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

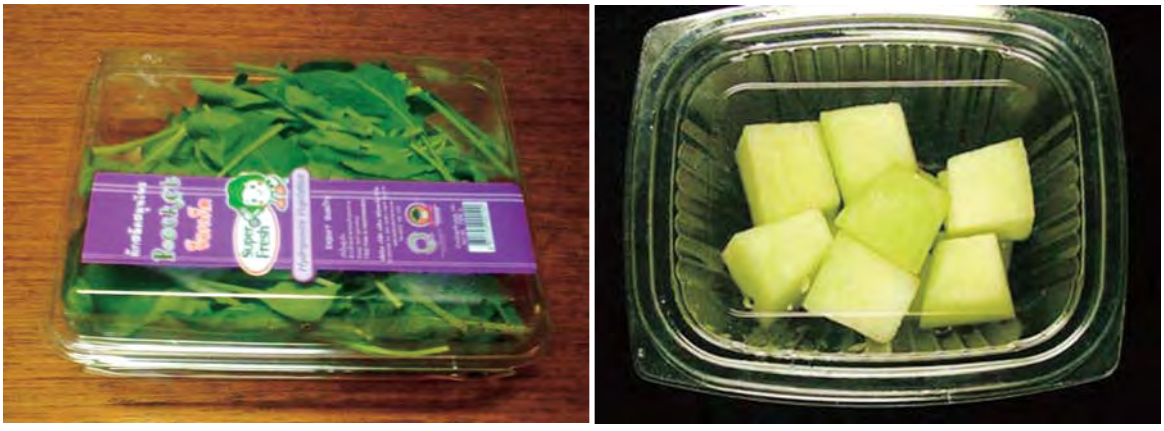

Photo 4.36 Clamshell tray with hinge interlock

Photo 4.37 Thermoformed tray featuring individual cups for protecting fruit

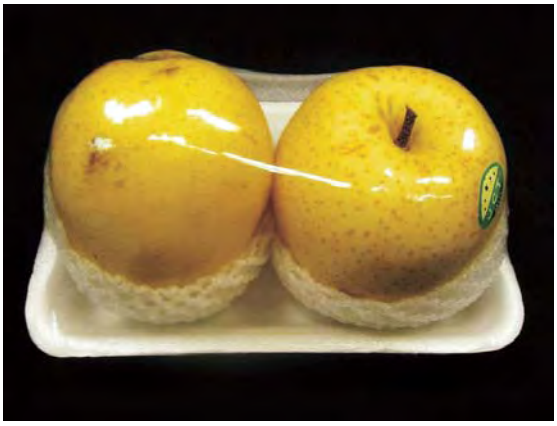

Photo 4.38 Foam tray overwrapped with film for retail

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.

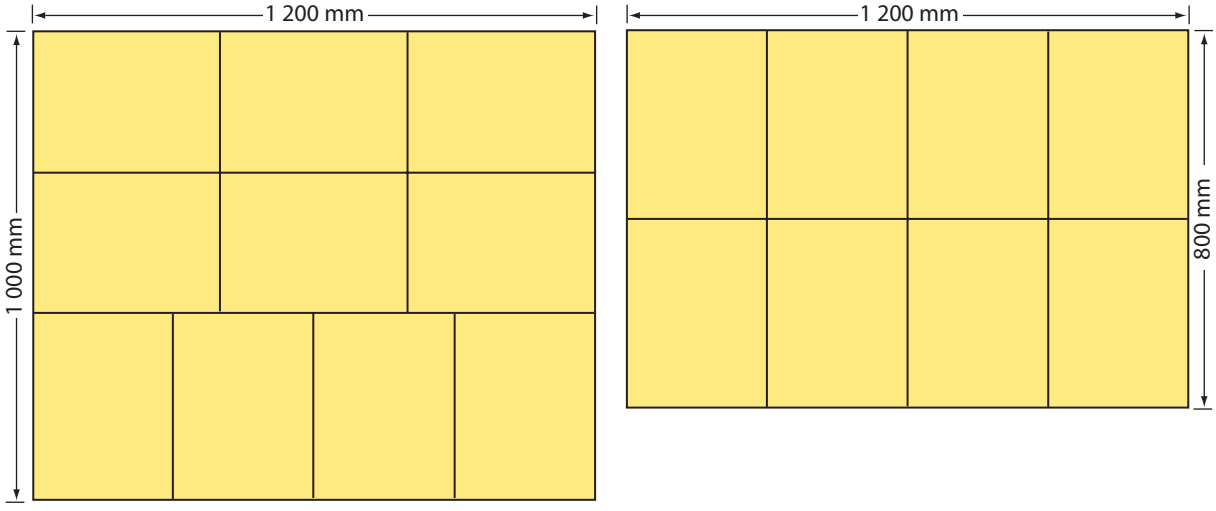

Figure 4.3 Pallet configurations for packaged mangoes

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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