baht/piece)
Foam tray (PS)	122 × 184 × 28	0.42
	124 × 272 × 28	0.31
	140 × 175 × 28	0.34
	166 × 226 × 28	0.62
	299 × 304 × 28	0.62
	144 × 203 × 16	0.41
	178 × 275 × 28	0.30
	178 × 178 × 30	0.38
	130 × 198 × 30	0.30
	144 × 203 × 30	0.26
	212 × 212 × 20	0.26
	85 × 139 × 20	0.25
	120 × 120 × 20	0.32
Clamshell tray	Ø114 × 50 mm	2.00
	By order	
Thermoformed tray	240 × 207 × 50	2.50
	315 × 150 × 40	3.80
Stretch/wrapping films Fresh wrap,	25 cm × 500 m	180–200/roll
M wrap, L wrap	30 cm × 30 m	20–25/roll
	30 cm × 500 m	200–220/roll
	35 cm × 500 m	200–220/roll
	40 cm × 500 m	220–250/roll
	45 cm × 500 m	220–250/roll
	60 cm × 500 m	250–300/roll
Net bag for fruits	40 × 28	0.80
	360–400 × 33	0.85
	360–400 × 36	0.90
	360–400 × 38	0.90
	400–440 × 43	1.20
Net bag for garlic	9.5 × 15	1.10
	9.5 × 17	1.10
	9.5 × 19	1.10
	9.5 × 20	1.10
	10 × 15	1.10
	10 × 17	1.10
	12 × 18	1.10
	12 × 20	1.10
	14 × 15	1.10
	14 × 20	1.10
	14 × 24	1.10
	14 × 26	1.10
Bundling tape	45 m (length)	12.50/roll

Table 4.9 Cost of accessories and cushioning materials for fresh produce commonly used in Thailand

Type	Length (mm)	Cost (baht/piece)
Foam net cushion	100	0.25–38
	120	0.33–0.40
	130	0.33–0.40
	140	0.36–0.50
	150	0.40–0.50
	170	0.46–0.69
	180	0.52–0.72
	200	0.56–0.88
	220	0.62–0.88
	240	0.68–0.92
	260	0.75–0.96
	300	0.85–1.25
	500	1.29–2.50
	550	1.62–3.00

5. Trends in packaging for fresh produce supply chains

5.1 Trends in packaging systems and technologies for fresh produce

Fresh produce is a key economic export of Thailand and is targeted for development in the coming decades. The success of fresh produce in international markets hinges on a number of factors and packaging plays a critical role in achieving that success. Advanced packaging technologies and innovations contribute tremendously to market growth.

Packaging technologies and their significance for Thailand, include:

- *Packaging technologies reduce damage and improve produce quality.*

  Packaging is used across the fresh produce industry from production to retail. "Packaging before harvest" such as fruit bagging reduces damage and improves produce quality from the point of origin. Proper selection of "packaging and cushioning systems" increases produce value by reducing bruising throughout the supply chain.

- *Controlled/modified atmosphere storage/packaging technologies extend the shelf-life of produce.*

  Controlled atmosphere (CA) storage and modified atmosphere packaging (MAP) technologies are known to extend the shelf-life of produce. Shelf-life extension offers opportunities for the export of produce by sea freight, resulting in a significant cost advantage.

- *Packaging technology and innovation add value to trade promotion*

  Consumers require packaging that offers specific benefits in addition to protection and preservation. Convenience has become one of the key consumer demands in recent

years. Consumers are searching for produce in retail packaging that is ready to serve/ cook, easy to open, re-sealable, and microwavable. Special, unique and innovative packaging can also be used as a marketing tool for trade promotion.

Trends in innovative packaging include "active packaging" that serves as more than an inert barrier and intelligent packaging, which senses the environment or conveys information about changes taking place in the product. Examples of packaging innovations developed in Thailand include an "active packaging film" developed by the National Metal and Materials Technology Center (MTEC), in collaboration with the Department of Packaging and Materials Technology of Kasetsart University. This film can extend produce shelf-life using the principle of equilibrium modified atmosphere.

Active packaging research on fresh produce to date has resulted in the development of packaging films that can actively change gas permeability in response to the environment, ethylene absorption, and the release of antimicrobial/antiseptic/insecticide substances.

"RipeSense" is an example of intelligent packaging that detects aroma compounds within the package and causes a change in the colour to indicate the ripeness of the fruits. The application of radio frequency identification (RFID) to packaging systems also facilitates the ability to track and trace products throughout the supply chain. Information about produce is becoming increasingly important to many parties involved in fruit and vegetable supply chains.

Apart from the above-mentioned packaging technologies, the following factors are significant in maintaining the quality and safety of produce from farm to table:

- Refrigerated and thermal protection technologies maintain the quality of produce throughout the supply chain.
- Temperature is a critical factor that impacts on the quality of produce. Prompt pre-cooling after harvest and optimum temperature control throughout produce supply chains are the most significant practices in maintaining produce quality.
- Processing technologies create new/value-added products for new markets.
- Potential exists for growth in the consumption of new/value-added products. Continued research and development are required as consumer trends shift towards the demand for produce of improved quality, in terms of appearance, taste, flavour, nutritive value and health benefits. Consumer demand for fresh-cut products is increasing rapidly in global markets and packaging plays a major role in maintaining quality and safety and in contributing to the sale of produce.
- Material and manufacturing technologies reduce the environmental impact of packaging. With rising global demand for environmentally friendly packaging materials, research on biodegradable/biopolymer packaging made from natural resources is increasingly gaining attention. One of the best known materials globally is polylactic acid.

In summary, the development of packaging technologies and innovations offers opportunity for value creation for Thai produce in global markets in response to diverse consumer demands. However, the relatively limited use of these technologies has limited development and growth of the Thai produce industry. Technologies such as RFID and intelligent packaging (e.g. ripeness indicators) will, however, be driven and influenced by global trade. Although controlled atmosphere storage is a challenging alternative for exporters because of cost concerns it is recommended for domestic storage to prolong the shelf-life of produce, particularly for off-season fruits and vegetables. Modified atmosphere packaging has been proven successful and used in the packaging of many fresh produce items and fresh-cut products in Thailand.

5.2 Traceability and packaging issues for fresh produce supply chains in Thailand

Traceability has become an increasingly important issue in many sectors especially in the food and fresh produce industry. Traceability is the ability to trace and track produce as it moves through the supply chain. Traceability allows all parties concerned to follow both the physical flow and the information flow of their fresh produce throughout the supply chain, through enabling technologies such as bar codes, RFID and electronic data interchange (EDI). Traceability plays a significant role in ensuring safety and security as well as quality of the traded products. Packaging is closely associated with traceability, as in most cases traceable items are the packaged product, shipping unit or shipment. Global trading involves transfer across boundaries of industry and region, hence global harmonization and agreements are required. There are a number of standards and regulations involving global traceability, which are related to fresh produce supply chains. These are listed below.

- GS1 has developed the Global Traceability Standard (GTS) within the GS1 Global Standards Management Process (GSMP), representing members from around the world from a wide range of industries. The GS1 GTS is designed to serve as the global reference for worldwide traceability and a tool to help companies and organizations to specifically meet their needs. The GS1 GTS is applicable to a wide variety of traceability applications and a wide range of enabling technologies such as barcodes, RFID, EDI, internet, etc. GS1 has published a traceability implementation guide for fresh fruits and vegetables, which was revised and updated in January 2010.[6]
- GLOBALGAP (formerly known as EUREPGAP) has established standards for certifying the global production processes for agricultural products. The aim of GLOBALGAP is to set a global reference system for Good Agricultural Practices (GAP). As of April 2010, the number of GLOBALGAP-certified producers from Thailand was 597.[7]

With expansion of world trade agreements, traceability will continue to play a key role in ensuring the safety or quality of international traded products. Various sectors are engaged in the implementation of traceability in Thailand. In order to build confidence, the Thai government recently launched a food traceability initiative. The Ministry of Agriculture and Cooperatives, in

[6]

[7] www.globalgap.org/cms/front_content.php?idcat=3

partnership with IBM, FXA Group and the Communications Authority of Thailand (CAT), is implementing a "Global Traceability Programme" to allow tracking capability from the retail level back to the farm using smart sensor technology and software programs. The pilot programme is currently applied to mangoes and processed chicken for export. Traceability information includes history and application or location, e.g. farm of origin, farm location, production history, temperature during shipment, etc.[8]

The Ministry of Agriculture and Cooperatives along with the National Bureau of Agricultural Commodity and Food Standards are raising the bar for Thailand as a produce exporter by adapting the EPCIS (Electronic Product Code Information Services) standard for traceability. Thailand is considered one of the world's most important producers and exporters of agriculture produce. Since 2005, businesses in the farming sector, producers and exporters have cooperated to improve standards for product quality and safety. These standards are specific for national use only. With EPCIS management, these standards will be accepted internationally. EPCIS is part of a project under the Agriculture and Food Safety Strategy B.E. 2553–2555 (2010–2012). The plan is to build confidence in Thai agriculture and food standards. With this new technology, data of farm, factories and other intermediaries can be traced back in the event of a problem. This can be rapidly done, thus reducing produce loss while building consumer satisfaction. It is hoped that more than 600 businesses and farmers will take part in this programme. Success in the establishment of EPCIS would help Thailand in negotiating with important markets such as Europe, North America and Japan.

The Netherlands is one of Thailand's fresh produce importers. Recently the European Office of Agriculture Affairs with the Thai Trade Center, The Hague, met to discuss issues dealing with trade with Thailand. One of the issues considered was cooperation between Thailand and the Netherlands to develop a traceability programme in order to trace produce back to the farm. Netherlands importers have expressed interest in the establishment of an organization to support Thai farmers. Within this framework, activities on contract farming will be initiated and farmers will be taught to improve Thai produce standards and lower chemical residues in the long run.

Thai exporters have focused on traceability systems for fresh produce for export to EU countries, in particular radio frequency identification (RFID), which is a system that collects and analyses information to enable correct tracing of the origin of the produce. The RFID system includes two parts: a *tag* with an embedded microchip to store information, and a *reader* to read the information. The information would be the address and number of the grower – data needed for traceability. RFID will help in the automatic and correct recording of information. It will also help save time in recording data. Information such as quality and packaging of the produce along the entire supply chain can be verified.[9]

[8] www.foodsafetynews.com/2010/03/thailand-launches-food-traceability-initiative/

[9] www.fxagroup.com/news/2007/20070412-TraceabilityInEurope.html

5.3 Programmes that promoting packaging systems in Thailand

With the Thai government's policy to campaign and promote Thai fruits on an international level, demand for Thai fruits has increased along with the demand to respond to buyer demands, which includes packaging. Various programmes exist for promoting fresh produce packaging in Thailand through all sectors: government, industry, academia and associations/non-profit organizations.

Among the most important programmes is the Perishable One Stop Service Export Center (POSSEC), which has been established through a partnership between the government and the private sector. POSSEC, located at Talaad Thai, is a 24-hour one-stop service for exporters. It provides all of the government services required to facilitate export in one location. POSSEC offers the following services:[10]

- export declaration, inspection, certification and clearance;
- transportation and export representative;
- marketing information;
- standards and regulations information;
- vapour heat treatment;
- fumigation;
- coating;
- sorting and packing facilities;
- storage and cold room facilities;
- export and financial advice.

Other organizations in Thailand play various roles in promoting packaging of fresh produce. The Department of Packaging and Materials Technology of Kasetsart University, established in 1980, is the first institute in Thailand, and in Asia and the Pacific to offer a degree programme in "Packaging Technology". The department has continued to play a significant role in producing qualified students, researches and services in packaging. It is a unit under the Faculty of Agro-Industry and has close collaboration with food science and post-harvest faculties. One key focus of the department is packaging of fresh produce.

The Thai Packaging Centre (TPC), supported by the Thailand Institute of Scientific and Technological Research (TISTR), has offered testing and services in the area of packaging. One project of the TPC was on the packaging design for specific fruits for export. The TPC also offers seminars in various topics including seminars on the packaging of fresh fruits.

The Department of Export Promotion under the Ministry of Commerce, the Thai Fresh Fruit Traders and Exporters Association along with the Thai Packaging Association (TPA), the Thai Packaging Centre and Thai Containers Group Co., Ltd. held a competition for packaging design for fresh produce under the title "future fresh". The activity was aimed at soliciting ideas and creativity of packaging designers and entrepreneurs. Students from the Department of Packaging and Materials Technology, Kasetsart University won the best design for its best structure and graphic.

[10] www.talaadthai.com/web/pr/intro.html

The Division of Product Development, Packaging and Printing, Department of Industrial Promotion has set up a consultation programme for small and medium businesses, related to packaging issues. One-to-one consultations and open seminars have been conducted by private-sector specialists and university professors. The programme aims to motivate the development of new packaging innovations, reduce repetition of package designs and train new designers.

Recently the Industrial Technology Assistance Program (iTAP) along with the Excellent Center for Eco-product development (XCEP) began a programme to promote Thailand's use of eco-friendly packaging. The project aims to help packaging businesses to realize the importance of their environmental impact and hopes to support and encourage the development of eco-friendly packaging.[4]

6. Conclusions and recommendations

6.1 Conclusion

As one of the world's leading producers and exporters of fresh produce, Thailand offers consumers a range of fruits and vegetables, each requiring different post-harvest management strategies to assure quality and safety.

Approximately 35 percent of total produce value in Thailand is lost owing to damage throughout the distribution system. Packaging plays an important role in preservation, storage, transport, distribution and retailing of fresh produce and is of significance in reducing losses and maintaining quality. Packaging is involved at every step of the chain in delivering fresh produce of good quality to consumers. Many different packaging options exist for fresh produce.

Good management designed to minimize waste and to reduce cost while maximizing overall value from the numerous distribution channels for fruits and vegetables in Thailand, is difficult to achieve. Without a proper understanding of the basic biology of produce and the correct usage of different types of packaging, the grower/packer/distributor can make improper use of packaging or might not use packaging at all, thereby leading to major losses.

With increasing consumer demand for Thai produce in the World market, the Thai government has enforced stricter agricultural standards and packaging related standards along the supply chain in conformance with international regulations. This is to ensure the safety and quality of agricultural commodities. These requirements, along with consideration for other factors such as environmental awareness, have caused difficulty for growers/distributors in meeting the obligations, due to their lack of knowledge and resources.

6.2 Recommendations

As the global market becomes increasingly competitive, the demand for quality produce has risen. Packaging plays a key role in maintaining quality in supply chains. An understanding of the proper selection and application of packaging systems and technologies is needed for the expansion of Thailand's produce in international trade. Produce characteristics must be taken into account in the packaging fruits and vegetables.

Meeting consumer demand for convenience is yet another major key to success. Sustainability issues and the environmental friendliness of packaging must be considered in line with current global trends. Continued research and development and cooperation between institutes, universities, and businesses in packaging related areas will be very useful in improving packaging. Training and other programs that promote packaging in Thailand should be continuously provided to strengthen the produce industry in the area of packaging and related matters. Advanced knowledge and technology transformation with experience sharing through networking will generate success in Thailand's fresh produce industry.

Key recommendations for packaging of fresh produce in Thai supply chains include:

- Proper post-harvest practices including pre-cooling must be applied to fresh produce prior to packaging, storage and distribution to ensure highest quality and safety.
- Appropriate packaging technologies such as modified atmosphere packaging and active packaging should be applied to fresh produce for better quality and longer shelf-life.
- Standardized corrugated boxes and crates for fresh produce should be established based on major global pallets used.
- Organized resources/systems/facilities should be set up and promoted for standardized boxes and crates, given that costs are substantially reduced with the volume of packaging procured.
- The weight and number of layers should be limited for produce packing in order to minimize damage and enhance produce protection as well as worker safety.
- The cold chain is very important for the distribution of fresh produce in Thailand. The organization of distribution systems and/or sharing facilities such as refrigerated trucks or thermal protection equipment should be set up in selected cities on distribution routes.
- Food safety is a critical concern of produce packaging in a supply chain. Food safety is currently neglected in many cases. Greater attention must be accorded to the proper sanitation of packaging as well as packing/operation/storage areas.
- Knowledge and basic/updated information on various aspects of packaging and distribution for fresh produce along with post-harvest practices and food safety should continually be transferred to all parties in a supply chain.
- An optimization concept of "packaging cost" and "damage cost" as well as logistic concept of "efficiency" should be made clearly understandable.
- The Thai produce industry would benefit greatly from cooperation and collaboration among all sectors (industry, academia, government) and all supply chain parties.

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Chapter V
Packaging in fresh produce supply chains in Viet Nam[11]

1. Introduction

Packaging of fresh fruits and vegetables is one of the most important steps in the long and complicated journey from the grower to the consumers. Bags, wooden boxes, plastic boxes, plastic baskets, bamboo baskets and cartons are convenient containers for harvesting, handling, packaging, transporting, distributing and marketing of fresh produce. The selection of appropriate packaging plays an important role in maintaining produce quality and in satisfying consumer demand.

Viet Nam produces a diversity of tropical fruits. A number of fruits are also sourced from its neighbouring countries (Thailand, Malaysia, the Philippines and Indonesia). These include mangoes, dragon fruits, star apples, longans, durians, rambutans and mangosteens, among others. A diverse range of vegetables is also grown in Viet Nam and is simultaneously harvested throughout the year to meet domestic and export market requirements. By and large, fresh produce horticultural supply chains in Viet Nam are relatively poorly organized with little attention paid to good post-harvest management practice. With an increasing market orientation, attention is increasingly paid to the implementation of good post-harvest practice.

This report documents the results of a survey on the use of packaging in fresh produce horticultural supply chains in Viet Nam.

2. Trends in fresh produce consumption in Viet Nam

Fruits and vegetables are popularly consumed by urban and rural households in Viet Nam. Positive economic growth of the country has led to shifts in consumer demand, technological change in marketing and strong retail purchasing power. Consumer preferences have changed with growing consumption of fruits and vegetables as well as meat. Consumers are increasingly concerned about the origin, the quality and the safety of produce. According to a survey conducted in Hanoi and Ho Chi Minh City, inhabitants of Hanoi consume 86 kg of vegetables and 68 kg of fruits per year, while inhabitants of Ho Chi Minh City consume 84.6 kg of vegetables and 74.6 kg of fruits per year. Eighty percent of people involved in the survey pay more attention to the safety of produce (Vneconomy) they consume.

[11] Ly Nguyen Binh.

Consumers pay attention to the freshness of the produce that they consume. This is more pronounced in the case of vegetables than in the case of fruits. Consumers in Ho Chi Minh City pay more attention to the physical appearance of produce, while in Hanoi they are more concerned with freshness attributes.

According to IFPRI[12] (2002) and ICARD[13] (2004), water morning glory (95 percent), tomatoes (88 percent) and bananas (87 percent) are the most popularly consumed fresh produce items in Viet Nam. Households in Viet Nam consume, on average, 71 kg of fresh produce per person per year, three-quarters of which are vegetables. As reported by IFPRI (2002), consumption of fresh produce has increased more rapidly in urban areas than in rural areas.

Produce consumption also varies by region. Beans, kohlrabies and cabbages are popularly consumed in the north, while oranges, bananas, mangoes and other fruits are widely consumed in the south. The contrast is clearest for the case of kohlrabi which is consumed by over 90 percent of rural households in mountainous northern and Red river delta regions, compared to less than 15 percent of households in the southeast and Mekong river delta regions. In urban areas, the percentage of households consuming all kinds of fresh produce is high.

Household consumption of fresh produce increases with rising incomes. The difference between the quantity of produce consumed per capita of the richest household group and that of the poorest household group is fivefold, i.e. 134 kg compared to 26 kg per capita per year. The difference is fourteenfold for fruit consumption and fourfold for vegetable consumption. The demand for oranges, bananas and mangoes rises as income of consumers increases, while that for kohlrabies is increasing much more slowly.

3. Marketing channels for fresh horticultural produce

Fresh produce is marketed through a range of different channels in Viet Nam. These channels include the traditional market, wholesale market, supermarket, convenience store, retail shop, middleman and street vendor. Wholesale markets play a key role in supplying fresh produce to consumers. Harvested fresh produce is brought to wholesale markets and is subsequently transported to traditional markets, small traders, supermarkets and street vendors. In terms of a schedule, activities at wholesale markets begin at around 10 p.m. and end at 5 a.m. the next day. Large volumes of produce are traded in wholesale markets. Main wholesale markets in Viet Nam include Den Lu (Hanoi city), Hoa Dinh (Bac Ninh province), Da Lat (Lam Dong province), Binh Dien and Thu Duc (Ho Chi Minh City).

An end-point of the supply chain of fresh agricultural produce is traditional markets. Vietnamese consumers procure fresh produce in traditional markets owing largely to the price and freshness. Traditional markets currently supply 90 percent of the fresh produce consumed locally in Viet Nam. Small vendors supply about 6 percent of fresh produce in Hanoi and 3 percent in Ho Chi Minh City. With positive economic growth, the number of supermarkets in Viet Nam has increased.

[12] IFPRI – International Food Policy Research Institute

[13] ICARD – Information Center for Agriculture and Rural Development

Supermarkets, however, account for a rather small percentage of the market (~10 percent) for fruits and vegetables in Viet Nam.

4. Bulk packaging options used in fresh produce supply chains

A number of different types of bulk packaging materials are available for the packaging of fresh produce for different supply chains. These include baskets, crates, bags, sacks, fibreboard boxes and plastic boxes.

Baskets

Several types of baskets, including hard and soft bamboo baskets and plastic baskets, are used for the bulk packaging of horticultural produce. These types of baskets are flexible containers and differ in size and shape. Hard bamboo baskets (Photo 5.1) are made from strips of the hard outer rind of the bamboo, while soft bamboo baskets (Photo 5.2) are made of the soft inner part of the bamboo. Plastic baskets are an alternative packaging container widely used in Viet Nam (Photo 5.3). These baskets are made of woven polypropylene (PP) strips (Photo 5.4).

Photo 5.1 Hard bamboo basket used for the bulk packaging of mangoes

Photo 5.2 Weaving soft bamboo baskets

Photo 5.3 Plastic basket used for bulk packaging

Photo 5.4 Weaving PP plastic baskets

Baskets are semi-rigid, and when in use can damage the produce. They must, therefore, be lined with padding material such as banana leaves, old newspapers or straw to protect fruit from bruising due to vibration. Hard bamboo baskets and plastic baskets can be repeatedly reused.

Crates

Wooden and plastic crates are rigid containers popularly used for the bulk packaging of fresh produce. Wooden crates are commonly used for shipping mangoes from Mekong delta areas in the south to markets in the north or to Chinese markets (Photo 5.5). Wooden crates provide good ventilation but may transfer microbial contamination to produce if they are not properly cleaned. Plastic crates are increasingly being used for the bulk packaging of fresh produce (Photo 5.6).

Photo 5.5 Stacks of wooden crates filled with mangoes

Photo 5.6 Reusable plastic crates

Bags

As flexible containers, net bags and plastic bags are used for the bulk packaging of produce. Net bags are made of PP material, suitable for packing relatively hard produce items such as potatoes, shallots, cabbages. Plastic bags (polyethylene bags) are widely used for packing vegetables such as paro onions, celery, radish, bitter melon, okra, cucumber, etc. Different types of bags used for hauling and transporting fresh produce are presented in Photos 5.7 to 5.12.

Photo 5.7 Net bags filled with potatoes

Photo 5.8 Net bags filled with cabbages

Photo 5.9 Paro onions in plastic bags

Photo 5.10 Apples packed in plastic bags

Photo 5.11 Fresh produce in plastic bags transported to wet market

Photo 5.12 Persimmon in plastic bags at retail market in Da Lat city

Sacks

Sacks are flexible containers normally used for packaging rice, fertilizer and other agricultural products including fruits. They are made of woven synthetic material, namely polypropylene (Photos 5.13 and 5.14).

Photo 5.13 Pomelos packed in PP sacks

Photo 5.14 Pomelos in PP sacks for local consumption

Fibreboard boxes/cartons

Fibreboard boxes or cartons popularly used for bulk packaging in Viet Nam are made of corrugated fibreboard. They are rectangular in shape and of different sizes with adequate ventilation holes for air and vapour exchange. They are well suited to the transportation of produce such as pomelos (Photo 5.15), mangoes (Photo 5.16), dragon fruits, and star apples.

Photo 5.15 Pomelos packed in corrugated boxes for export

Photo 5.16 Mangoes in cartons for export

Plastic boxes

Small fruits such as longans, acerolas and litchis are packaged in plastic boxes for export.

Photo 5.17 Longans in plastic boxes for export

5. Use of bulk and retail packaging in supply chains

In general, in Viet Nam, there are five different types of fresh produce horticultural supply chains: (1) farm to wholesale market to retail market; (2) farm to retail market; (3) farm to supermarket; (4) farm to international market; and (5) farm to street vendor. Each chain is operated by stakeholders of appropriate qualification.

5.1 Farm-wholesale market-retail market chain

With its subtropical climate, Da Lat city and the neighbourhood belonging to Lam Dong province of the central highland are two main regions for fresh produce production which supply the domestic demand of the entire country. Fresh produce outputs of this region include potato, paprika, carrot, cabbage, cauliflower, kohlrabi, lettuce, pumpkin, tomato, etc. Produce harvested on farms is transported to wholesale markets before being distributed to retail markets for local consumption. In terms of packaging, harvested produce is placed in plastic crates, bamboo baskets or net bags (Photos 5.18 to 5.23), and is subsequently transported to packing houses by vans, where it is subjected to preliminary treatment and repackaging prior to being transferred to wholesale markets of different provinces in the south and the north.

Photo 5.18 A plot of lettuce in Lam Dong province

Photo 5.19 Harvesting lettuce in Lam Dong province

Photo 5.20 A plot of lettuce in Lam Dong province

Photo 5.21 Harvesting lettuce at Xuan Huong Farm, Lam Dong province

Photo 5.22 Harvesting cabbage

Photo 5.23 Harvesting kohlrabi

On arrival at the packing house, cabbages and root vegetables such as onions, potatoes and sweet potatoes are packed in net bags, while stem vegetables including paro onions, celery and other vegetables are packed in bulk plastic bags. Chinese cabbages, lettuce and other leafy vegetables are packed in plastic crates lined with layers of old newspaper at the bottom (Photo 5.24). Tomatoes and white radishes are packed in small mesh bags and are placed in plastic crates (Photo 5.25).

Photo 5.24 Chinese cabbages packed in plastic crates

Photo 5.25 Tomatoes packed in small mesh bags

With its tropical climate, the Mekong river delta of Viet Nam is a main region for the production of tropical fruits including mangoes, longans, oranges, pomelos, durians, rambutans, star apples, pineapples and dragon fruits. Fruits are transferred to bamboo baskets or plastic crates at harvest (Photos 5.26 and 5.27).

Photo 5.26 Harvested pineapples in bamboo baskets

Photo 5.27 Harvested dragon fruits in plastic crate

On arrival at the packing house, fruits are subjected to preliminary treatments and are packed in suitable packages for either the local or international market. Local markets invest relatively little in the application of post-harvest technology to maintain quality or enhance shelf-life. Pomelos destined for the local market are packed in bulk plastic bags, mangoes are packed in wooden crates (Photo 5.28), while dragon fruits are packed in plastic crates (Photo 5.29). In contrast, the sector dealing with export goes further on the application of post-harvest technology to meet the demand of the importers (see supply chain for export).

Photo 5.28 Mangoes packed in wooden crates for local consumption

Photo 5.29 Dragon fruits in plastic crates

Wholesale markets are a major link of fresh produce horticultural supply chains in Viet Nam. Most fruits and vegetables are packed in bulk PE and PP plastic bags, fibreboard cartons or plastic containers for transportation to wholesale markets (Photos 5.30 and 5.31). At wholesale markets, vegetables are placed in plastic crates (Photo 5.32), bamboo baskets (Photo 5.33), or large mesh bags (Photo 5.34). Fruits are placed in foam tanks, fibreboard boxes or plastic crates (Photo 5.35).

Photo 5.30 Transportation of packed produce by van

Photo 5.31 Transportation of pomelo by boat without any packaging

Photo 5.32 Lettuce in plastic crates in a wholesale market

Photo 5.33 Cabbages in bamboo baskets in a wholesale market

Photo 5.34 Produce in mesh bags in a wholesale market

Photo 5.35 Produce in fibreboard boxes and plastic crates in a wholesale market

At retail markets, fruits are commonly displayed in foam trays (Photo 5.36), aluminium trays (Photo 5.37), foam nets (Photo 5.38), fibreboard boxes (Photo 5.39) or bamboo baskets (Photos 5.40 and 5.41).

Photo 5.36 Fruits in foam trays at a retail market

Photo 5.37 Fruits in aluminium trays at a retail market

Photo 5.38 Guavas in foam nets at a retail market

Photo 5.39 Apples in fibreboard boxes at a retail market

Photo 5.40 Limes in bamboo baskets at a retail market

Photo 5.41 Fruits in bamboo baskets and aluminium trays at a retail market

5.2 Farm-retail market chain

Another type of supply chain is the "farm to retail market" chain. Growers of this type of supply chain, in general, own small farms ranging between 0.2 and 0.5 ha in size, and lack knowledge of post-harvest technology. Supply chains are generally not organized. Produce is handled in bulk packaging and goes through a series of intermediaries before ending up at wet markets. Produce of this supply chain do not meet food safety standards and, therefore, cannot be sold in supermarkets and hypermarkets (Photos 5.42 to 5.47).

Photo 5.42 A plot of water morning glory

Photo 5.43 Harvesting water morning glory

Photo 5.44 Water morning glory in bulk packs ready for sale

Photo 5.45 Water morning glory sold to a middleman

Photo 5.46 Chinese chives ready for sale

Photo 5.47 Chinese chives in bulk packaging sold to middleman

5.3 Farm-supermarket, hypermarket, restaurant, and caterer chain

A general requirement of buyers (supermarkets, hypermarkets) in this supply chain is the need to fulfil VietGAP (GlobalGAP) or similar requirements approved by the provincial Department of Plant Protection to ensure safety and wholesomeness. Harvested produce is transferred to plastic crates and is transported to packing houses and subjected to preliminary treatments including trimming (Photos 5.48 and 5.49), ozone washing (Photo 5.50), spin-drying (Photo 5.51), and packaging (Photos 5.52 and 5.53).

Photo 5.48 Fresh produce in plastic crates at packing house

Photo 5.49 Packaging produce for a supermarket

Photo 5.50 Treating radish with ozonated water

Photo 5.51 Spin-drying produce

Photo 5.52 Retail packaging of radish

Photo 5.53 Labelling of retail packages

At supermarkets or hypermarkets, fresh produce is generally packaged in PP or PE bags (Photos 5.54a, b, c), foam trays (Photo 5.55) or small mesh bags (Photo 5.56) and stored under refrigerated conditions. One of the newest trends in produce packaging for upper-class markets is the shrink-wrapping of individual produce items (Photo 5.57). Shrink-wrapping has successfully been used to pack onions, sweet corn, cucumbers and a variety of tropical produce items. The use of clamshells is gaining popularity owing to their low cost, versatility and the excellent protection they provide to produce, as well as their consumer appeal. Clamshells are most often used for the packaging of high-value produce items such as acerolas, berries, mushrooms, or items that are easily damaged by crushing (Photo 5.58).

(a) (b) (c)

Photo 5.54 (a) Radish in retail plastic packaging; (b) Water morning glory in retail plastic packaging; (c) Sweet potato leaves in retail plastic packaging

Photo 5.55 Fruits packaged in film overwrapped foam trays

Photo 5.56 Produce packaged in mesh bags

Photo 5.57 Shrink-wrapped produce

Photo 5.58 Berries packaged in clamshell containers

5.4 Farm-international market chain

In Viet Nam, this type of supply chain is mainly set up for fruit export. Fruits sold on the international market to date include longans (of Tien Giang province) which are exported to China, Canada, the United Kingdom and France; dragon fruits (of Binh Thuan) which are exported to China and the United States market; and pomelos (of Ben Tre and Vinh Long) which are exported to the European market. Production of these fruits must be compliant with GlobalGAP. Harvested fruits are transferred to bamboo or plastic baskets for transportation to packing houses for further treatment. At the packing house, fruits are trimmed, washed with hot water or steam, and packed in suitable packages for shipping. In some cases, fruits must be irradiated prior to distribution.

5.5 Farm-street vendor chain

Typically, this type of supply chain involves households that own a small farm and lack knowledge of post-harvest technology and GlobalGAP. Fresh produce is grown using traditional know-how. Requirements for food hygiene and food safety are not fulfilled. Packaging used in this chain include bulk containers, i.e. iron baskets (Photos 5.59 and 5.60), plastic tubs (Photo 5.61) and plastic bags (Photo 5.62).

Photo 5.59 Kohlrabies in iron baskets for selling

Photo 5.60 Metal baskets used by street vendors for marketing fresh produce

Photo 5.61 Marketing of fresh produce in tubs by street vendors

Photo 5.62 Marketing of tubers in sacks by street vendors

6. Transportation of fresh produce

Farmers transport produce from the farm to farmhouse or shed by means of hauling cart, single-wheel cart, bicycle, or by carrying the container on the shoulder or on foot. If they are required to deliver the produce to the trader's collection point, they use either a motorbike, three-wheel cart or bicycle. On the other hand, traders use boats/sampans, motorbikes, pickups or trucks to collect the fruits from the suppliers. Wholesalers normally receive their purchases from suppliers who transport the packed vegetables using motorbike, minitruck or car. Retailers depend on the use of motorbikes (Photo 5.63 or three-wheel carts to transport their produce.

Photo 5.63 Motorbike with mounted wooden crate for transporting produce

7. Cost of packaging

The cost of packaging is dependent on the type of package, size and design of the package, packaging accessories, packaging labour, handling labour, transport, and duties (if applicable). The cost of packaging fresh produce in horticultural supply chains for domestic markets is rather low in view of the fact that the cost of packaging labour, packaging materials and transport are relatively low. In the case of supply chains for international markets, packaging costs are higher. An example of packaging costs for longan supply chains for European markets is presented in Table 5.1.

Table 5.1 Costs (in Vietnamese Dong [VND]) of packaging of longan using plastic boxes

	Plastic box
Acquisition cost (VND/unit)	25 000
Useful life	once
Average cost per use	25 000
Number of box per truck	2 058
Capacity per box (kg)	10
Volume per truck (kg)	20 580
Transport cost per truck	61 740 000
Transport cost per kg	3 000
Packaging cost per kg	2 500
Packaging labour cost per kg	200
Handling labour cost per kg	300
Cost of care and maintenance of packaging materials per piece	0
Maintenance cost per kg	0
Total cost per kg (VND)	**6 000**

Assumptions:
Transport facility: 40-ft truck (12.2 m × 2.44 m × 2.59 m)
Route: Cai Be district, Tien Giang province, Viet Nam to main ports of Europe
Size of plastic box: 57.3 cm × 33.6 cm × 17 cm

8. In-country programmes to promote the use of packaging

In order to improve the status of current horticultural supply chains in the country, the central government has provided a substantial amount of funding to support the implementation of GlobalGAP certification programmes by farmers, using the One Village One Product (OVOP) model. At the same time, the local governments of different provinces are calling for proposals that deal with the application of post-harvest technology for the improvement of fresh produce horticultural supply chains. Private-sector entities have also started to invest in fresh produce horticultural supply chains for domestic and international markets.

9. Regulations

Vietnamese produce exports must be packaged in conformance with regulations of importing countries. The Canadian market, for example, requires that fresh horticultural produce is suitably packaged in packaging of the appropriate type and size. Packaging must be appropriately labelled with complete and precise instructions in both English and French, including the name of the produce, Canadian classification, quantity, name and address of the manufacturer, and original country or the country where the produce was grown.

In the case of horticultural exports destined for the EU, specific requirements are provided for the grading, packaging and labelling of each type of fruit.

The packaging of food in Viet Nam is regulated by general laws. In accordance with the state law for food hygiene and safety, enacted on 26 July 2003, food packaging must be sanitary, disinfected, able to protect the food product, and convenient for labelling. Furthermore, only certified wrappings are allowed to be used when there is direct contact with food. The Vietnam Food Administration is the only agency having the competence to examine and certify packaging. Some Vietnamese Standards (TCVN) also provide for the packaging of specific types of fresh produce. These Vietnamese standards are still not detailed enough. TCVN 4845-89 for fresh tomato, for example, simply refers to bulk packaging. Nonetheless, there is growing concern and awareness of the importance of packaging by consumers, food manufacturers and the government.

The government is increasingly becoming more stringent on the use of packaging in the food industry. The Vietnamese Food Administration and other related organizations are attempting to establish rules that govern the use of packaging. A number of government agencies and universities are engaged in research on fresh produce packaging activities.

10. Case study: longan supply chain

10.1 Background

In the Mekong river delta, the farmers of Tien Giang province organized a fruit production farm system of 380 ha that produces 'Tieu Da Bo' longans for export to international markets including Chinese, Canadian, French, United Kingdom and Near East markets.

10.2 Description of the supply chain

The supply chain of longans is run by Ngoc Ngan Pte, a private enterprise located in Hoa Khanh commune, Cai Be district, Tien Giang province. With the support of ECIB (European Chamber of International Business) in the form of facilities and the transfer of technology, 100 tonnes of GAP-certified longans is harvested on a daily basis. This volume is enough for loading into four, 40-ft refrigerated trucks for international distribution.

Longan fruits are harvested and transferred into deep bamboo baskets. The fruits are subsequently transferred to plastic crates and transported to the packing house of Ngoc Ngan Pte. At the packing house, longans are trimmed, thermally treated, sorted and packed layer by layer in plastic boxes with a capacity of 10 kg each. The boxes are labelled and are carefully tied using PP ribbon, prior to being irradiated. Boxes of longans are loaded onto trucks for transportation (Photos 5.64 to 5.67).

Photo 5.64 Longans at farm

Photo 5.65 Packaging of longans in plastic boxes

Photo 5.66 Packaged longans loaded into a refrigerated truck for export

Photo 5.67 Arranging boxes of longans inside a refrigerated truck

11. Conclusion

Packaging plays a critical role in maintaining quality and in assuring safety in fresh produce supply chains, from harvest to the market. Greater awareness must be raised as to the critical role of packaging in reducing losses of fresh produce, and in enhancing its marketability. Supportive government policies are required to assist businesses that want to invest in upgrading the safety and quality of their fresh produce outputs. Education of stakeholders on the importance of packaging in supply chains would contribute greatly to reducing losses in these chains.

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Annex 1

Standards and regulations related to fresh produce packaging for regional and international export markets

International standards and regulations in the area of packaging

The expansion of international trade has created a greater need and demand for the international standardization of packaging. Governments and relevant organizations have established standards and regulations for fresh produce packaging, which can be mandatory or voluntary depending on the regulators/regulatory bodies. Global standards and regulations have increasingly been developed for worldwide use. Major developments as well as existing standards of relevance to the packaging of fresh produce are summarized below.

Codex

Standards and guidelines most relevant to the packaging of fresh produce have been developed by the Codex Alimentarius Commission, established under the joint FAO/WHO Food Standards Programme. Codex Standards for any specific fruits and vegetables generally include packaging. In general, packaging for fresh fruits and vegetables must properly protect the produce. Materials used inside the package must be new, clean, and must not cause damage to the produce. Marking or labelling is referred to in CODEX STAN 1-1985, Rev. 1-1991), and packages must be free of all foreign matter.

Packaging of fresh fruits and vegetables shall also comply with the Codex Recommended International Code of Practice for Packaging and Transport of Fresh Fruits and Vegetables (CAC/RCP 44-1995, Amd. 1-2004). This recommendation includes details for proper packaging and transportation in maintaining quality of fresh produce during transportation and marketing. In summary, the recommendation covers from transport equipment (design, condition and loading method) to packaging (forms, materials, packing methods, shipping containers, unit loads and pre-cooling practices).[14]

ISO

One of the most important packaging standards at the international level is that established according to the ISO. ISO facilitates standards development through working mechanisms of technical committees (TCs). Among the seven (TCs that fall under the technical sector of "Packaging/Distribution of Goods", ISO/TC 122 "Packaging" is the most important in the packaging areas. Other TCs most relevant to packaging in a supply chain under the "Packaging/Distribution of Goods" technical sector include TC 51 "Pallets for unit load method of materials handling", TC 101 "Continuous mechanical handling equipment", TC 104 "Freight containers" and TC 110 "Industrial trucks".

[14] www.codexalimentarius.net/web/index_en.jsp

The scope of the Technical Committee 122 covers standardization in the field of packaging with regard to terminology and definitions, packaging dimensions, performance requirements and tests. Each subcommittee (SC)/working group (WG) further identifies in greater detail the specifics of each of these areas. For example, TC 122/WG 4 focuses on the bar code symbols on unit loads and transport packages, TC 122/WG 10 focuses on supply chain applications of RFID, and TC 122/SC 3 focuses on performance requirements and tests for means of packaging, packages and unit loads as required by ISO/TC 122. The TC 122/SC 4 with its scope in "packaging and environment" has become more significant in recent years. TC 122 consists of 30 participating countries including Thailand (represented by TISI) and 43 observing countries.

Other TCs most related to packaging of fresh produce in a supply chain are TC 6 "Paper, board and pulps" and TC 34 "Food products". The scope of TC 6 covers the areas of paper, board and pulps, which are among the most important materials for shipping containers. Standardization provided by TC 34 covers food in the food chain from production to consumption, including food safety and quality management and requirements for packaging, storage and transportation. Some TCs that should be mentioned here are TC 34/WG 10 "Food irradiation", TC 34/WG 12 "Application of ISO 9001:2000 in the agriculture", TC 34/SC 3 "Fruit and vegetable products", and TC 34/SC 17 "Management systems for food safety".[15]

CEN

The European Committee for Standardization (Comité Européen de Normalisation, CEN) is an international non-profit organization, which provide a platform for the development of European Standards (ENs) and other products. CEN consists of 31 member countries, which are the national standards organizations of the 27 European Union countries and Croatia and the three countries of the European Free Trade Association (EFTA). CEN national members are responsible for the implementation of European Standards as national standards. CEN cooperates with ISO by various means including adoption of the same text, as both an ISO Standard and a European Standard for common EN/ISO standards, according the Vienna Agreement signed in 1991.

CEN works in a vast range of most economic areas, grouped by sectors, of which the "Transport and packaging" is among the active sectors. Under this sector, the Technical Committee 261 "Packaging" has developed standards in a wide range of this area. CEN/TC 261 has now published nearly 200 documents or technical reports. CEN/TC 261 comprises SCs and WGs that focus on various areas, e.g. CEN/TC 261/SC 5 "Primary packaging and transport packaging", CEN/TC 261/SC 5/WG 12 "Marking", CEN/TC 261/SC 5/WG 14 "Test methods and test schedule", CEN/TC 261/SC 5/WG 34 "Pallets", and CEN/TC 261/WG 1 "Management of hygiene in the production of packaging for foodstuff".

With growing concern for the environment, the following standards in the areas of packaging and packaging waste have been published in the Official Journal of the European Union C 44 of 2005/02/19:

- EN 13427: 2004, Packaging – Requirements for the use of European Standards in the field of packaging and packaging waste

[15] www.iso.org/iso/home.html

- EN 13428: 2004, Packaging – Requirements specific to manufacturing and composition – Prevention by source reduction
- EN 13429: 2004, Packaging – Reuse
- EN 13430: 2004, Packaging – Requirements for packaging recoverable by material recycling
- EN 13431: 2004, Packaging – Requirements for packaging recoverable in the form of energy recovery, including specification of minimum inferior calorific value
- EN 13432: 2000, Packaging – Requirements for packaging recoverable through composting and biodegradation – Test scheme and evaluation criteria for the final acceptance of packaging

Other CEN/TC subcommittees and working groups related to packaging of fresh produce in supply chain include CEN/TC 172 "Pulp, paper and board", CEN/TC 194 "Utensils in contact with food", CEN/TC 249 "Plastic", and CEN/TC 320 "Transport – logistics and services".[16]

ATSM International (originally the American Society for Testing and Materials)

ASTM is one of the world's largest standards development organizations. ASTM International's standards cover diverse industry areas. ASTM Committee D10 focuses on packaging with 16 technical subcommittees divided into 3 divisions. The D10 Committee generally meets in conjunction with Committee F02 on Flexible Barrier Packaging. D10 standards are referenced by various organizations including the United States Department of Agriculture, the United States Environmental Protection Agency and the United States Food and Drug Administration.[17]

ISPM

ISPM 15 is one of the United Nations' International Standards for Phytosanitary Measures (ISPM), developed by the International Plant Protection Convention (IPPC). The standard describes phytosanitary measures that reduce the risk of the introduction and spread of quarantine pests associated with the movement in international trade of packaging material made from raw wood. Wood packaging material covered by this standard includes dunnage, but excludes packaging made from wood processed in such a way that it is free from pests (e.g. plywood).

The phytosanitary measures described in this standard are not intended to provide ongoing protection from contaminating pests or other organisms. The Revision of ISPM No. 15 (2009) under Annex 1 requires that wood used to manufacture ISPM 15-compliant wood packaging must be made from debarked wood, not to be confused with "bark-free wood". ISPM 15 was updated to adopt the bark restriction regulations proposed by the European Union. This new revised standard went into effect on 1 September 2005. In situations where packages or goods distribution do not comply with this regulation, they cannot be sent to those countries participating in previous agreements, i.e. Australia, Brazil, China, Republic of Korea, the United States, EU members and others.[18]

[16] www.cen.eu/cen/AboutUs/Pages/default.aspx

[17] www.astm.org/

[18] www.ippc.int/index.php?id=13399&L=0

TAPPI

TAPPI (founded as the Technical Association of Pulp and Paper Industry) is a professional association for pulp, paper, packaging and converting industries. TAPPI develops standards related to pulp, paper and related products. TAPPI standards include test methods and other documents such as specifications, guidelines, glossaries, practices, etc.[19]

BRC

BRC (the British Retail Consortium) is a trade association representing British retailers. In 1998 the BRC first introduced the BRC Technical Food Standard, which later evolved into a global standard. The Packaging Standard was first published in 2002, the Consumer Products Standard in 2003, and finally the BRC Global Standard – Storage and Distribution in 2006. The BRC global standards specify requirements for ensuring production, packaging, storage and distribution of safe food and consumer products. In addition, BRC global standards are complementary to quality management systems such as ISO and HACCP. BRC standards are continuously reviewed and revised with inputs from a range of stakeholders. Companies can be certified against BRC standards through the certification bodies accredited by their national accreditation body and approved by the BRC. Four BRC global standards exist:

- *BRC Global Standard for Food Safety*

  The Global Standard for Food Safety was first introduced in 1998 and has continued to evolve with inputs from a wide range of stakeholders. The BRC has also published interpretation guidelines for fresh produce packers which fall under category 5: fruits, vegetables, and nuts and concentrate on particular issues within the fresh produce industry to accompany the latest Global Standard for Food Safety – Issue 5.

- *BRC Global Standard for Consumer Products*

  This standard sets out to ensure the production and supply of consumer goods that are safe, legal and of consistent quality.

- *BRC Global Standard for Packaging and Packaging Materials*

  The BRC partnered with the Packaging Society (formerly the Institute of Packaging – IOP) to set out the BRC/IOP Global Standard for Packaging and Packaging Materials. The packaging industry is divided into specific sectors: glass, paper and board, metals (cans and foil products), plastics, wood and other materials.

- BRC Global Standard for Storage and Distribution

  The BRC Global Standard for Storage and Distribution is aimed at ensuring product safety and integrity through the supply chain, which is applicable to all transportation forms and different product types including food products, consumer products and packaging materials. The standards are separated based on different sectors within the supply chain: storage, distribution, wholesaling and contracted specialist services.[20]

[19] www.tappi.org/

[20] www.brcglobalstandards.com/

NMFC

The National Motor Freight Classification (NMFC) is a standard developed by the National Motor Freight Traffic Association. The NMFC provides internationally recognized standards, specifications, rules and requirements for comparative commodities transportation. The NMFC sets requirements for proper packaging for carrier motor freight shipment. Examples include: Item 222 "Specifications for fibreboard boxes, corrugated or solid", Item 222-1 "Specifications for fibreboard – boxes certificate of box manufacturers", Item 222-5 "Specifications for fibreboard boxes – Styles of fibreboard boxes", Item 222-6 "Specifications for fibreboard boxes – Definitions of terms and abbreviations", Item 680 "Packing or packaging – General", Item 682 "Pictorial precautionary markings", Item 580 "Marking or tagging freight", and Item 568 "Heavy or bulky freight – Loading or unloading".[21]

ISTA

The International Safe Transit Association (ISTA) develops test procedures and standards to ensure safe delivery of packaged products. ISTA has been recognized worldwide for over 60 years for its package performance testing. ISTA" certification mark provides confidence that the packaged product will survive the hazards in the distribution environment. The ISTA certified lab demonstrates its qualification in conducting ISTA package performance testing, while ISTA certified packaging laboratory professionals (CPLP) enhance credibility of testing and lab operations. ISTA's test procedures and standards are based on the most current global data, continually provided by its members.[22]

Other relevant standards, regulations and requirements include:

United States Food and Drug Administration (USFDA) Regulations

The most related Code of Federal Regulations (CFR) is Title 2: Food and Drugs which contains regulations and rules concerning food and colour additive petitions and food ingredient and food packaging notifications. This regulates paper, paperboard, adhesives and coatings, and polymers for food packaging as indirect additives. FDA's nutrition labelling for fresh produce is voluntary.

[21] www.nmfta.org/Pages/Nmfc.aspx

[22] www.ista.org/

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