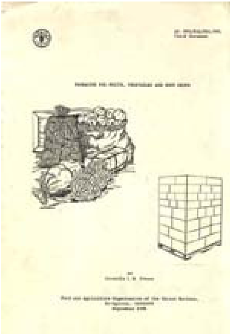

Packaging for fruits, vegetables and root crops

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Food and Agriculture Organization of the United Nations, Bridgetown, BARBADOS
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1. Introduction

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The main objective of this manual is to describe how post-harvest handling and marketing can be improved through better packaging.

Inter-regional exports of the English speaking independent countries in the Eastern Caribbean amount to more than 60,000 tonnes of produce traded, valued at some EC$ 90 million per year. If we assume a 20 percent loss, the economical loss caused by post-harvest losses could well be over EC$ 18 million every year. Consequently, reducing these losses with only one percent results in the marketability of an extra 600 tonnes of produce valued at EC$ 1 million every year in the regional markets.

Total world fresh produce exports in 1986 were estimated at US$ 226,505 million. A loss of one percent equals a financial loss of US$ 227 million. Only a small part of the world production of agricultural produce is exported and according to FAO estimates post-harvest losses were in the order of 20 - 33% of all food produced. A small reduction in post-harvest losses will result in lower financial losses and in an increased availability of food.

Other financial losses such as loss of market opportunities, loss of quality, loss of goodwill, etc. can also result in a financial loss for the trader or farmer.

One, and perhaps the most important, means of reducing post-harvest losses is the introduction of improved packaging material together with improved packaging techniques.

Chapter 2 of this manual describes the causes of post-harvest losses and the influence of packaging on these losses, while Chapter 3 reviews the functions and Chapter 4 the types and designs of different forms of packaging. Chapter 5 describes the importance of unitisation and standardisation of packaging and the ways in which it can improve marketing efficiency. The crucial question of the cost of packaging is discussed in Chapter 6 and Chapter 7 introduces a system to help in deciding which package type to invest in. The information to be printed on a label is described in Chapter 8 and Chapter 9 deals with retail packaging of fresh produce. Three instruction sheets for training and demonstration purposes are included at the end of this manual.

FIG.1.The packaging

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2. Packaging and post-harvest losses

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Post-harvest losses are losses occurring in the period between harvesting and consumption. The term 'losses' in the context of this manual is used in a wider sense, including all types of losses for the farmer, trader and consumer (e.g. weight loss, quality loss, financial loss, loss of goodwill, loss of marketing opportunities, loss of nutritional value, etc.).

FIG.1.Packaging and post-harvest losses

The distribution system for fresh produce in the Eastern Caribbean is complex. The movement of the produce from the farm to the consumer consists of many handling steps, uses low technology and is in the hands of many small traders. These factors, amongst others and combined with the high perishability of fresh produce, are contributing to high spoilage and unnecessary loss of produce.

Post-harvest losses are generally classified according to their primary causal agent. Frequently a post-harvest loss is a result of multiple causes and a succession of malpractices along the marketing chain.

2.1. Direct causes of post-harvest losses

2.1.1. Mechanical injuries

Losses caused by mechanical injuries include cuts, bruises, abrasions and punctures and can be categorised into four major types of injuries.

FIG.2. Mechanical injuries

a. Impact injuries, resulting from:

- dropping the product onto a hard surface;
- dropping the product into the back of a car;
- excessive drops during loading and unloading;
- suddenly stopping or accelerating a vehicle.

Loading and unloading is mostly done by hand, whereby crates are thrown into the pick-up, on board and into the hold.

Proper, rigid packages possibly with cushioning of each item within the package can reduce these impact losses

b. Vibration or abrasion injuries result when produce is able to move within a container because of:

- vehicles with small wheels and bad shock-absorbers;
- weak crates;
- bad roads;
- transmission vibration.

FIG.1. Transmission vibration.

Fields in isolated hilly areas cannot always be reached by vehicles, so that produce has to be carried from the field to the road or track, which are often in a bad condition. Trucks and pick-ups used on these roads are also often in a bad condition. Tight filling of the crates can decrease the vibration of produce within the boxes and consequently reduce the injury. If the box is not completely filled with produce, it is suggested to use for instance shredded paper to tight-fill the box. Over-tight filling can lead to compression injury.

c. Compression injuries are caused by improper packing and inadequate package performance resulting from:

FIG.2. Compression injuries

- over-packing of crates and boxes;
- too high stacking of crates;
- weak packaging.

A high stack of (weak) crates or baskets leads to bulging and consequently to compression of the produce inside.

Rain or sea water can weaken the strength of carton boxes resulting in more compression injuries on the produce.

d. Puncturing injuries resulting from:

- nails or splinters from the crate or box;
- fingers or nails of a person;
- other crates, fork-lifts, etc.
- hard and sharp stalks of fruit.

FIG.3. Puncturing injuries

Baskets and old wooden crates and some of the plastic crates often have sharp edges which can easily damage the produce. Rigid crates with proper grips can reduce the incidence of puncturing.

2.1.2. Physical and environmental factors

Physical and environmental losses include the various responses of produce to excessive or insufficient heat, cold, gases or humidity.

Proper packaging is required to allow ventilation and heat exchange to maintain proper temperature level, to reduce the air and gas exchange (oxygen, carbon dioxide, ethylene) and to minimise water loss.

Holes in cartons should be at least five percent of the total box surface to allow for ventilation. Consumer packages slow the respiration rate by maintaining low oxygen and high carbondioxyde levels, protect the produce from ethylene and odour absorption and reduce the waterlogs.

2.1.3. Biological and microbiological losses

Biological and microbiological losses refer to the consumption of or damage to produce by insects, birds, rodents, bacteria, etc. Correct packaging, stacking and storing can reduce the incidence of this type of losses.

FIG.1. Biological and microbiological losses

2.1.4. (Bio-)chemical and physiological losses

Chemical and biochemical losses include undesirable reactions between chemical compounds and contamination with harmful substances such as certain pesticides. Treating the timber for the wooden crates incorrectly may influence the quality of the produce.

FIG.2. (Bio-)chemical and physiological losses

An example of losses due to physiological reactions is the sprouting of tubers.

2.2. Indirect causes of post-harvest losses

Indirect or secondary causes of post-harvest losses are losses due to external factors. Packaging can improve marketability and handling, thus decreasing losses.

Some indirect causes of post-harvest losses are:

a. Consumers' demand.

Promotional campaigns for local produce could include nice looking packaging material.

b. Inadequate marketing systems.

The large number of people involved in marketing of produce regionally contributes to greater losses since every person is responsible for a step in the marketing chain, often resulting in delayed marketing of produce. Suitable, uniform packaging with control of the content could speed up the flow of produce through the marketing channels.

d. Facilities.

Limited access exists to facilities such as stores, coldrooms, drying and curing rooms. Improved packaging will contribute to more efficient handling in and use of these facilities. More efficient use of these facilities will reduce the cost and thus decrease the price of the produce.

Transport of fresh produce in the Eastern Caribbean is not adequate and rather costly. In general, small pickups are used to transport produce from the farm to the port and wooden schooners are used for the transport between the islands. Produce is stowed up to three meters high in the hold without any physical protection. Deck cargo is either not protected against sun, rain or sea water, or is completely sealed in canvas preventing an airflow and suffocating the produce.

As long as small pickups and wooden schooners are used for transport standardised packaging cannot be introduced successfully.

e. Policy changes (e.g. agricultural diversification, quality standards, price policy).

Change of supply can be caused by for example seasonality, large imports or by Government policies like the ban Barbados placed on imports of mangoes from Dominica and St. Lucia due to mango seedweevil pest.

Government rules can force a trader to use special type of packaging such as carton boxes required for the French speaking islands.

f. Lack of training and awareness among people involved in the marketing system.

g. Underdeveloped infrastructure (roads, harbour facilities).

h. Cost of transport.

The inter-island freight cost is paid per unit, whether it is a box, crate or basket. These units are made as large as possible and packed as full as possible in order to save on transport costs. As a result product losses are high and crates are too heavy and too large to be carried by one person.

i. Unreliable supplies of packaging or high cost of packaging.

FIG.1. Indirect causes of post-harvest losses

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3. Characteristics of packaging

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Part of the post-harvest losses of fresh produce in less developed regions are a result of mechanical injuries due to poor handling and inadequate packaging. In more developed marketing systems packages serves also other objectives, such as market penetration, competitiveness.

Proper packaging of a product can reduce not only bruising and crushing, but can also improve marketing of produce, reduce moisture loss, prevent (re-)contamination of the product with spoilage organisms, reduce pilferage, maintain a sanitary environment during marketing.

All aspects of packaging must be taken into account when considering the introduction of new packaging. These aspects involve, among others, cost of packaging material, labour, acceptance by trader and consumers and changes in product condition. The ultimate goal of packaging must lead to easier handling of the produce, a better quality and better marketable product.

The characteristics of packaging are to contain, to protect, to communicate and to market the product.

A. To contain produce

- As an efficient handling unit, easy to be handled by one person.
- As a marketable unit. e.g. units with the same content and weight.

B. To protect produce against

- Rough handling during loading, unloading and transport - rigid crate.
- Pressure during stacking.
- Moisture or water loss with consequent weight and appearance loss.
- Heat: air flow through crate or box via ventilation holes.
- Fumigation possible through ventilation holes.

FIG.1.Characteritics of packaging

C. To communicate:

- Identification: a label with country of origin, volume, type or variety of product, etc. printed on it.
- Marketing, advertising: recognisable trade name and trademark.

D. To market the product:

- Proper packaging will lead to reduced injuries of fruits and vegetables and subsequently to improvement of appearance.
- Standard units (weight, count) of a certain produce will increase speed and efficiency of marketing.
- With reduced costs of transport and handling, stacking and combining of packages into layer units like pallets is possible. A more efficient use of space and reduced losses will lower the marketing costs.
- Labels and slots facilitate inspection.

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4. Classification and designs for packaging

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There are many different types of package in use throughout the world (see Annex I), many of which have been carefully evaluated with respect to produce and market system, while other types have often been adopted for general use without thorough evaluation. Changes to improve such packages are still required. Some different types of package include:

1. Sacks: flexible, made of plastic or jute.

   i. bags: small size sack
   ii. nets: sacks made of open mesh

2. Wooden crates.

3. Carton or fibreboard boxes.

4. Plastic crates.

5. Pallet boxes and shipping containers.

6. Baskets: made of woven strips of leaves, bamboo, plastic, etc.

4.1. Sacks and nets

Materials

The materials used for sacks and nets may be woven natural fibre (jute, kenaf, sisal, cotton), woven synthetic (polypropylene, polyethylene), knitted natural fabric (cotton), knitted synthetic (polyethylene) or non-woven synthetic (propylene).

FIG.1. Sacks and nets

Advantages and disadvantages of sacks and nets.

The advantages of using sacks and nets are merely financial. The sacks and nets are cheap, have a low weight/volume ratio and, if made of a synthetic material, will not rot.

The disadvantages include a low protection against puncturing, compression, vibration and impact injuries such as dropping, difficult stacking, a low rate of vapour transmission and the need of special stitching equipment.

In general, nets are only suitable for hard produce such as coconuts and root crops (potatoes, onions).

4.2. Wooden crates

Advantages and disadvantages

Commonly used are wirebound crates for citrus/potatoes, wooden trays for tomatoes and wooden field crates.

The advantages of wooden crates are:

- The crates can be manufactured and repaired locally.
- Wood is relatively resistant to different weather conditions and (sea)water.
- Wooden crates are often used on more than one journey and have a higher efficiency for larger fruits, e.g. watermelons.
- Most crates have good ventilation and fast pre-cooling is possible.

Disadvantages of wooden crates are:

- Untreated wood can easily become contaminated with fungi and bacteria.
- Treatment of wooden crates with paint or other chemicals may cause produce deterioration.
- The material may be too hard or rough for produce like soft fruits, and therefore liners of a soft material may be needed.
- Disposal of the crates after use.
- Manufacturing of wooden crates puts an extra claim on the natural forest resources.

Design

A wooden crate consists of rigid corners with planks nailed or stretched against those corners. Plank thickness varies normally between 3 and 8 mm. Cutting the wood will result in loss due to the saw thickness (2-3 mm). A slicing machine can be used for thin planks up to 6 mm but these machines are expensive. There are several different constructions possible for wooden crates:

a. Nailed crates: (e.g. apple or pear crate ,field crate)

FIG.1. Nailed crates

Nailed crates are rigid and strong boxes which serve as multi-trip containers with a long life time.

The planks have a thickness of at least 6 mm. Because of the rigidity the crate is quite heavy and the initial cost is high compared to, for instance, wirebound crates. Spacing between the planks, (bottom, sides) and/or between top side plank and the bottom of the next crate creates is recommended for good ventilation.

Nailed crates are frequently used for domestic transport e.g. as a field crate or as a crate to transport produce from the producer to the wholesaler or trader.

Water has no direct influence on the strength of the crate, but rot will. An advantage of nailed crates is the possibility to repair the crate.

Disadvantages of the rigid nailed crate include the high return freight volume. A partial solution to this problem is to put one crate in two other crates which are placed opposite each other; so three empty crates will take up the space of two stacked crates.

b. Stitched crates: (tomato)

FIG.1. Stitched crates

Stitched crates are made of thin (3-4 mm) pieces of wood stitched together. Corner pieces, mostly triangular, provide the necessary strength to stack crates. This type of crate is mainly used for single journeys.

c. Wirebound crates: (orange crate, grapefruit crate, potato crate)

FIG.2. Wirebound crates

As a rigid, cheap crate with a good stacking strength it is mainly used for single journeys. Wirebound crates are stitched crates with a wire under the stitches which gives extra strength to the container. The wire also serves as a hinge and as a lock for the lid. These crates provide good ventilation and fast pre-cooling is possible. The price of these crates is low (around US$ 1.10 FOB and US$ 1.80 CIF St. Vincent).

Using them carefully, wirebound crates are capable of sustaining several journeys, which is proven by the (re-)use of Dutch wirebound potato crates in the inter-island trade.

d. Wooden collapsible crate (TDRI):

A wooden crate was designed by the Tropical Development and Research Institute (TDRI) for the huckster trade from Dominica. It consists of a removable top and bottom part and the crate can be folded using the hinges on the corners. The crate performed well in trials and it was possible to make up to twelve trips to other islands using the same crate. The price in 1987 was around US$ 8.00.

A more detailed description of this crate is given in

Annex II.

4.3. Fibreboard boxes

FIG.3. Fibreboard boxes

Fibreboard boxes are frequently used because of their low weight, their range of sizes and shapes and their availability.

Materials

a. Solid fibreboard boxes (cartons): have a thickness between 0.85 and 3 mm. If treated with wax these boxes are reasonably moisture resistant. The boxes are used for tomato, cucumber and ginger transport. Most of them are printed with attractive colours, a brand name and a label. The information can be stamped on this label after filling the box.

b. Corrugated fibreboard boxes: have a thickness varying from 1.2 up to 8 mm. The strength of corrugated fibreboard is determined by the type of fluting material, the type of facing material and its thickness and a single or double wall. Fluting and facings are kept in place by water resistant glue.

FIG.4. Corrugated fibreboard boxes

New box designs are usually tested for bursting strength, puncture strength, flat crush strength and edge crush (stacking) strength and it is advisable to use only such tested designs.

Advantages and disadvantages

Advantages of fibreboard boxes:

- Low weight and easy to handle.
- The relatively soft walls have a cushioning effect.
- The box can have any design, although it is recommended to use sizes fitting on the standard design of pallets.
- The boxes are delivered flat and assembling boxes can be done locally.
- The box has a low purchase cost.
- The material can be printed to give the box a pleasant and recognisable appearance. Also the label can be included in this print.

Disadvantages of fibreboard boxes:

- Moisture and high humidity can seriously weaken the box. Washed produce should be dried before putting it into the box. Empty boxes should be stored in a dry place preferably flat on top of pallets and not for long periods of time. For certain commodities waxed carton boxes are preferred.
- The low rigidity causes the stacking strength to be lower than for wooden or plastic crates. The fibreboard boxes are easily damaged by rough handling and ropes and too much weight on top of the

box can crush the perishable produce inside.

- Ventilation holes are usually small, because large holes would seriously influence the strength of the box. It is advised that the hole surfaces are at least 5 percent of the total box surface. Decreasing the size of the holes by not properly closing telescope boxes or not properly stacking the boxes will decrease heat exchange, resulting in higher temperatures of the produce and increased spoilage. Vertical oblong slots, instead of round holes, have the advantage that the hole stays partly open even when the telescope box lid is not completely closed.
- The boxes are not re-usable.

4.4. Plastic crates

In general, plastic crates are more expensive than wooden crates or carton boxes, but as a result of their longer life span the running costs are relatively low. Of course the possibility of pilferage of the crates should be taken into account when considering purchase of this type of packaging.

The hard surfaces have no cushioning effect, but, on the other hand, a hard, smooth surface is easy to clean and gives good protection to the produce.

Materials

Plastic crates are usually made of high density polyethylene (HDPE) or polypropylene (PP). Polyethylene has a higher impact strength and a low degradation by ultra-violet radiation while polypropylene has a better scratch resistance. The performance of both materials can be improved by adding anti-oxidants and UV protectants (for sunlight protection).

Advantages and disadvantages

Advantages of plastic crates:

- As a strong, rigid crate these plastic crates can be used for many journeys, making the cost per journey relatively low (Chapter 6).
- Different sizes and shapes are available to suit different customers needs. Colours can be used for marketing purposes.
- The containers are easy to clean and to disinfect.
- Plastic crates are strong and weather resistant and, because of their water resistance, the containers can be used in humid areas and during hydro-cooling.

Disadvantages of plastic crates:

- The hard surfaces can damage the produce and it is advised to use liners.
- The high purchase cost combined with the risk of pilferage could make this type of crate a financial risk.
- These crates generally have to be imported.
- Because this crate can be used several times, the extra cost for the return trip should be included in the total running cost.
- The loss of space (40-80 mm on the sides and around 10 mm from the height).

Design

Plastic crates can have a stacking, a stack-nest or a collapsible design, the differences being particularly important when the crate is transported empty, since the volume determines the price to be paid for transport.

Collapsible plastic crates are the most expensive crates to purchase followed by stack-nest plastic crates and then the stacking crates. Prices F.O.B. in 1987 for a plastic crate with a size of 600 x 400 x 300 mm were respectively around US$ 25.-, US$ 13.- and US$ 11.-. It should be mentioned here that a similar size stacking crate can be purchased in Venezuela for approximately F.O.B. US$ 5.20 (1988 price).

a. Stacking crates

Because of the squared design with only the corner slightly rounded, an efficient use of available space is possible. Depending on the size of the crate, the loss of loading space compared with loose break bulk is between 20 and 30 percent.

Although stacking crates have a rigid design, some space during the return trip can be gained by putting one crate inside two others (see also wooden crates) and in order to overlap crates during stacking some space gaps in the rim of the crate are needed.

b. Stack-nest crates

FIG.1. Stack-nest crates

i. Stack-nest crate with swing bars Because of its vertically tapered shape the inside volume of a stack-nest crate is less than that of a crate with a squared design. Effective loading space is 5080 percent depending on the size of the crate. With the swing bar design five nested crates will use up the space of two stacked crates of the same size. If the bars are swung out the crates can be nested. A swing bar (9 mm) is swung from the outside or from the side over the top of the crate and forming a support for the following crate. The stack-nest crate is slightly weaker than the stack crate, because the bar is not resting on the corners (the strongest part of the crate) but on the long side of the crate. The swing bar is placed 1 to 2 cm under the rim of the crate and stacking is therefore easy. The crate on top should be placed within this rim. Sometimes a provision is made on the bottom side of the crate for the swine bar to fit in.

ii. Stack-nest crate with cover.

FIG.2. Stack-nest crate with cover.

Instead of the swing bar, the crate is closed by two cover parts on top of which the next crate can be stacked. An advantage is that this cover can be sealed, preventing pilferage of produce. The crates with cover are up to 50 percent more expensive than the ones without a cover.

iii. 180 stack-nest crate.

FIG.3. 180 stack-nest crate.

By making supports at several places inside the box, the box can be stacked and in a 180 degrees turned position be nested. These supports require extra space and dirt will assemble in the corners created by the supports.

c. Collapsible crates

A collapsible crate consists of a base with sides attached to it by plastic or metal hinges. Despite the saving of space when folded and their attractive design, this crate is generally not accepted in trade, most likely because of the high purchase cost.

4.5. Pallet boxes

Where conditions like the size of the field, the method of harvesting, the level of processing and packaging and the commodity allow better transport and storage, a higher efficiency can be reached by using pallet boxes.

Pallet boxes have the standard floor size of a pallet (1200 x 1000 mm)and, depending on the commodity, have standard heights.

Advantages of a pallet box system:

- Less manual handling and thus reduced cost in loading, filling and unloading (e.g. citrus harvest).
- More efficient use of available storage as compared to smaller crates.
- Increased speed of mechanical harvest.

Disadvantages of a pallet box system:

- The return volume of most of the pallet boxes is the same as the full load.
- The system requires higher investments in fork-lift trucks, trailers and handling systems to empty the pallet box.
- Because of the larger volumes, the produce is more easily injured during filling and unloading and the top layers will have made more movements during transport than when packed in smaller boxes.

FIG.1. Pallet boxes

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5. Unitisation and standardisation

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A unit is a certain quantity or volume chosen as a standard. Several units can be combined to one larger unit (e.g. pallet) or divided into smaller sub-units (e.g. consumer packages). The advantages of a system where all involved use the same standard sizes and preferably the same type of packaging are:

- A uniform handling method and the use of combined, larger, quantities at one time, resulting in reduction of handling time, labour cost and damage to the produce.
- If the produce in the combined unit (e.g. a pallet full of boxes with oranges) has the same quality grade, this combined unit can be marketed as a whole.
- Standard units will have standard shipping tariffs.
- Higher production volumes of crates of only a few sizes will decrease the cost per crate, decrease the storeroom size for the different crates and guarantee a more stable supply of crates.

Combined units are of course most efficiently used if larger quantities of one commodity are transported. Nonetheless, even a small trader with uniform size crates or boxes can benefit from standardisation.

In Europe there is a move towards the ISO/OECD1 standards and the United States Department of Agriculture is supporting the MUM standards in the United States. Both standards are more or less similar using the standard size pallet of 1200 x 1000 mm.

Instruction sheet 1 demonstrates the use and benefits of standardised sizes of packages.

5.1. Pallets and containers

The most common pallet sizes are 1200 mm x 1000 mm and 1200 mm x 800 mm. A standard pallet with sizes 48 x 40 inches (1219 mm x 1016 mm), as used in the United States, is comparable to the 1200 mm x 1000 mm pallet and integrates very well into the metric system. The use of pallets and standard boxes will reduce handling of the boxes and therefore save handling time and reduce post-harvest losses.

FIG.1 Pallets and containers

The boxes on the pallet should be aligned in such a way that the ventilation holes of the different boxes are aligned and thus air can flow through the stack.

Boxes stacked on the pallet should be secured with posts on the four corners tied together with a rope or with a net over the stack or with glue between the boxes or with tape around and over the stack.

Pallets loaded with rigid wooden or plastic crates can be stacked on top of each other. A higher utilisation grade of the store may be reached since the height of the storeroom is fully utilised.

Sometimes pallets do not fit properly in containers or on trailers, resulting in a loss of available transport space. Shipping containers usually have the following dimensions:

Type of container	**Size**	**Dimensions**	
Twenty foot	External	20 x 8 x 8 feet	(6.10 x 2.44 x 2.44 m)
	Internal		(5.29 x 2.18 x 2.02 m)
Forty foot	External	40 x 8 x 8 feet	(12.19 x 2.44 x 2.44m)
	Internal		(11.33 x 2.28 x 2.19 m)

Trailers have according to traffic regulations a maximum outside width of 2.60 meter. With thin, high quality insulation it is just possible to position the pallets in the refrigerated trailer with one pallet using the width (1.20 meter) and one pallet the length (1.00 meter), using a total width of 2.20 meter.

Where containers or smaller trailers are used, pallets should be positioned in the length, thus using only 2.00 meter of the width.

In any case, it is advisable to keep some space between the (hot) wall and the crates. The cold air in the refrigerated container or trailer will form a barrier between the hot wall and the produce.

The use of pallets requires investment in handling and transport devices such as fork-lifts, trucks, hand carts and loading forklift devices on a ship. Also the vessels should have a preferably squared hold to reach the highest efficiency possible, when loading the pallets. Thus practically none of the vessels currently used in the inter-island trade are suitable for loading with palletised loads.

5.2. Standards for packages

A number of non-standard sizes of packages are in use all over the world and a list of some different sizes is given in Annex I.

The International Standard Organisation (ISO) gives a series of dimensions for rigid rectangular packages based on a standard plan dimension or module of 600 x 400 mm. This is the external size of a package unit when fully loaded (including 'bulge'). No plus tolerance is allowed, although a minus tolerance of up to 10 mm is accepted. ISO standard 3394 gives a most complete picture of multiples and submultiples divided from the module size (See Annex III).

Both the OECD and MUM standards have pallet size 1200 mm x 1000 mm as a standard unit and derive the

sub-multiples from these sizes. The OECD and MUM standards are less comprehensive than the ISO standard.

Recommended sizes in mm for OECD and MUM standards are:

	OECD	**MUM**
Pallet size (mm)	1200 x 1000	1200 x 1000
	1200 x800	-
Box size (mm)	-	600 x 500
	600 x400	600 x 400
		500 x 400
	500 x300	500 x 300
	400 x300	400 x300

FIG.1.Mixed load layer concept

FIG.2.Stacking pattern per layer

All standards leave the height of the crate to the discretion of the user. The height is greatly influenced by the commodity, type of crate, required weight/count, stacking method, etc. Using standard heights would simplify the transport of crates.

The United Fresh Fruit and Vegetable Association (UFFVA) together with the United States Development Agency (USDA) tested several package sizes and showed that most of the packages now in use can be replaced by one of the five MUM-sizes with little or no change in volume, weight and/or count. Their

suggestions for standardised packages can be found in Annex IV.

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6. Cost calculation

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Before making a decision on which package type to introduce it is wise to analyse costs and benefits.

The packing costs will depend on:

- **The type of the crate.**
- **The size of the crate.**
- **The design of the crate.**
- **The quantity of crates purchased.**
- **Transport and import costs and duties.**
- **The container assembling costs (carton boxes).**
- **The need for internal packaging materials (liners, pads, dividers).**

Also factors such as acceptance by the customer, pilferage, possibility to repair, local manufacturing and availability should be taken into account when calculating the cost of a crate.

The importance of the characteristics of packaging, as described in Chapter 3, will depend on the situation in which the packages are used. However, it may be difficult to estimate cost benefits from reduced losses, increased goodwill of consumers, increased marketing efficiency, better quality of the produce and reduced handling time.

An example is given below of a cost analysis of four different types of packaging: a wooden collapsible crate, a plastic stack-nest crate, a plastic stack crate and a carton (fibreboard) box.

Instruction sheet 2 clearly outlines the different direct costs which determine the total cost of a certain type of package.

a. Wooden collapsible crate (600 x 400 x 330 mm)

	US$
Crate locally made in Dominica (approximately EC$ 20.-)	7.50
Estimated number of trips: 12 trips per crate	0.63
Freight and return costs per trip (1 + 2/5 times US$ 2.50)	3.50
Total cost wooden crate per return trip	US$ 4.13

b. Plastic stack-nest crate (600 x 400 x 310 mm) (July 1988, US$ 1.00 - DF1 2.05)

	US$
Container: 780 crates x DF1 21.95	8,351.71
Cost, Freight and Insurance (Netherlands - Barbados: DF1 6,900)	3,365.85

	+
Total price 780 crates C.I.F. Barbados	11,717.56
Per crate C.I.F.	15.02

Taking into consideration customs duty, consumption tax, stamp duty and local transport one crate would cost approximately US$ 24.00. With an estimated number of forty journeys the cost per trip is around US$ 0.60 per trip. If we estimate the cost of transport between two islands at US$ 2.50 plus 2/5 of this cost for the return freight (nested) the total transport cost is US$ 3.50 per trip.

Total cost stack-nest crate per return trip US$ 4.10

c. Plastic stack crate (600 x 400 x 310 mm) (September 1988)

	US$
One container: approximately 600 crates x US$ 5.17	3102.00
Cost, Freight and Insurance (Venezuela - Barbados)	1000 00
	+
Total C.I.F. Barbados, 600 crates	4102.00
Per crate C.I.F.	6.84
60% duty, tax	4 10
	+
Total price per crate	10.94

During the return trip when crates are empty, one crate can be stored inside two others. This type of crate will be able to withstand an estimated forty trips and this means US$ 10.94/40 - US$ 0.27 per trip. The transport costs (US$ 2.50 and 2/3 * US$ 2.50 for the return freight) are around US$ 4.17.

Total cost plastic stack crate per return trip - US$ 4.44

d. Carton (banana) box (508 x 330 x 184 mm)

	US$
Price St. Lucia (EC$ 2.35)	0.87
Price Dominica (EC$ 3.00)	1.11
Freight costs per single trip	1.50
Total cost per box (Dominica) per single trip	2.61

Because the volume of the carton box is only 39% of the volume of the plastic and wooden crates, the total cost has to be multiplied by 2.57 to enable a comparison with the other crates.

Total cost for 2.57 carton boxes per single trip - US$ 6.70

From an economical point of view, the above comparison is in favour of the plastic stack and stack-nest and the wooden collapsible crate, but the risk of pilferage of plastic crates is high and therefore the actual running cost for the plastic crates may be much higher. The carton boxes have no return freight and the traders do not have to worry about returning of boxes. Also government policies or consumers demands could force the farmer or trader to use the more expensive carton boxes in order to get the produce sold.

Plastic crates are very suitable as field crates for transporting produce from the field to the packing shed. In that case the farmer can keep control over his crates, or where there is an abundance of plastic crates, a refund system can be established. If the crates are to be used as field crates the economical comparison, without the transport cost, is as follows:

Wooden collapsible crate	**US$ 0.63**
Plastic stack-nest crate	US$ 0.60
Plastic stack crate	US$ 0.27
Carton box (US$ 0.87 * 2.57)	US$ 2.24

Using these figures only, the plastic stack crate is clearly the cheapest crate and, as was to be expected, it is not advisable to use carton boxes as field crates.

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7. Which type of packaging to use?

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The product requirements, the marketing system and the personal preference will determine the type of packaging to use. Whatever type of packaging is used it must have at least one of the characteristics mentioned in Chapter 3 and the packaging must pay for itself either by preventing losses, or by making the

produce more marketable, or by decreasing the transport and handling costs.

The requirements for packaging are summarised in a checklist. An empty form and an example are given in Annex V, and instruction sheet 3 is designed as a training guide for deciding which type of package to invest in. Although the importance of each item in the checklist may differ for each trader, commodity and market system, it should be assumed that crates used in the interisland trade in the Eastern Caribbean must meet the following requirements:

- **The crates should withstand very rough handling.**
- **One of the standard ISO/OECD/MUM system sizes is preferred.**
- **The crates should be of a collapsible or stack-nest design, in order to decrease return cost or to have no return cost at all.**
- **The crates should be large enough to hold melons and pumpkins, but should also be suitable to hold smaller produce.**
- **A maximum of 25 kilogram of produce per crate to keep the crate manageable for one person.**

In the first column of the checklist each characteristic (containing, protection, communication, marketing and cost/miscellaneous) gets a weight percentage according to the importance of that characteristic in the trade. Protection could be for certain traders the most important function of packaging and for others cost may be the most important factor. Marketing and communication are not yet important characteristics of packaging in the inter-island trade but they may well be in near future. The total of the first column must be hundred percent.

In the second column the percentages given to the main characteristics are further divided over the subcharacteristics. For instance, protection during handling is considered the most important part of the protection function of packaging, while the use of liners (which are not commonly used), is rated as not important. Again the total of this column should be hundred percent.

In each of the following columns one type of package is specified such as woven basket, carton box, plastic stack-nest crate and a larger plastic stack-nest crate. Working through the checklist for each package, a value is given in the first column under the package: ++ = excellent, + =good, o = fair,— = unsuitable, — — extremely unsuitable.

In the second column the importance of the sub-characteristics and the value for the package are multiplied, e.g. 5% and value ++ gives (5 x 2)+ = 10+ and 3% and value - gives (3 x 1)— = 3—. Finally this column is added up (+ and —) and the results in each package column should represent a fair comparison between the different packages.

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8. Labelling of packages

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The importance of labelling of packages was described in Chapter 3. Each container should be marked with a label with the following information:

- Country of origin.
- Name and address of exporter or grower.
- Brand name.
- Description of content (product, variety, size, class, quality grade).

- **Gross weight.**
- **Net weight or count.**
- **Overall dimensions in metric units.**
- **Full name and address of receiver.**

The following rules should be maintained with regards to labels:

1. **Each container should have at least two labels on both short sides of the container.**
2. **The label should be placed in such a way that it is least liable to be damaged or dirtied.**
3. **Each long side of the container should contain general information such as brand name, type of commodity and a logo.**
4. **Extra information such as FRAGILE, TOP or special storage or handling requirements should be placed on top and at least on one of the sides of the crate.**
5. **Only water-proof ink should be used.**
6. **Differences in colour for the different commodities and grades should be used, where these additional cost can be accounted for.**
7. **Obsolete labels should be removed or taped off.**
8. **Hand written information on the label should be in blockwriting.**
9. **Other remarks such as date of packaging, legal remarks and marking for electronic scanning could be included.**

Fig.1.Labelling of packages

Large exporters will use their own labels with their name, address and the product already printed on them.

A whole pallet load will receive a packing list with the name and address of the receiver, the variety, class, weight and other information of the load.Smaller exporters can design their own blank label and stencil it.

Stamps can be used for the name of the exporter and for other information required. The name of the receiver can be filled in with a water-proof marker pen.

If the labels are not self-adhesive, special label gluers (4 or 6 inches width) can be used to glue the label. The most simple solution of course is to use a brush to add the glue to the box and onto the label. Special care must be taken to prevent the glue from touching the produce, since this may affect quality.

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9. Retail packaging

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Prepackaging or retail packaging of certain commodities in specially designed consumer packages has the following advantages:

a. **Deterioration or decay is slowed down.**
b. **The reduction of spoilage caused by consumers selecting out of a bulk of produce.**
c. **Time needed for weighing and checking after selecting by the consumer will be reduced.**
d. **Advertisement by abundant supply.**
e. **More protection to the produce.**

Deterioration or decay is decreased because the prepackages create a micro-climate with a lower oxygen and

a higher carbon dioxide level and a higher relative humidity is reached. Too high a relative humidity, however, can lead to sprouting of roots and tubers and low oxygen levels will decrease respiration to such a level that produce will suffocate and rot.

In general, leafy vegetables require a high relative humidity level to prevent wilting and only a few holes in the package are recommended. Root crops require more holes, or even the use of nets as packaging material because too high relative humidities or too low oxygen levels cause sprouting.

Moulded trays, wrapped with film liners, combine four to six units (citrus, apple, etc.) to one larger unit. The tray will give the produce protection from the bottom side and some protection on the sides. The top will only be properly protected when the larger units are properly stacked.

Most commonly used materials are low-density polypropylene for bagging, regenerated cellulose or cellophane for overwrapping the trays and polyvinyl chloride film for overwrapping trays.

Polyethylene and polypropylene have a low permeability for gases and vapour and it is necessary to make holes in the bags. Other materials have higher permeabilities or permeabilities for only one of the gases or vapour and even between different brands of the same material are differences in permeability. It is recommended to purchase film material suitable for a certain commodity and to test this film material first on a small scale.

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10. Instruction sheet

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10.1 Instruction sheet 1: standardisation and unitisation

Objectives:

1. **To get familiar with the use of standardisation and unitisation in packaging, using a model on scale(1:10).**
2. **To identify the advantages of standardised as compared to non-standardised systems.**

Materials:

- **1Plank, size 12 cm x 10 cm x 1 cm**
- **15 Blocks, size 6 cm x 4 cm x 3 cm (bottom - 6 cm x 4 cm)**
- **8 Blocks, size 5 cm x 3 cm x 3 cm (bottom - 5 cm x 3 cm)**
- **10 Blocks, size 4 cm x 3 cm x 3 cm (bottom - 4 cm x 3 cm)**
- **6 Blocks, size 5 cm x 4 cm x 3 cm (bottom - 5 cm x 4 cm)**
- **20 Blocks, size 4 cm x 3 cm x 1.5 cm (bottom - 4 cm x 3 cm)**
- **8 Blocks, size 5.08 cm x 3.30 cm x 1.84 cm (bottom - 5.08 cm x 3.30 cm)**

Most of these blocks can be cut from one length (210 cm) of a plank with the size of 3 cm x 4 cm. Further to that a length of 12 cm with size 10 cm x 1 cm and a length of 50 cm with size 3 cm x 3 cm are needed. For the last 8 blocks on the list it is suggested to take a length of 50 cm with size 4 cm x 2 cm and to plain this plank to size 3.30 cm x 1.84 cm before cutting into 8 blocks.

Clearly mark the blocks with 'BOTTOM' and 'TOP'. Mark the cubes on one side of each cube with their size,

being 10 times the scale size. For example 60 x 40 x 30.

FIG.1.Mixed load layer concept

FIG.2.Stacking pattern per layer

Instruction:

1.

a. **Place the plank 120 x 100 mm in front of you.**
b. **Place one layer of cubes size 60 x 40 x 30 (bottom down) on the plank in such a way that they exactly fit on the plank.**
c. **Draw the top view of the boxes on the plank in Figure 1.**
d. **Place a second layer using the cubes with size 60 x 40 x 30 (bottom down) on top of first layer in such a way that they exactly fit on the plank and that they consolidate the first layer.**
e. **Draw the top view of the boxes on the plank in Figure 2.**
f. **Place a third layer using the cubes with size 60 x 40 x 30 (bottom down) on top of the second layer in such a way that they exactly fit on the plank and that they consolidate the second layer.**
g. **Draw the top view of the boxes on the plank in Figure 3.**
h. **Clear the plank.**

FIG.1.FIGURE A

2.

a. **Place one layer of cubes with size 60 x 40 x 30 -(bottom down) on the plank in such a way that the blocks** exactly fit on the plank.

b. Draw the top view of the boxes on the plank in Figure 4. .
c. Place a second layer using the cubes with size 50 x 30 x 30 (bottom down).
d. Draw the top view of the boxes on the plank in Figure 5.
e. Place a third layer using the cubes with size 40 x 30 x 30 (bottom down).
f. Draw the top view of the boxes on the plank in Figure 6.
g. Place a fourth layer using the cubes with size 50 x 40 x 30 (bottom down).
h. Draw the top view of the boxes on the plank in Figure 7.

FIG.2.FIGURE B

3.

a. Remove the second, third and fourth layer.
b. Place a second layer using the cubes with size 40 x 30 x 15 (bottom down).
c. Draw the top view of the boxes on the plank in Figure 8.
d. Place on the second layer a third layer using three (3) cubes with size 60 x 40 x 30 (bottom down), four (4) cubes of size 40 x 30 x 15 (bottom down) and four cubes of 40 x 30 x 15 (on the side).
e. Draw the top view of the boxes on the plank in Figure 9.
f. Clear the plank.

FIG.1.FIGURE C

4.

a. Place a layer of cubes size 5.08 x 3.30 x 1.84 cm (bottom down) on the plank. The cubes must fit within the boundaries of the plank.

b. **Draw the top view of the boxes in Figure 10.**
c. **How many cubes could be placed on the plank?**

The surface of the plank is 120 cm x 100 cm =12,000 cm^2 . The surface of a banana box is 50.8 cm x 33.0 cm = 1,676 cm^2 . Thus the banana boxes together, as you placed them on the plank will occupy:

…….. cubes x 1676 cm^2 =…………………cm^2.

The efficiency is:

Surface all boxes

…………cm^2

………………… x 100% =…………….x 100% = ………… %

Surface plank 12,000 cm

10.2 Instruction sheet 2: cost calculation packaging

Objectives:

1. **To become familiar with cost calculations for different types of packaging.**
2. **To demonstrate the difference between purchase cost and running cost.**

Remark:

The figures and data in this example are fictitious and may need modification to a real life situation.

Information:

A marketing board in the East Caribbean wants to introduce a new type of field crate. The crate will be used to transport the produce from the field to the packing shed.

The marketing board considers two crates, e.g. a locally manufactured wooden crate and an imported plastic stack crate, both crates are the same size 60 x 40 x 30 cm.

The following general data are available:

- **1 US$ - 2.70 EC$.**
- **The average value of the produce per trip amounts EC$ 25.00.**
- **The tax and duty on imported crates is 40% of the F.O.B. and freight costs. The duty on locally manufactured goods is EC$ 1.00.**
- **The distribution cost of a crate by the marketing board is EC$ 1.00.**
- **It is advised to use a liner at a cost of EC$ 0.75 per trip.**
- **The transport cost per trip (full from the field to the packing shed and empty from the packing shed to the field) amounts EC$ 2.00.**
- **The handling cost of the crate in the packing shed (accepting, storage and re-issuing) is estimated at EC$ 0.25 per trip.**

Extra data on the wooden crate:

- **Cost F.O.B. of one wooden crate is EC$ 12.00. .**
- **Transport cost to the packing shed is EC. 0.25 per crate.**
- **Cleaning of this wooden crate costs EC$ 0.50 per trip**
- **Estimated loss of produce caused by using the wooden crate (splinters, cracking of wood, infestation by fungus in wood) is estimated at 5% of the value of the content.**
- **It is expected that each crate can survive 20 trips, but that EC' 2.00 is needed over the lifetime of the crate to do some minor repairs (nails, new planks, etc.)**

Extra data on the plastic crate:

- **Cost F.O.B. of one plastic crate is US$ 5.17 and the transport cost, including insurance and freight will amount US$ 1.50 per crate.**
- **There will be no repair cost.**
- **It is estimated that the crate will survive 40 trips.**
- **Cleaning of this crate costs EC$ 0.25 per trip.**
- **The estimated loss when using this plastic crate are 2% of the value of the content.**

Instruction:

a. Hake a calculation of the running costs of each of the crates per trip. An empty sheet is attached to do the calculations.

b. Fill in the following table:

	Wooden crate	**Plastic crate**
Purchase cost (g):	EC$/crate	EC$/crate

Running cost (x):	EC$/trip	EC$/trip

c. Which other costs or financial losses does the farmer, trader or consumer have to take into consideration when comparing the cost of different types of packages?

1……………………………………………………………………………………………………

2……………………………………………………………………………………………………

3……………………………………………………………………………………………………

4……………………………………………………………………………………………………

5……………………………………………………………………………………………………

6……………………………………………………………………………………………………

7……………………………………………………………………………………………………

8……………………………………………………………………………………………………

9……………………………………………………………………………………………………

10…………………………………………………………………………………………………

Currency used : Exchange rate : 1 US$ -=

Date : …/…/19…

Description crates: Crate 1: ………………

Crate 2: ………………

Crate 3: ………………

DESCRIPTION DIRECT COSTS CRATE 1 CRATE 2 CRATE 3

---

a. Purchase cost F.O.B

b. Freight and insurance

c. Purchase cost C.I.F. (a + b)

d. Tax/duty

e. Purchase wholesale (c + d)

f. Distribution coat

g. Purchase cost user (e + f)

h. Total repair cost over life time

i. Total cost (g + h)

j. Average total runs

k. Crate cost per run (i /j)

l. Cost liner material

m. Cost label

n. Ready for shipment (k +l + m)

o. Handling cost, e.g. (un)loading

p. Transport cost (field to shed)

q. Cost delivered at shed (n +o +p)

r. return freight cost empty crate

s. Cleaning cost

t. Extra cost per run (q+ r+ s)

---

u. Market value produce per crate

v. Estimated lose of produce (%)

w. Value estimated lose (u*v/100)

x. Total cost per trip (t + w)

10.3 Instruction sheet 3: choice of packaging

Objectives:

1. **To become familiar with the different characteristics of packaging.**
2. **To learn to decide which package to use and to invest in.**

Remark:

This example is only indicative and should be adapted to each individual situation.

Information:

An exporter would like to introduce standard crates to the farmers who supply the produce (mainly citrus, mango, avocado, sweet potato and eddoe). The exporter intends to import or manufacture the crates and sell them to the farmers without any profit. Most of the farms can be reached by small trucks. The following options are to be considered:

a. **A woven basket without cover. Price EC$ 5.00, can be used for 10 trips, height: 80 cm, diameter: 70 cm and volume is 150 liter.**
b. **A wooden crate. Price EC$ 20.00, for 20 trips, size 60 x 40 x 30 cm and volume is 60 liter.**
c. **A plastic stack crate. Price EC$ 30.00, suitable for 50 trips, size 60 x 40 x 30 cm and volume 60 liter.**
d. **A plastic stack-nest crate. Price EC$ 65.00, for 50 trips, size 60 x 40 x 30 cm and volume 55 liter.**

Instruction:

a. Give your personal preference (1, 2, 3 or 4) for each of the four crates.

Preference:

- **Woven basket …**
- **Wooden crate …**
- **Plastic stack crate …**
- **Plastic stack-nest crate …**

b. Fill in, on the attached empty form, the priority you give to each of the group of characteristics (column 1) and to each characteristic (column 2). The total of each of the columns must be 100.

c. Give values to the characteristics (column A) for each of the four different types of packaging. ++ =excellent; + = good; o = fair; — = unsuitable; — — = extremely unsuitable.

d. Multiply the priorities (column 2) with the values (column A) of each of the crates and note down the result in column B. For example 8 times (++) - 16 +, 4 times (0) - 0. etc.

e. Add up column B for each of the crates.

f. Write the results for the different crates (as found in e.) behind the personal preference in a.

Does your personal preference correspond with the results in column B? If not, what may be the reason?

g. Compare column B of the two crates with the highest total and note the characteristics that differ most for the two crates.

CHECKLIST

CONTAINING	**1**	**2**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
1 Suitable capacity for the range of fruits, vegetables and rootcrops										
2 Easily handled by one person										
3 Standard design										
4 Palletization										
PROTECTING										
5 Stable when stacked										
6 Consistent dimension resist the pressure when stacked										
7 Good ventilation										
8 Protection during										

handling, transport and marketing										
9 Smooth surface material, no sharp edges										
10 Liners available										
11 Easy to clean										
12 Pilfer proof /closed with cover										
COMMUNICATING										
13 Easy to attach label										
14 Advertisment/ Brandname on box										
MARKETING										
15 Presentation										
16 Acceptable for customs control										
COST-MISCELLANEOUS										
17 Reasonable purchase cost										
18 Durable/Deterioration										
19 Repairable										

20 Consistent supply guaranteed										
21 Low cargo volume when empty										
22 Local manufacturing possible										
23 Transport/fitting an pick-up or handcart										
24 Loss of crates										
25										
26										
TOTAL	100%	100% N.A.		N.A.		N.A.		N.A.		

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11. Annexes

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FIG.1.Annex 1.Different types and sizes of packaging.

Annex II. Wooden collapsible crate, developed by TDRI.

SPECIFICATIONS AND ILLUSTRATIONS: FOLDING WOODCRATE CUTTING LIST AND FITMENTS REQUIRED FOR BASIC AND MODIFIED MARK IV CRATE

Basic Mark IV Crate

The cutting flat required for the basic Mark IV crate with 6 mm boards for the lid, and 6 mm boards and struts for the bottom is listed la Table 1 and other parts are listed In Table 2.

TABLE 1 CUTTING LIST FOR MARK IV CRATE

Item No.	Description	Material	No. required	Length mm	Width mm	Thickness mm
1	Side rail	Gommler	4	580	25	15

2	End rail	Gommler	4	380	25	15
3	Side board	Mahot cochon	14	298	70	6
4	Centre end board, wide	Mahot cochon	2	265	70	7
5	End board, narrow	Hahot cochon	8	330	50	6
6	End cross batten	Mahot cochon	2	326	35	6
7	Lid board	Mahot cochon	4	520	75	6
8	Lid batten	Mahot cochon	3	380	25	15
9	Bottom board	Mahot cochon	4	570	75	6
10	Bottom abut	Mahot cochon	3	322	35	6

There is a 2 &m tolerance on these figures. The use of reinforcing wire around the top and bottom of each side and end panel increases the dimensions by approximately 4 mm each way. The crate thus gives a 600 mm x 400 mm module suitable for pallet stacking.

Taken from: Report on a woodcrate development project in Dominica, for the East Caribbean, September - December 1986, by M.B. Burbage, tropical Development and Research Institute, London.

TABLE 2 FITMENTS REQUIRED FOR MARK IV CRATE

Item No.	Description	Size	Amount Required	Purpose
1	Rivet; domed head; aluminium alloy.	4.8 mm x 30 mm	8	Corner hinge.

2	Washers, metal	To fit rivets	8	-
3	Binding wire.	2 mm diameter	6.5 metres	Lid flea; crate reinforcement.
4	Staples; galvanised.	15 mm Chise1 point	8	To fix ties to lid battens.
			32	To fix reinforced wire to rails.
5	Staples; galvanised.	18 mm Chise1 point*	70	To fix end cross battens to boards; lid boards and bottom boards to battens/struts.
6	Staples; galvanised.	30 mm Chise1 point	94	To fix aide and end boards to rails.

*** Initially 15 mm staples were used to fix bottom boards to struts; after the further drop-testing, these were changed to 18 mm to allow full clinching. 18 mm diverging point staples may be substituted for up to 54 of the 18 mm chisel point staples.**

Crate Mark IV A - Thicker Lid and Bottom

Items in Table 1 should be altered as shown In Table 3.

TABLE 3 ALTERATIONS TO CUTTING LIST FOR MARK IV A CRATE

Item No.	Description	Material	No. required	Length mm	Width mm	Thickness mm

7	Lid Board	Mahot cochon	4	520	75	9
9	Bottom Board	Mahot cochon	4	570	75	9
10	Bottom Strut	Mahot cochon	3	322	35	9

Similarly, the 24 x 18 mm staples required for each of the lid and bottom should be changed to 30 mm staples. The minimum staple else necessary la 28 mm for the lids and 22 mm for the bottoms.

Crate Mark IV B - Thicker Lid and Bottom: Lid Extension

The alterations to the bottom are as for Mark IV A. Item 7 should be altered to length 545 mm, width 75 mm and thickness, 9 mm, to allow one end of the lid to fit under the side rail. The four metal ties may be retained but two or four plastic or string ties may be substituted.

TABLE 4 EQUIPMENT REQUIRED FOR WOODCRATE MANUFACTURE

Item	**Number Required**	
	Minimum	**Preferred**
Band shingle saw	1	
or Heavy duty bandsaw	1	
or Circular saw (most wasteful of wood)	1	
and Peeling or slicing machinery (for cutting thin boards)	1	
Drill (to make rivet holes)	1	

Pop rivet gun	1	
Pneumatic stapler, hand-held (one for each staple type/sise)	1	3
Compressor (2 staplers run from 1 compressor)	1	2

<u>Note</u>. The use of a bent shingle saw has been suggested but information on blade life using mahot cochon and gommler is not available. Careful assessment is necessary of blade life/replacement blade cost for both the band shingle saw and bandsaw, versus wood wastage using a circular saw. A specially hardened metal cutting blade is recommended If a bandsaw la employed, but this is not resharpenable; use of an ordinary steel blade would involve frequent sharpening and purchase of a sharpening machine; this option is likely to prove more expensive than using a specially hardened blade.

It has not been possible to identify a peeling/slicing machine or a veneer lathe that would give suitable thickness boards or throughput, but it may be possible to have an appropriate machine manufactured. Known machines give 8 maximum thickness of 8 mm which would be satisfactory for box boards but not for the 9 mm boards of lid and bottom. Typical output would be higher than required eg 400 boards under 80 mm wide per minute. Again, the coat, if a suitable slicing machine can be identified, may militate against purchase, as 20,000 to 25,000 appears to be the average price for models from EC producers.

The equipment list presupposes access to workbench, plane, fabrication jigs (made from steel angle), and hand tools such as hammers and bolt cutters. Details of potential suppliers follow for Items where local supply is unlikely.

Potential Suppliers of Equipment for Woodcrate Manufacture

1. Band shingle saw (current model is for cedar shingles)

George Schell
335 Main Street
Foxboro Ontario KOK 2BO
Canada

It la possible that a one-off machine could be manufactured in Dominica with expertise from staff of Dominica Timbers or Davis Brothers.

2. Bandsaw

Wadkin plc (700 mm bandsaw, for saw blades up to 27 mm wide; coat approx. 2,500 fob)

Green Lane Works

Leicester LE5 4PF

England

George Schell (address as for 1) (Current models coat approx. Canadian $7000).

3. Peeling/Slicing Machine

Angelo Cremona and Figlio S. Cremona and Figlio

Viale Lombardia 275 Via Farina 7

20052 Monza 20058 Villasanta (Milano)

Italy Italy

T.E.M.S.A. (agents for Corali) Corali

8 Avenue Jean-Foucault Fonderie Officine die carobbio di Bruno

34500 Beziers Corali

France Via Bolgare 10

24060 Carobbio degli Angeli

Bergamo

Italy

(ea. Slicing machine with cutting width 950 mm, size of cut strips 10 mm to 180 mm; maximum thickness 8 mm; coat 20,000 to 25,000 approx.).

4. Stapling Machine

BeA Fastening Systems Ltd British Industrial

Fastenings

Swinemore Industrial Estate BIF House

Beverley Gatehouse Road

Humberside HU17 OLA Aylesbury

England Bucks HP19 3DS

England

(various models, from 265)

5. Air Compressor

Suppliers as for 4. (Models with output 3.5 cfm to 4.2 cfm, from 260)

6. Staples

(Suppliers as for 4. eg 15 mm chisel point, 5.37 per 5000

18 mm chisel point, 6.04 per 5000

30 mm chisel point, 3.73 per 2000 from BeA)

7. Rivets

Aluminium alloy, domed head.

Primary Fixings Gesipa Fasteners

127 Jockey Road Dalton Road

Sutton Coldfield Keighley

Birmingham B73 5PJ West Yorkshire BD21 4JU

England England

(Minimum size required, 4.8 mm x 30 mm; grip length 22-26 mm 34.99 per 1000 from Primary Fixings).

8. Potential Suppliers of Plastic Closures

Ease-Lok Ltd Hellermann Insuloid

Unit G3 Sharston Works

Insworth Technology Park Leestone Road

Insworth Lane Wythenshawe

Gloucester GL3 1DL Manchester M22 4RH

England England

R K Packaging Ltd Tripack (UK) Ltd

261 Bedford Road Lancaster Approach

Kempston North Killingholme

Bedford MK42 8BP South Humberside DN40 3JZ

England England

Annex III. DIMENSIONS OF TRANSPORT PACKAGES

Multiples	
mm	**inches**
1200 x 1000	47.25 x 39.37
1200 x 800	47.25 x 31.50
1200 x 600	47.25 x 23.62
1200 x 400	47.25 x 15.75
800 x 600	31.50 x 23.62
Module	
mm	**inches**
600 x 400	23.62 x 15.75
Sub-multiples	
mm	inches
600 x 400	23.62 x 15.75
300 x 400	11.81 x 15.75
200 x 400	7.88 x 15.75
150 x 400	5.90 x 15.75
120 x 400	4.72 x 15.75

600 x 200	23.62 x 7.87
300 x 200	11.81 x 7.87
200 x 200	7.88 x 7.87
150 x 200	5.90 x 7.87
120 x 200	4.72 x 7.87
600 x 133	23.62 x 5.25
300 x 133	11.81 x 5.25
200 x 133	7.88 x 5.25
150 x 133	5.90 x 5.25
120 x 133	4.72 x 5.25
600 x 100	23.62 x 3.93
300 x 100	11.81 x 3.93
200 x 100	7.88 x 3.93
150 x 100	5.90 x 3.93
120 x 100	4.72 x 3.93

Annex IV. STANDARDS FOR TRANSPORT PACKAGES

Standard floor size : 600 x 400 mm		

Height (mm)	Commodity	Content
300	Cabbage green	18 head
300	Cabbage green 7"	14 head
300	Lettuce (4-5")	40 head
300	Lettuce (4 1/2-5")	30 head
300	Lettuce (5 1/2-6 1/2)	24 head
Standard floor size : 400 x 300 mm		
Height	**Commodity**	**Content**
150	Okra	1/2 bunch
200	Eggplant	
300	Bean (green)	31.5 pound
300	Lemon (115+119)	132 count
300	Lemon (165+172)	185 count
300	Pear	44.8 pound
300	Pepper (hot)	1 bunch
Standard floor size : 500 x 300 mm		
Height	**Commodity**	**Content**
140	Grape	22.0 pound
160	Peach 2 1/4	26.0 pound
160	Peach 2 3/8	23.5 pound

160	Peach 2 7/16	25.9 pound
160	Peach 2 5/8	24.0 pound
160	Peach 2 13/16	24.5 pound
160	Peach 2 1/8	24.5 pound
200/300/400	Orange 88	90 count
200/300/400	Orange 100	98 count
200/300/400	Orange 113	110 count
230	Tomato	29.5 pound
250	Beans green	28 pound
300	Broccoli	14 bunches
300	Cucumber	85 count
300	Eggplant	21 count
300	Grapefruit 27	32 count
300	Grapefruit 36	40 count
300	Grapefruit 40	38 count
300	Grapefruit 48	53 count
300	Lettuce 4 1/2-5 1/2	24 head
300	Peach (South 2 1/4")	45.8 pound
300	Pepper (Cuban)	25.8 pound
300	Pepper (green)	75 count

300	Pepper (red)	1 1/9 bunch
300	Potato (white)	57.2 jumble
300	Potato (round red)	45.0 pound
300	Romaine	18 head
300	Squash (Acorn)	33 count
300	Squash (Butternut)	24 count
300	Zucchini	1 1/9 bunch
Standard floor size : 500 x 400 mm		
Height	**Commodity**	**Content**
110	Grape	24.0 pound
210	Melon, honeydew 7 3/4"	5 count
300	Cabbage (red)	16 head
300	Celery (Michigan 3")	38 count
300	Greens (spinach, turnip, kale, collard)	25.6 pound
300	Lettuce (4-5")	32 head
300	Lettuce (5 1/2-6 1/2")	18 head

Annex V. COMPARING DIFFERENT PACKAGES USING THE CHECKLIST

In this example a comparison is made using the checklist (see next page) between:

- **A carton box (banana), telescope design, size 508 x 330 x 184 mm, round slots, cost approximately US$ 1.-**
- **A wooden collapsible crate, 600 x 400 x 300 mm, cost around US$ 10.-**
- **A plastic stack-nest crate, 600 x 400 x 300 mm, cost around US$ 8.-**
- **A woven basket diameter 700 mm, height 800 mm, cost around US$2.-**

Column 1

The package in this example is meant for use in the inter-island trade of fruits, vegetables and root crops and should be able to hold different commodities. The most important function of packaging in the inter-island trade is protection (40%), followed by cost (30%) and containing produce (20%) and then marketing and communication (5% each).

Column 2

Protection during handling, transport and marketing is considered the most important sub-function of protection (15%), followed by good ventilation, consistent dimensions, easy to clean and pilfer-proof (each 5%), etc.

Columns 3 to 6

Ad 1. The huckster/trafficker trade deals with all kind of perishable produce and the volumes of one commodity traded per huckster or trafficker often do not justify the use of packages with different capacities. The basket of one meter high is not suitable for soft fruits. The capacity of the carton box (30 liter) is not sufficient for large commodities such as watermelons.

Ad 2. Shifting of cargo is mainly done by hand and a basket with a volume of around 200 liter cannot be lifted by one person. The carton box is too easy to handle, in which case the person will lift two boxes at once and the grip will easily tear due to the higher weight.

Ad 3. A standard design would simplify handling of produce, but the holds of most inter-island vessels are not build for standard packaging. The basket is the only package in this example which has different designs and sizes.

Ad 4. Also here the sum of pallets is restrained by the hold of the vessels. Best fitting on a pallet are the 600 x 400 mm size crates, followed by the carton box.

Ad 5. The basket can not be stacked properly. The wooden and plastic crates are stable due to the larger floor size (600 x 400 mm) and to the height per crate (only five crates for a height of 1.50 meter). The carton box can reasonably be stacked.

FIG.1.CHECKLIST

Ad 6. The hold of an wooden vessel is at least 2 meters high and the package on the bottom should not collapse under the pressure of the stack. The rigid wooden and plastic crates will maintain their shape even with high stacking. The carton box will indent when not properly (corner on top of corner) stacked.

Ad 7. As long as the conditions in the hold of the vessels have not changed, there will be no need for ventilation of the crates and a relatively low priority has been given to this item. The best ventilation can be obtained by the plastic and wooden crate. Liners of palm leaves inside the basket prevent good ventilation. The telescopic carton boxes are often overfilled and consequently not properly closed with the result that the ventilation holes are not in line anymore.

Ad 8. Pallets are not yet used in the inter-island trade and every crate has to be picked up and put down several times before it reaches its destination. In order to prevent losses this item should have a very high importance. Both the wooden and plastic crate give a very good protection.

Ad 9. Baskets may have sharp edges, whereas plastic crates and carton boxes have smooth surfaces.

Ad 10. Not applicable. Liners are not yet in use in the inter-island trade.

Ad 11. Plastic crates are much easier to clean than wooden crates or baskets. Carton boxes are only used once.

Ad 12. Only the plastic stack-nest crate has no cover and pilferage of produce is possible.

Ad 13. A label is difficult to attach to a basket and easiest to attach to a carton box.

Ad 14. Logo and brand name can be printed in colour on a carton box.

Ad 15. Carton boxes are very suitable for presenting produce, whereas woven baskets are not suitable.

Ad 16. Depending on importing country. Some countries do no longer accept baskets.

Ad 17. Baskets and carton boxes have the lowest purchase cost.

Ad 18. The wooden and plastic crates can be used for several journeys resulting in a lower running cost of these packages per trip.

Ad 19. Carton boxes and plastic crates are not repairable. Only wooden crates can be repaired locally.

Ad 20. The same for all package types.

Ad 21. The freight costs in the Eastern Caribbean are high and a low cargo volume of empty crates is important. The basket uses the same volume on the return trip. Both the wooden and the plastic crates have a return freight volume of around 40 percent for the full crate. The carton box is only a single trip package and has no return freight.

Ad 22. Only plastic crates can not be manufactured locally.

Ad 23. Baskets can not be stacked properly and are difficult to transport.

Ad 24. Carton boxes are meant for one single trip and do not have to be returned, whereas crates are not always returned to their owners.

CHECKLIST

CONTAINING

1 Suitable capacity for the range of fruits, vegetables and rootcrops

2 Easily handled by one person

3 Standard design

4 Palletization

PROTECTING

5 Stable when stacked

6 Consistent dimension, resist the pressure when stacked

7 Good ventilation

8 Protection during handling, transport and marketing

9 Smooth surface material, no sharp edges

10 Liners available

11 Easy to clean

12 Pilfer proof/closed with cover

COMMUNICATING

13 Easy to attach label

14 Advertisement/ Brandname on box

15 Presentation

16 Acceptable for customs control

COST-MISCELANEOUS

17 Reasonable purchase cost

18 Durable/Deterioration

19 Repairable

20 Consistent supply guaranteed

21 Low cargo volume when empty

22 Local manufacturing possible

23 Transport/fitting or, pick-up or handcart

24 Loss of crates

TOTAL 100% 100% N.A. N.A. N.A. N.A.

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