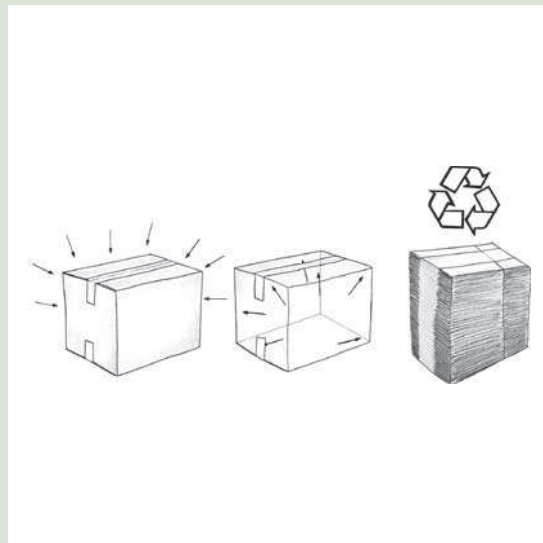
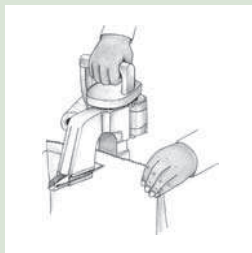


Packaging of agricultural products



Agrodok 50

**Packaging of agricultural
products**

Peter Fellows

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Foreword

This booklet is intended to be a practical manual that describes methods and materials that can be used by small-scale producers in developing countries to package agricultural products. It covers foods that are grown and/or processed on farms and then transported to wholesale markets or processors, or in some cases to retailers for sales to customers.

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Peter Fellows

Contents

1	Introduction	6
1.1	Focus	6
1.2	Structure	7
1.3	Requirements of packaging	8
1.4	Research to improve packaging	13
2	Cereals and legumes	17
2.1	Dried whole grains	17
2.2	Flours	19
3	Cooking oils and essences	21
3.1	Cooking oils	21
3.2	Essences or essential oils	22
4	Horticultural products	23
4.1	Fresh crops	23
4.2	Dried crops	25
4.3	Fried chips	27
5	Animal products	28
5.1	Fresh meat and fish	28
5.2	Dried and smoked meat and fish	29
5.3	Milk	30
5.4	Eggs	31
6	Honey and syrups	33
6.1	Honey	33
6.2	Syrups	34
7	Types of shipping containers	35
7.1	Boxes, trays, baskets and crates	35
7.2	Sacks	37
7.3	Drums, barrels and cans	38

7.4	Shrink-wrapping and stretch-wrapping	40
7.5	Re-use and recycling of shipping containers	41
8	Types of retail containers	42
8.1	Choice of packing material	42
8.2	Bags, sachets and wrapping materials	43
8.3	Bottles, pots and jars	46
8.4	Cartons, tubs and trays	48
8.5	A note on labelling	49
8.6	Tamper-resistance and tamper-evidence	50
8.7	Re-use and recycling of retail containers	51
9	Filling and sealing	53
9.1	Filling and sealing of shipping containers	53
9.2	Cleaning and filling of retail containers	55
9.3	Capping and sealing equipment	58
9.4	Ensuring minimum fill-weight	63
	Further reading	64
	Useful addresses	66
	Glossary	68

1 Introduction

Packaging food means wrapping or containing it in some form of material that will protect it during storage, transport and distribution. Packaging prevents food from becoming damaged due to impact or crushing, contaminated by insects and micro-organisms, or affected by moisture, air or odours. In general, packaging prevents foods from spoiling, losing value and losing volume through leakage or spillage.

1.1 Focus

This Agrodok is written for small-scale producers and traders in developing countries who package (or are interested in packaging) agricultural products for storage or selling. It describes methods and materials to pack foods that are grown and/or processed on farms and then transported to wholesale markets or processors, or in some cases to retailers for sale to customers.

The aim of this Agrodok is to enable producers and traders to improve (or start) the packaging of their products and to thereby reduce losses caused by damage or spoilage. Fewer losses mean greater profits.

Useful related information can also be found in Agrodok 31: **Storage of tropical agricultural products**, which is also published by Agromisa and CTA. Agrodok 31 describes methods used to store foods until they are used or sold. Good storage methods also prevent damage and losses, and many fresh or dried foods can be stored un-packaged until further use. The advantage of good packaging, however, is that it reduces losses even further, makes handling and trading of the product easier and, for retail trading, improves the marketability of the product.

1.2 Structure

This Agrodok is divided into eight chapters. Section 1.3 in this introduction describes the reasons for packaging agricultural products, the costs involved, the availability of packing materials, the constraints that may be faced and ways in which some constraints may be overcome. Two case studies (Section 1.4) from Sri Lanka and India show how improvements to the packaging used for shipping containers can improve both the quality of fresh fruits sent to market and also the producers' and traders' incomes.

Chapters 2 to 6 describe the packaging requirements and the packaging options for different groups of agricultural products, as different foods require different levels of protection. These groups are: cereals and legumes, cooking oils and essences, horticultural products, animal products, and honey and syrups. As an example, dried grains (Ch. 2) are stable and require relatively little protection, whereas milk and fresh meat or fish (Ch. 5) require much greater protection to prevent loss of quality and spoilage and to reduce the risk of food poisoning.

Each chapter first outlines the purposes of packaging for the particular group of foods. It then describes the requirements containers must fulfil in order to protect foods during storage and transport to markets, and the main packaging options that are likely to be available in developing countries.

Chapters 7 and 8 outline the properties and comparative advantages of different packaging materials, respectively for shipping containers and retail packaging. Chapter 9 gives a description of the types of filling/sealing equipment that are available for small-scale operations with or without electricity. Annex 1 lists sources of information and Annex 2 lists packaging support organisations.

1.3 Requirements of packaging

In general, food packaging must fulfil the following requirements:

- It must hold the contents and keep them secure without leakage or breakage until they are used, and enable the food to be handled conveniently.
- It must protect the food against a range of hazards during distribution and storage. This includes serving as a barrier to dirt, microorganisms and other contaminants; protecting the food from damage caused by insects, birds and rodents; protecting it from crushing or other physical damage; and protecting it from the effects of heat and light that can cause rancidity, or moisture pickup or loss that can cause softening, wilting or other types of quality deterioration.
- It should be suitable for recycling or re-use, or be easily disposed of to prevent waste packaging from causing environmental pollution.

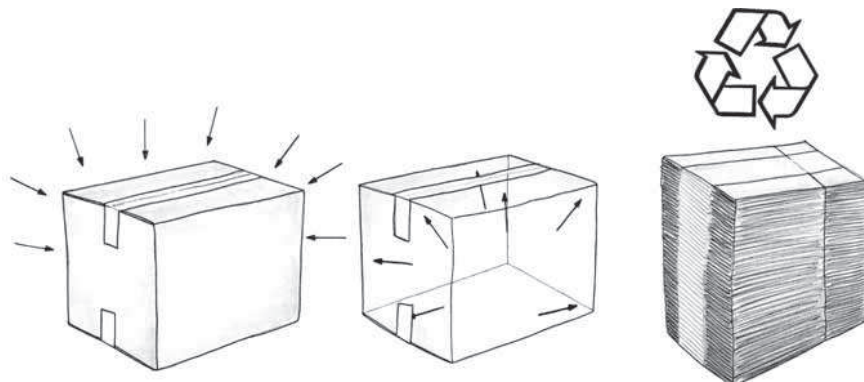


Figure 1: Protecting, containing and disposing

The selection of a packaging material for a particular agricultural product depends on both its technical suitability (i.e. how well the package protects the food for the required shelf life) and the method used to sell the food.

Type of selling system

There are a number of different selling systems that small-scale food producers can use to sell their products. These include:

- direct sales to customers in local rural markets
- sales to traders and middlemen who visit the farms and then sell the products on to wholesalers or processors
- sales to agents or buyers from food processing companies or government institutions
- sales to collection centres, which in turn supply food processors
- sales to urban wholesalers or retailers.

Local rural markets

Packaging requirements are less demanding for local selling systems in which the food is not transported far and customers buy from bulk containers. Examples include grains or flour sold from sacks or fresh fruits and vegetables sold from crates or baskets.

Sales to traders, agents and buyers from companies

When traders, agents or commercial buyers visit farms, they frequently require foods to be packaged before they take delivery. Some may provide the packaging materials, but these may often be poor-quality, re-used materials that can contaminate foods. Other buyers require the producer to provide the packaging.

Traders often prefer to use types of packaging that take up the least space on haulage vehicles so that loads can be maximised. This may not be the best type of packaging for a particular crop and can result in damage to the crop during transport (e.g. fresh fruits transported in sacks instead of crates).

Sales to collection centres

Where products such as milk are taken to collection centres, the producer may be supplied with a suitable container, and transport from the collection centre to urban markets or food processing companies is then done under the control of the centre using bulk transporters.

A shipping container can be any type of sack, box, drum, barrel, etc., that contains and protects the food during transport and storage until it is processed or sold. These containers are not covered by the laws that

apply to retail containers. So they do not require a label or printing to identify the contents and the producer, although some producers may choose to advertise their foods on the container..



Figure 2: Shipping containers for vegetables

Retail sales

For food products that producers sell directly to urban retailers, such as dried herbs and spices or honey, the packaging requirements are more complicated: the package not only has to protect the food, but also to advertise it and attract customers. This requires attention to the design of the packaging and the information presented on the label, both of which may be subject to local legislation.

The design aspects of packaging are outside the scope of this Agrodok, but sources of information on labelling retail containers are given in Stewart (2007) and Coles et al. (2003); see Further Readings.

Cost and availability of packaging materials

The cost and availability of different packaging materials in a particular area also determine which packaging materials are used. The cost of a package should be considered in relation to the value of the food. For example, producers would incur serious financial losses if they used the wrong packaging materials for high-value foods that deteriorate without the correct packaging (e.g. cooking oils). These foods should therefore receive a higher level of investment in packaging than lower-value crops. This type of cost-benefit analysis should be carried out before selecting the best type of packaging for individual foods.

The amount of money available to producers to pay for packaging materials also depends on which of the above markets they sell their produce to. For example, direct sales to urban retailers provide greater added-value and generate a higher income for producers. This in turn allows greater investment in packaging for their products. Conversely, sales of low added-value products (e.g. root crops) in rural markets or sales to middlemen often mean that farmers do not earn enough money to package their crops in suitable materials.

Availability of packaging materials

The choice of available packaging materials is often very limited in developing countries and especially for rural producers. This difficulty in obtaining suitable packaging materials is a major constraint on the supply of good-quality crops and animal products in many countries. Most developing countries do not have their own packaging manufacturers; and packaging materials must therefore be imported.

The types of packaging materials that are stocked by import agents depend on the local demand. If this is too small, the agent cannot meet the large minimum order sizes that are required by overseas packaging

manufacturers. This means that the only materials available to producers are those that have the highest demand (and usually the lowest cost); and these materials may not be suitable for the types of foods being produced. If unsuitable packaging materials are used, there is a risk that foods will deteriorate too quickly and lose both quality and value before they are sold. For some foods, incorrect packaging can cause an increased risk of food poisoning to consumers (e.g. incorrect packaging of fresh meat and fish).

Finally, a further constraint on the use of correct packaging by small-scale producers in some countries is a lack of rural infrastructure. For example, the absence of electricity prevents the use of sack stitching or heat-sealing machines for plastic bags, and poor roads cause excessive breakage of glass containers, damage to sacks, etc.

Ways to overcome some constraints

The above constraints on the supply of suitable packaging materials and equipment may be overcome in a number of different ways:

- Some traders, middlemen and other buying agents supply packaging materials to producers, and some also offer advice and support on the correct ways of packaging and storing crops.
- Agricultural extension workers offer a similar service in some countries.
- Farmers' co-operatives enable producers to purchase packaging materials in bulk to reduce costs; to share transport costs; and also to share filling and sealing equipment to reduce the level of each individual's investment in the equipment.
- Finally, publications such as this Agrodok booklet and others listed in Further Reading can be used by extension agents to address the lack of knowledge or awareness among producers of the packaging options that are available and allow them to recommend the correct types of packaging materials and equipment required for different crops and animal products.

1.4 Research to improve packaging

Two case studies from Sri Lanka and India are provided below to show how improvements to the packaging used for shipping containers can improve both the quality of fresh fruits sent to market and the producers' or traders' incomes. The case studies also show the usefulness of research in co-operation with the target group and the importance of looking closely at the local situation before introducing new packaging.

Case Study 1: Transporting fresh mangoes in Sri Lanka

In Sri Lanka, fresh mango is transported from farms to market in re-used tea chests. During transport there is build up of heat and humidity, due to the lack of ventilation that leads to increased disease, mainly stem-end rot. To prevent losses, such conditions should be avoided. A study was undertaken to reduce damage to the crop and to improve incomes for the people concerned. Slatted wooden transport crates were introduced to collection agents in co-operation with a rural credit co-operative society that harvests and collects 40 - 60% of the mangoes in Sri Lanka. Traders visit farmers and buy the right to harvest trees. Post-harvest losses are therefore not important to the farmer because they are the responsibility of the trader and any reduction in post-harvest losses benefits the traders and others in the marketing chain. A high-value local variety of mango, which is highly susceptible to damage and disease, was ripened for five days and transported to market in both the slatted crates or tea chests from three different harvesting areas (Ampara - distance 350 km, journey time 10 hours, Anamaduwa - distance 100 km, journey time 3 hours, and Nikeweretiya - distance 150 km, journey time 5 hours). Two types of crate were used: a deep crate measuring 40 x 40 x 61 cm - the same size as the tea chests, and a shallow crate measuring 40 x 61 x 40 cm.

The study showed a significant improvement with fewer rejected fruits from Ampara and Anamaduwa when both types of slatted crates were used instead of tea chests. Fruits from Nikeweretiya were improved using the shallow slatted crates. It also showed that transport over a long distance during the day results in the highest losses, which is partly prevented by using slatted crates. Night transport produces fairly low losses that can be reduced further by using slatted crates.

Local traders considered that the crates were a good way of storing fruit at collection points:

- Deep slatted crates combined ease of handling and transport with good ventilation, resulting in a noticeable reduction of losses.

- The slatted structure allows visual inspection (avoiding the need to unload for inspection and the resulting rejects caused by more frequent handling).
- Sorting at the market is easier and quicker because there are fewer rejects and more uniform ripening, and the women involved can devote more of their time to other activities.
- There is less skin irritation caused by sorting because the slatted structure allows the irritating sap from the stem to dry.

The financial benefits of the slatted crates were calculated. The improved crates produce a 6% increase in marketable fruit. Assuming that each crate is used three times per month during each of the two four-month mango seasons, and that a crate holds 250 fruits valued at Rs 4 each, the average additional income was calculated to be Rs 1440 per crate per year ($6\% \times 250 \text{ fruits} \times 3 \text{ times per month} \times 4 \text{ months} \times 2 \text{ seasons} \times \text{Rs } 4$).

The cost of each crate is Rs 100 and the estimated annual repair cost Rs 16. Taking into account the interest of 24% on the finance required to purchase new crates, the average life of a crate and repair costs, the total additional costs to the trader each year are Rs 40 per crate. This means that the net financial gain is Rs 1400 per crate each year and the investment in the crate is repaid in one month.

The involvement of the target group during the trial helped with the adoption of the technique by the traders, and loans were under consideration to enable collection agents to purchase slatted crates. The study recommended that traders should aim for the shortest delay during collection; transport at night when it is cool; and use slatted crates that provide better ventilation and reduce the build up of heat and humidity.

Case Study 2: Transporting fresh tomatoes in India

In India, the situation is different and traders already used slatted boxes to transport fresh tomatoes. Small-scale growers at Shargaon in Himachal Pradesh produce the tomatoes during June to August, and because this region is the only source of supply to Delhi during this time, growers get a good price for their crop. There are frequent rains from mid-June to August, with high humidity and average temperatures of 33–34°C in June, falling to 25°C in August. Tomatoes are picked and put into small baskets or plastic crates, and these are emptied into a larger basket, made of split bamboo with a capacity of 30 – 40 kg. The tomatoes are then sorted and packed for transport to market. Growers traditionally use wooden boxes measuring 39 x 28 x 20 cm called peti to transport their produce. The boxes have a capacity of 13 – 14 kg tomatoes and cost around Rs 18–20 per box. They are readily available in kit form, which the growers buy and assemble using a hammer and nails.

The boxes allow air to enter and have a smooth inner finish, though nails may sometimes protrude. Pine needles or dry grass is placed between the layers of fruit to provide cushioning and protection. A sheet of newspaper is placed on top and the lid is nailed on.

Growers carry the petis on their back or on mules to the roadside, where they remain on damp ground for up to four hours until picked up by the transporter. Trucks are used to transport the boxes, with each truck carrying around 600 petis, stacked in columns of up to 8 tiers. A tarpaulin covering is used to protect the cargo from rain. Hill roads are narrow, with hairpin bends, steep gradients and many potholes. Journeys therefore expose the fruit to vertical, sideways, forward and backward movement in the boxes. During unloading, the boxes are thrown and caught, but occasionally a miss causes a box to fall onto the hard floor.

The Himachal government has banned the felling of trees used to make the boxes in order to reduce deforestation. Corrugated fibreboard boxes were investigated as a potential replacement for the wooden peti. The boxes are a similar shape and volume as a peti with 8 vent holes on both the longer sides, on the top and bottom. Trials of 15 kg capacity boxes were made with local growers to:

- Find out whether they could withstand the 350 km, 12 hour road journey to Delhi,
- Compare the protection given to the tomatoes with the peti,
- Get feedback from growers and traders on ease of filling, handling, price etc., and
- Modify the boxes based on the trial and feedback.

During the trial, the cartons were carefully filled with 15 kg tomatoes, shaken once or twice during filling to ensure proper settling, and secured with straps before loading on to the trucks. Tomatoes were also packaged in petis to compare the efficacy of the new carton. The cartons were stacked in columns of four and the petis in columns of seven to give the same overall column heights. After the journey there was no damage to any of the boxes, despite the fact that some cartons were exposed to slight wetting due to a leaky tarpaulin. Overall the damage to the tomatoes was 1.5% in cartons and 2.1% in petis, showing an acceptable level for both types of packaging.

Feedback from growers in Shargaon and traders in Delhi suggested that the size of the carton be kept close to that of the peti and they also insisted that the price should be similar. Based on the results of the trial, cartons will have a volume of 21.6 litres, and the outer surface will be treated with varnish to reduce damage due to rain. It is concluded that the cartons offer a viable alternative to the traditional wooden boxes for the transport of horticultural produce and therefore have an impact on deforestation.

Source: '**New packaging options for transporting tomatoes in India**' by Girja Sharan and Kishor Rawale, Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad 380015, India, published in ITDG Food Chain 29, 15-18, 2001, and '**Slatted wood crates: reducing losses of fresh mango**' by R S Wilson Wijeratnam, Ceylon Institute of Scientific and Industrial Research, Colombo, Sri Lanka and F W Korthals Altes, TOOL Foundation, Amsterdam, The Netherlands, published in ITDG Food Chain 16, 4-6, Nov., 1995)

http://practicalaction.org/docs/agroprocessing/FC29_1518.pdf

http://practicalaction.org/docs/agroprocessing/food_chain_16.pdf

2 Cereals and legumes

A large number of cereal and legume crops are produced as staple foods, including maize, millet, rice, sorghum, and many different types of peas and beans (e.g. chickpeas, cowpeas, Lima beans, Navy beans, pigeon peas, soybeans, groundnuts). These are usually dried on farms before sale. Producers may also mill grains to produce flours, which are either sold locally or to traders. This section describes the packaging requirements and options for dried grains and flours.

The details of the methods used to store cereals and legumes at the farm, until they are used or sold, are given in Agrodok 31: **Storage of tropical agricultural products**.

2.1 Dried whole grains

When grains are properly dried, their low moisture content protects them against the growth of moulds or bacteria. The packaging requirements of properly dried whole grains are therefore twofold:

- 1 contain the grains and prevent losses,
- 2 prevent contamination by insects, animals and 'foreign bodies' (e.g. fragments of metal/wood), or odours (e.g. diesel fumes).

In dry climates, grains do not absorb moisture from the air. But in very humid areas they may pick up moisture, and this would result in mould growth. Moulds not only spoil grains, but some can produce aflatoxins (see Glossary) that cause food poisoning. In these areas the package should also be moisture proof to protect the grains.

Wholesale

The packaging options depend on the type of selling system used in a particular area. For example, many producers supply unsorted and uncleaned whole grains to traders and wholesalers. The grains are packed in bulk into sacks made from locally available materials (e.g.

sisal, kenaf, cotton). Newer materials such as multi-walled paper sacks and woven polypropylene sacks are increasingly common.



Figure 3: Rice sacks in store

Sacks should be clean and free from old grains, oil or grease, and there should be no holes or tearing of the material. Sacks may be sealed by hand-stitching using twine or a locally available vegetable fibre, or at a larger scale using an electric sack-stitcher.

Selling unsorted grain reduces the costs to farmers and also their investment in cleaning and sorting. However, unsorted crops that contain discoloured or insect-damaged grains or contaminants such as weed seeds, chaff and leaves have a lower value, and farmers therefore receive lower prices. It is the traders who add value to the crops by cleaning and sorting them.

Retail sales

More enterprising farmers clean, sort and pack grains in retail bags to make their businesses more profitable. The costs of sorting, plus the cost of the packaging materials, mean that the price for the products is higher. However, the sorted grains may also have a high demand because they are better quality and guaranteed to be free from dirt or stones. They are also hygienically packed with a guaranteed weight per pack.

Types of packaging for retail sales include sacks or thick polythene bags that are ideally heat-sealed, although stapling is sufficient to retain the grain in the pack. Brown 'Kraft' paper sacks and bags that are stitched, stapled, glued or sealed with tape are also used for retail sales. Polythene and paper packaging are usually widely available and can often be printed by local print companies. Other plastic films that are a better barrier to moisture and air are not necessary for packaged grains and are likely to be considerably more expensive.

2.2 Flours

Milling grains to produce flours is an on-farm business in many areas. In custom (or 'contract' or 'service') milling, customers bring their grain to a mill. They have it milled for a fee or in exchange for a portion of the flour, and the miller does not package the flour.

Wholesale

Bulk flour for sale to wholesalers, bakeries, institutional customers (e.g. schools, colleges, prisons, army barracks, etc.) or international food relief operations is packed into 50 kg sacks. If the demand exists, flour can also be made from mixtures of grains and legumes for specialist markets (e.g. 'composite' bakery flours, weaning food mixes, pre-prepared breakfast cereal mixtures, or specialist flours for people suffering from intolerance to wheat).

As with grains, the main packaging requirement is to contain the flour to prevent losses and to prevent it becoming contaminated with dirt or insects. Sacks made from woven polypropylene or natural fibres such as thick cotton are suitable. Each type can be sealed with a sack-stitcher if electricity is available, or by hand if it is not. Alternatively, multi-walled paper sacks can be used and sealed using a sack stitcher or glue.

Retail sales

In many countries, millers also pack flour into paper or polythene retail bags, which compete with flour that is sold in markets from open sacks. To compete effectively, the retail bags of flour must have similar benefits for the customer to those described for cleaned grains above (i.e. guaranteed quality, freedom from contaminants, guaranteed weight). The bags should be fully sealed to prevent loss of flour. Paper bags should be sealed using glue or stitching, but not stapling, which would not adequately contain the flour. Polythene bags should be heat-sealed. The bags may be contained in cardboard boxes for distribution to retailers, or at a larger scale they may be stacked on pallets or held together by stretch-wrapping.

All types of grains and flours are packed by hand into bags or sacks at small scales of operation. The sacks/bags are weighed to ensure that they contain the correct net weight and then sealed. Larger scales of operation use bagging machines.

3 Cooking oils and essences

3.1 Cooking oils

Cooking oils are produced from a variety of nuts (e.g. palm kernel, coconut), seeds (e.g. sesame), fruits (e.g. palm) and legumes (e.g. groundnut). They are high-value products that have a high demand for both domestic cooking and for other food processing. Oils are preserved by their low moisture content, but they can spoil and become rancid if they are exposed to air, light, heat, moisture, or some types of metal (e.g. copper or iron). Correct packaging and storage in a cool dark storeroom are the main methods to preserve oils to give a shelf life of several months. The packaging should also prevent contamination of oils and prevent the oil from picking up odours from other materials.



Figure 4: Cooking oil

Shipping containers

Bulk shipping containers for cooking oils are usually drums made from steel or food-grade plastic. These are often re-used and it is essential that all traces of old oil are removed by thorough cleaning, and that the drums are fully dried before being re-filled with oil. This is because old oil is likely to be rancid and water can also cause oil to go rancid. Although cooking oil is sold from bulk containers in some markets, this is not recommended because the shelf life of the oil is significantly reduced by exposure to air, heat and light. Insects and dirt can also contaminate the oil.

Retail packing

It is preferable to pack oil into a sealed container. The simplest pack is a polythene bag that is tied or heat-sealed. However, this only protects

the oil from contamination and it does not prevent rancidity, so the shelf life is short. Better retail packs for oil include coloured glass bottles (colour reduces light entering the container) or food-grade plastic bottles. These should be sealed with an airtight cap, such as a Crown cap or a roll-on-pilfer-proof cap. If these are not available, a cork seal is a suitable alternative. The bottles should be distributed and stored in cardboard boxes to reduce the amount of light and heat that is transmitted to the oil. For more details on heat-sealing, corking and capping, see Chapter 9.

3.2 Essences or essential oils

Essences are also known as ‘essential oils’. They are high-value oils that are used for flavouring foods and for other products (e.g. cosmetics). They are produced by distilling the oil from aromatic plants such as eucalyptus, lemon grass and a wide range of herb and spice plants (e.g. cloves, coriander and cinnamon). Their high value is due to the volatile aromas that they contain. The packaging should both prevent the loss of these aromas, and also prevent the oil from changing flavour or becoming rancid, due to contact with air, light or moisture.



Figure 5: Bottles of food essences

Coloured glass reduces the influence of sunlight and the metal screw-caps prevent the loss of aromas and the changing of flavour due to contact with air.

In practice, small coloured glass bottles, sealed with metal screw-caps are the only suitable containers for these products. They are transported and stored in cardboard boxes to protect the glass bottles against breakage and also to reduce light and heat transmission to the essences.

4 Horticultural products

A large number of horticultural crops, including fruits, vegetables, herbs, spices and root crops, are produced for sale as fresh foods. They undergo no processing, sometimes minimal treatment such as washing and cooling, before being transported to markets. Because of their short harvest season, there is often an over-supply that causes prices and incomes to fall. For this reason, some producers dry their crops to add value and extend sales throughout the year. Others mill dried root crops to flours, or fry selected fruits (e.g. banana) or root crops to make snack foods for local sale.

This section describes the packaging requirements of fresh, dried and fried horticultural products. Packaging requirements for dried and milled root crops are the same as for cereal flours, see Section 2.2.

4.1 Fresh crops

After harvest, a number of changes take place to fresh crops: they lose water and begin to wilt or shrivel; fruits continue to ripen; and micro-organisms and naturally occurring enzymes change a crop's colour, flavour and texture. These changes are more rapid if the crop is damaged or infected with moulds or bacteria. The speed of these changes varies with different types of crops and different varieties, but compared to other crops such as cereals, there is a limited amount of time available before they must be sold or processed. This short shelf life means that packaging is only required to contain the crops and prevent damage during transport, storage and sale. If the crops are kept in cold-rooms, they may require packaging to prevent them losing water and shrivelling.

Storage and transport

At harvesting crops should be placed carefully in containers that are also used for storage and transport. This reduces the amount of han-

dling and keeps damage to a minimum. If produce such as vegetables or root crops is dirty, it should be washed before packing and storage.

Produce should not be piled onto lorries for transport. Stackable trays or crates are the most appropriate shipping containers for fruits and vegetables.

It is important that the crates are small enough to be moved easily when full; that the crop cannot be crushed by stacking the crates; and that the crates are strong enough to support the weight of other full crates above them without collapsing. The crates can be made from wood; or plastic (polypropylene) crates may be available. High-value fruits such as avocado or mango intended for supermarkets or for export are packed into crates or cardboard boxes.

The layers of fruit are separated by liners made from paper pulp or plastic that also hold fruits in place or by layers of dried grass or straw. This minimises damage to the fruit during transport.

Harder fruits and vegetables, herbs, spices and root crops are often packed into sacks made from textiles or paper to prevent contamination by dirt and insects.



Figure 6: Stackable fruit trays and crates prevent fruits and vegetables being crushed



Figure 7: Paper pulp liner: separates layers of fruit and keeps the fruits in place

Polythene sacks are generally unsuitable as shipping containers because they do not allow moisture to escape from the crop, which can cause mould growth and rotting. However, sacks that have perforations allow moisture to escape and fresh air to enter. This keeps the produce fresh and prevents mould growth and rotting.

Retail sales

Horticultural products are often not packaged for retail sale, but some supermarkets now pack fruits and vegetables into perforated polythene bags. An alternative is plastic trays covered in cling-film, which are used for fresh herbs and more valuable fruits and vegetables. Root crops are usually sold without packaging, but some supermarkets pack these in perforated polythene bags.



Figure 8: Fresh vegetables in polythene bag

4.2 Dried crops

Drying removes most of the water from horticultural produce to prevent microbial growth and extend the shelf life. The reduction in weight and bulk also makes transport cheaper.

Some dried foods are fragile and require packing in boxes to prevent them from being crushed.

In dry climates, dried foods do not pick up moisture from the air. Packaging is only necessary to contain them and prevent contamination by dirt and insects. In humid climates, some types of dried foods pick up moisture and become mouldy. The stability of dried foods therefore depends on the humidity of the air and the type of food.

Foods that absorb moisture from humid air include dried fruits such as mango or pineapple, and dried vegetables. Dried root crops and some types of dried fruit such as raisins do not easily absorb moisture. This difference determines the packaging requirement for different dried horticultural products.

Moisture proof packaging

Dried fruits and vegetables that absorb moisture from the air should be packed in airtight, moisture proof containers. Some also need protection from light to maintain their colour. Moisture proof shipping containers include steel, plastic or paperboard drums or cardboard boxes that may be lined with polythene.

For retail sale, dried fruits are usually packaged in one of the many different types of plastic film and sealed using a heat sealer. In general, thin polythene film is the cheapest and most widely available material, but it is only suitable for storing dried fruits and vegetables for a short time before they pick up moisture, soften and go mouldy.

Polypropylene has better barrier properties and therefore gives a longer shelf life, but



Figure 9: Moisture proof plastic container, used for spices for retail sales

it is more expensive and it may not be available. Other more complex films, such as laminated films made from polythene and aluminium foil, offer better protection to dried foods, but are more expensive and more difficult to find in developing countries. See also section 8.2 on bags, sachets and plastic films.

Preferably packs of dried foods are also contained in a box or carton. This prevents crushing and excludes light, which can cause loss of colour and development of off-flavours during storage. Cartons may be collated on pallets and stretch-wrapped for distribution.

4.3 Fried chips

Root crops and banana or plantain fruits are also prepared as fried snack foods. Heat during frying destroys enzymes and micro-organisms, and moisture is removed which preserves the foods. The main cause of spoilage is rancidity of frying oil that remains on the product. Fried snack foods are therefore packed in moisture proof, light-proof and airtight containers to give a shelf life of several weeks or months. The most common type of packaging is heat-sealed polypropylene bags. These are contained in cardboard boxes to prevent crushing and breakage of the fragile slices. The boxes also reduce light and heat transmission and so reduce rancidity of oil that remains on the fried foods.

5 Animal products

5.1 Fresh meat and fish

Freshly caught fish and freshly slaughtered meat are highly perishable foods. They require careful handling and packaging to prevent them from rapidly spoiling and losing their value. Spoiled meat and fish can also cause severe food poisoning.

The main factors to prevent spoilage are:

- rapid cooling of the fish or meat
- good hygiene by food handlers
- properly cleaned equipment
- sanitary environmental conditions
- correct type of packaging

Whole carcasses are not usually packaged, but smaller carcasses (e.g. goat or lamb) may be wrapped in muslin cloth to keep them clean. Joints of fresh meat and whole fish should be transported to markets in shipping boxes. These were traditionally made from wood, but wooden boxes are difficult to properly clean and pose the risk of contaminating the food with wood splinters.

Food-grade plastic trays and boxes are more hygienic and are steadily replacing wooden boxes. Fish should be packed with crushed ice in boxes or trays to reduce spoilage during transport to markets.

Because of their short shelf life, fresh meat and fish are usually packaged for retail sale in simple wrappers or bags made from greaseproof paper or polythene. Newspaper wrappers should not be used because the ink can dissolve in meat or fish fats and it is poisonous. Polythene bags may be tied or heat-sealed. In some countries, plastic trays with cling film covering are used for retail display.



Figure 10: Retail display pack for fresh meat and fish

5.2 Dried and smoked meat and fish

Meat and fish can be preserved through the process of drying or smoking. This involves:

- removing water to dry the food
- heating the meat or fish to destroy contaminating bacteria, and/or
- smoking the product to produce chemicals that prevent bacterial growth.

In areas where drying and smoking are traditional on-farm preservation methods, the climate allows the food to remain stable for long periods. In these conditions, provided the food is kept cool and dry, it will not become rancid or mouldy. Only a simple package is required to contain the food and to keep it clean. Muslin cloths are sometimes used to wrap smoked joints of meat. Traditionally, wooden boxes or textile sacks have been used to transport these foods. In many areas these are being replaced by cardboard boxes lined with polythene or food-grade plastic shipping trays or boxes.

Retail containers include paper or plastic bags that are tied, stapled, or sealed with tape or plastic trays that are covered in cling-film.

In areas where the climate is more humid, additional protection is required to prevent the dried or smoked meat/fish from picking up moisture from the air. If the products become moist they can rapidly go mouldy and become unsalable.

The most common type of packaging is heat-sealed plastic bags. Polythene is the cheapest plastic and is suitable for a shelf life of a few weeks. If a longer shelf life is required, polypropylene is a better barrier to air and moisture, and so prevents the products from becoming rancid or mouldy. Bags of smoked or dried products are packed into cardboard shipping boxes to reduce damage from crushing or impacts, and to reduce transmission of light and heat to the products. At larger scales of operation, boxes may be collated on pallets and stretch-wrapped.

5.3 Milk

Like fresh fish and meat, milk is a highly perishable food that requires careful handling and packaging to prevent it from rapidly spoiling or causing food poisoning. The main factors that prevent spoilage are similar to those for meat and fish (i.e. rapid cooling of raw milk and good hygiene by handlers). Milk is also pasteurised by heating it. This gives a slightly longer shelf life provided the equipment is prop-



Figure 11: A small churn used to transport milk

erly cleaned, the milk is processed under sanitary conditions, and the correct type of packaging is used.

Dairy farmers who supply a milk collection centre or a local dairy are often provided with an aluminium milk churn to carry the milk. This is lightproof and prevents contamination of the milk by dirt, dust and insects. It is essential that churns are thoroughly cleaned, sterilised with dilute bleach, and dried before being re-filled with milk.

In some places, raw milk is sold from churns by ladling it into customers' own containers and no retail packaging is involved. In other areas, the simplest packaging is polythene bags that are tied for sale in local markets or shops. Sales of pasteurised milk in more sophisticated urban shops may require packaging in heat-sealed plastic bags or in food-grade plastic bottles, fitted with foil lids or screw caps. Glass bottles are not widely used for milk in developing countries because they are too expensive. In larger production units, plastic bottles may be transported in cardboard boxes or collated in cardboard trays and shrink-wrapped for distribution to retail stores.

5.4 Eggs

Although a fresh egg is highly perishable, it is protected by the egg shell, which prevents loss of moisture and contamination by bacteria, insects, etc. This preserves the egg for several days or weeks, depending on the climate and storage conditions. Packaging is required to prevent damage to the egg shells during transport to markets. Traditionally, baskets lined with straw or dried grass were used. Upgraded packaging uses moulded paper pulp or plastic egg trays that are contained within cardboard boxes. The trays separate individual eggs and hold them in position, while also providing cushioning to prevent damage caused by impacts.

Smaller paper pulp or plastic cartons that contain 6 - 18 eggs are also used for both shipping containers and retail display packs. They are

packed into cardboard or corrugated cardboard boxes to prevent damage from impacts or crushing during transport.



Figure 12: Paper pulp carton for retail sales

6 Honey and syrups

6.1 Honey

Honey is a valuable product that is sold either to domestic customers or as an ingredient for bakeries and other food processors. Honey is not only used as a food, but it also contains medicinal ingredients, some of which are not found in other foodstuffs. In many countries honey is sold in pharmacies, and it is used as a home remedy or in traditional medicine.

When properly harvested and processed, honey is stable for many months due to its low moisture content. Packaging is required to contain the honey and to prevent contamination by insects and, in humid areas, to prevent it picking up moisture from the air..

After harvesting, honey can be packaged straight away as comb honey, cut-comb honey or chunk honey. Alternatively, the honey can be separated from the wax by draining, pressing or centrifuging. The separated honey is liquid, but some types will later crystallise, depending on the types and amounts of different sugars that are present. Crystallised honey is made soft by creaming it, that is, mixing it while it is warm. Honey is not pasteurised and opening the lid does not influence the expiry date.

Shipping containers

Honey is often collected and transported to a processing unit using plastic ‘jerry cans’, which are widely used to hold water. These are acceptable for short-term transport, but if honey is stored for more than a day or two, then stainless steel or food-grade plastic storage tanks should be used. All containers should be thoroughly washed and dried before being re-used. This prevents moisture getting into the honey, which would cause it to ferment and spoil.

Honey is preserved by its low moisture content (below 18%) and packaging is mainly needed to contain the honey and prevent contamination by insects.

Retail packaging

The most common types of retail packaging for honey are transparent glass jars or bottles fitted with screw-caps. Fillers for dispensing honey into jars are described in section 9.2.

If glass jars are too expensive or not readily available, plastic pots are a suitable alternative for honey. Honey can also be packed into plastic sachets that are heat sealed.

The label on a honey jar or bottle may show its origin. This can be the type of flower from which the honey is made by bees, or the area from which it comes. Pictures of flowers, bees, honeycomb or a traditional hive are often found on the label.



Figure 13: Honey in transparent glass jar

6.2 Syrups

Syrups are made by boiling fruit juices or tree saps until their moisture content is low enough to preserve them. They are used domestically as an alternative to honey, or as an ingredient by bakeries or confectionery and ice cream makers. They have similar properties and packaging requirements to honey as described above.

7 Types of shipping containers

This chapter outlines the properties and comparative advantages of different types of shipping containers which are used for different types of foods. Shipping containers, protect the food during transport and storage, and can be of several types:

- 1 boxes, trays, baskets and crates
- 2 sacks of variable materials
- 3 drums, barrels and cans
- 4 Stretch-wrapping and shrink-wrapping

7.1 Boxes, trays, baskets and crates

Cardboard boxes

Corrugated cardboard boxes and cartons prevent damage to foods caused by impacts and compression, and they are therefore widely used to contain bottled or plastic-packaged foods. Boxes that have smaller, more numerous corrugations are more rigid; whereas those that have larger corrugations or double- and triple-wall corrugated materials provide cushioning and resist impact damage.

The size and shape of the box should be carefully chosen so that it prevents the contents moving and becoming damaged during transport. The box design that uses the least amount of cardboard, and so is the most economical, has a ratio of 'length : width : height' of '2:1:2'. Corrugated boxes that are lined with polythene or wax-coated grease-proof paper are used for wet or greasy foods such as fresh meat or fish.

Wooden boxes, trays and crates

Wooden boxes, trays and crates protect foods against crushing, are easy to stack and have a good weight-to-strength ratio. They are widely used to transport fruits and vegetables to prevent damage by crushing.

Plastic containers

Plastic containers (usually high-density polythene or polypropylene) are more easily cleaned for re-use, cannot contaminate foods with splinters, and in some countries may be imported at a lower cost than wooden containers. Because of these advantages they are replacing wooden boxes, trays and crates.

Egg and fruit trays

Moulded trays for eggs or high-value soft fruits are made from paper-pulp, plastic or foamed polystyrene. The shapes are designed to fit individual eggs or fruits and hold them securely during transport and distribution. They are stackable when empty so that they can be re-used.

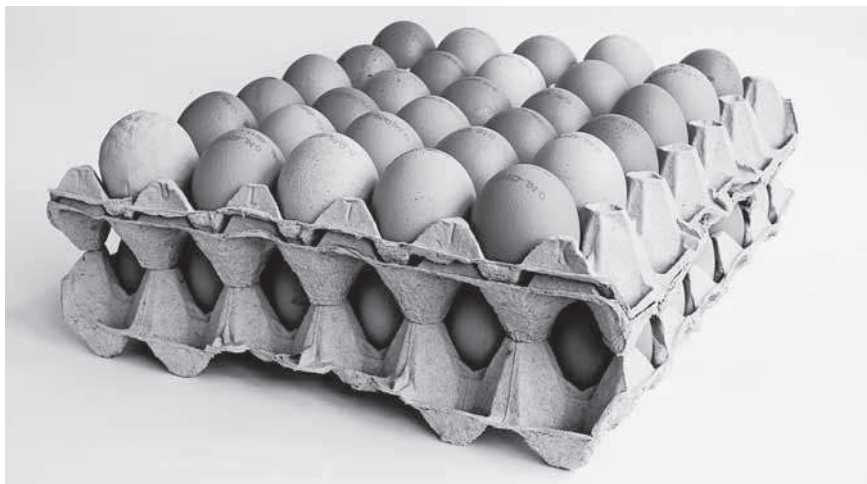


Figure 14: Moulded paper pulp tray for transporting eggs

Baskets

Baskets have a number of advantages: they can be made from locally available plants (itself an income-generating opportunity for farmers); they are lightweight and strong, they are reusable and they are biodegradable. However, apart from protecting foods against damage due to crushing or impacts, they do not extend the shelf life of foods. As a

result they are mainly used to transport fresh crops to markets, or occasionally for retail display of fruits, eggs, etc.

Re-use of containers

Ideally, all types of boxes, trays, baskets and crates should be reusable over many journeys. However, some transporters resist carrying empty containers because they take up too much space, and in practice many containers are used for only a single journey (although they may be re-used for different purposes at their destination). Designing these containers to be stackable when empty means that they take up less space and are more likely to be transported and re-used.

7.2 Sacks

Sacks are made from woven jute, calico (a closely woven, strong cotton fabric), coarse canvas made from fibres of the kenaf or sisal plants, or plastics such as polypropylene and polyethylene. They are used as shipping containers for a wide variety of foods including flours, cereal grains, legumes and root crops. Plant fibres are also made into cord and string, which is used to make net sacks or bags to transport hard fruits.

Textile sacks

Textile sacks are flexible, lightweight and resistant to tearing. They have good durability, and may be chemically treated to reduce rotting, although they remain bio-degradable. Their rough surfaces are non-slip, which makes them easier and safer to stack than plastic sacks. Most textile sacks can be re-used several times after washing to remove old flour or grain, or other contaminants such as grease and oil from transport vehicles. However, they are not waterproof and should therefore be kept covered against rain. They are widely used to transport fresh or dried crops, but in some countries they are being replaced by finely woven polypropylene, high-density polythene, or multi-walled paper sacks.

Polypropylene sacks

Finely woven polypropylene sacks are more water-resistant and hard-wearing, and some types are produced with non-slip properties.

High-density polythene sacks

High-density polythene is a strong, thick (500-gauge) plastic that is a good barrier to air and moisture. Sacks made from this material resist tearing and puncturing, and form a strong seal when heat-sealed to prevent loss of the contents. They are waterproof and may be used instead of paper or textile sacks. However, they can slip when stacked and they are not suitable for fresh crops unless they are perforated.

Polythene sacks are often used to supply fertilisers and other agricultural chemicals and it is essential that these sacks are not re-used to transport foods. Even after thorough washing, the chemicals can remain in the plastic and can taint foods, especially flours and grains that easily pick up off-flavours.

Single- or multi-walled paper sacks

Kraft paper is used for single- or multi-walled paper sacks for grains, flour, fruits and vegetables. They can be re-used several times provided that they are not torn or contaminated by grease, oil, etc., and are usually sealed with a sack-stitcher.

7.3 Drums, barrels and cans

Drums

Imported large (200 litre) steel drums are re-used as shipping containers for oils, although cheaper plastic drums are steadily replacing them. Large paperboard drums lined with polythene are a cheaper alternative to metal drums for dried foods or fatty foods. They are lightweight, resist compression and may be made water-resistant for outside storage.

Plastic drums made from polypropylene or high-density polythene are now increasingly available. Care is needed to ensure that only food-

grade plastic containers are used in contact with foods. Food-grade plastic drums are generally white, but the colour in itself is not a guarantee that the plastic material is a food grade quality.

Barrels

Wooden barrels are no longer widely used as shipping containers for liquid foods and have been replaced by metal or plastic drums for oils. Aluminium churns are used to collect and transport milk to collection centres.



Figure 15: Food-grade plastic drums

Cans

There are few can-making factories in developing countries and the high cost of new cans makes them expensive to import compared to most other containers. They are heavier than plastic containers and therefore have higher transport costs. Small-scale producers therefore generally do not use new metal cans because of these disadvantages and/or lack of availability.

Metal cans that have push-on lids (e.g. tins for milk powder or coffee powder) are re-used to pack dried foods or cooking oils. Similarly, 20-litre cans that have screw-on lids, used for imported cooking oils, are re-used to transport locally made cooking oils. These metal cans totally protect the oil from rancidity and contamination.

7.4 Shrink-wrapping and stretch-wrapping

Stretch-wrapping

The properties of polythene can be altered to make it 'cling' to itself for use as 'cling film' or in stretch-wrapping. In stretch-wrapping, the film is wrapped under tension around boxes on a pallet.

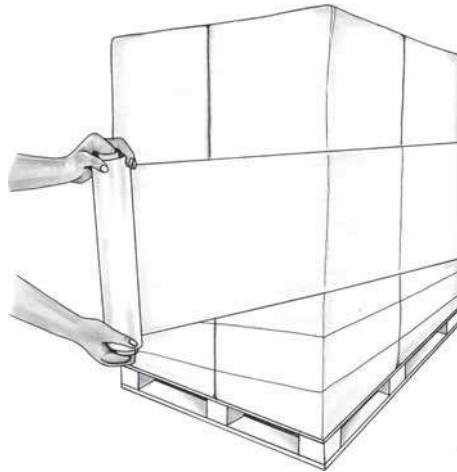


Figure 16: Stretch-wrapping of boxes on a pallet

Shrink-wrapping

Thin polythene film shrinks when it is heated and it is used in shrink-wrapping. Shrink-wrapping of bottles, jars, etc., is replacing cardboard distribution boxes in many countries because it is cheaper. The film is shrunk using hot air, either in a shrink-wrapping machine or by using a hot-air gun or hair dryer.



Figure 17: Shrink-wrapped bottles

7.5 Re-use and recycling of shipping containers

The more expensive shipping containers, including drums, barrels, cans and boxes are usually re-used for many journeys and some may last for several years.

They require careful cleaning and thorough drying between uses. Other types of shipping container, such as sacks, baskets and trays have lower costs and are sometimes made from locally available materials. These are re-used when the cost of transporting empty containers back to producers is lower than the cost of new containers, but being less durable, these are frequently single-journey packages. However, they may find alternative uses to pack non-food items at their destinations.

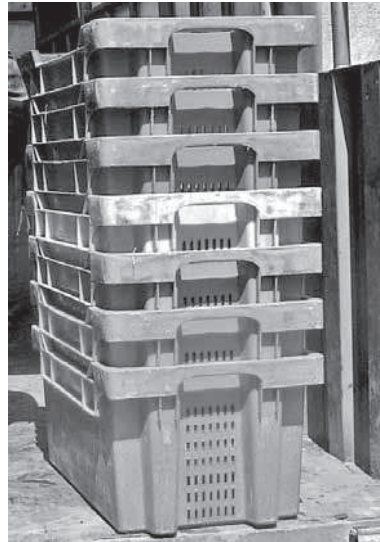


Figure 18: Stackable crates for re-use

8 Types of retail containers

Retail containers are used for retail sales and home storage. There is a wide variety of retail containers that can be used to package products:

- 1 Bags, sachets and wrapping materials
- 2 Bottles, pots and jars
- 3 Cartons, trays and tubs

Specific issues for retail packaging are labelling and tamper-resistance and -evidence. These are described in sections 8.5 and 8.6.

8.1 Choice of packing material

Producers should first find out which types are locally available and then discuss with the supplier(s) the most cost-effective options, taking into account the following factors:

- Is the material suitable to be in contact with a particular food?
- Should it be resistant to fats or oils?
- Should it be a barrier to air or moisture? How much of a barrier is needed?
- Does the material melt at a low temperature, which would make it unsuitable (e.g. for hot-filling pasteurised milk)?
- Are the colour, clarity, and surface finish of the packaging suitable for the intended product?
- Can the material be printed locally?
- Are special filling or sealing machines required for the material?
- Is the material strong enough to prevent damage from impacts or crushing? Is a stronger shipping container needed to protect the packaging material and its contents?
- Can the containers be stacked when empty to reduce transport and storage costs?
- Can the material be re-used or disposed of with minimum environmental pollution?

8.2 Bags, sachets and wrapping materials

Paper bags

Paper bags are made from either 1) strong, brown Kraft paper for holding 0.5 - 5 kg amounts of flour or grains, or 2) weaker white 'sulphite' paper for wrapping smaller amounts of dried foods. Local printing companies can often print paper bags, whereas these printers may be unable to print plastic films.

Wrapping with (treated) paper and muslin

Meats and fish are wrapped in greaseproof paper that is resistant to oils and fats and retains some of its strength when wet. Paper can also be treated with wax or laminated with polythene to make it moisture proof and allow it to be heat sealed. Tissue paper is a soft paper that is used to protect valuable fruits against bruising and contamination by dust. Textile bags are not widely used, but muslin is an open-mesh, light fabric that is used to wrap foods such as smoked meats or small carcasses to keep them clean.

Plastic bags and sachets

Plastic bags and sachets are increasingly common in nearly all developing countries, due to their relatively low cost and good barrier properties to moisture and air. They are heat sealable to prevent leakage of contents; they are lightweight and do not take up much space during



Figure 19: Retail bag of strong brown Kraft paper

storage and distribution; unlike paper, they are strong when wet; and they are easy to handle and convenient for the retailer and consumer.



Figure 20: Dried fruits in polypropylene bags

The main disadvantages are that (aside from cellulose films) they are produced from non-renewable oil reserves, and they are not biodegradable. Environmental pollution caused by discarded plastic retail containers is an increasing problem in urban areas of many developing countries.

See section 9.3 on sealing equipment for plastic bags and sachets.

Plastic films

There is a very wide range of plastic films made from different types of plastic polymers. Each type of film can be made with different thicknesses, strengths and resistance to moisture and air. Some films (e.g. polyester, polythene, polypropylene) can be treated ('oriented') to increase their strength, flexibility and barrier properties. There is thus a very large number of possible plastic films to choose from. Professional advice is needed when selecting a material to ensure that it is suitable for the intended product and the required shelf life. However, as described in the introduction to this booklet, relatively few types of plastic film are likely to be available in most developing countries, or the cost of more unusual films is too high for small-scale processors.

Characteristics and uses of different types of films:

- **Polythene** is the most widely available film, because it is less expensive than most other films. It is heat sealable, inert, odour-free and it shrinks when heated. It is a good moisture barrier, but it is relatively permeable to air and it is a poor odour barrier.
- **Polypropylene** is a clear strong film that resists puncturing and is a moderate/good barrier to moisture, air and odours. It is used in similar applications to polythene. Oriented polypropylene has similar properties but is a better barrier to air, odours and moisture. It is used to pack fried snack foods and dried foods.
- Other single films include **polyester**, **cellulose film** and **cellulose derivatives**, **polystyrene** and **polyvinyl chloride (PVC)**, but these are more expensive and not widely available in developing countries.
- **Coatings** - There are also a large number of films that are coated either with other polymers or with aluminium to improve their barrier properties to oils, air, moisture, odours and light.
- Finally, there are **laminated films** (in which two or more films are bonded together) and **co-extruded films** (where two or more layers of different polymers are extruded together to make a single film). These can be used for fried snack foods, cereals and dried foods, but they are much more expensive than polypropylene and they are not widely used in developing countries.

All films can be supplied as rolls or as sachets in which three sides are heat-sealed. Most small-scale processors use pre-formed sachets because the machine needed to make the sachets and seal them (known as a 'form-fill-seal' machine) is very expensive. When using pre-formed sachets, the producer fills the pack and heat-seals the fourth side with a simple heat sealer.

Printing

In most countries, it is necessary to specify whether any printing is needed on bags, films or sachets when the materials are ordered from the supplier, because local printing companies are usually not equipped to print these materials.

8.3 Bottles, pots and jars

Glass bottles and jars

Glass bottles and jars completely protect foods against micro-organisms, pests, moisture, air and odours. Coloured glass also protects foods against light. Glass does not react with foods and unlike plastic, does not contain chemicals that can migrate into foods. Containers are rigid, which allows stacking without damage, and they are transparent to display the contents.

Glass containers are re-useable (with new lids) but they should be thoroughly cleaned using detergent and preferably sterilised before reuse. Jars and bottles can be sterilised by soaking in dilute bleach and then rinsing them in clean water, or better by heating them. They can be heated in an oven for 10-15 minutes or steam sterilised. Steam sterilisation is explained in Section 9.2.



Figure 21: Glass pot for good protection and display

The main disadvantages of glass bottles and jars are that they weigh more than most other types of packaging, which incurs higher trans-

port costs; the containers are easily broken, especially when transported over rough roads; and there are potentially serious hazards from glass splinters or fragments that can contaminate foods. Glass containers are still widely used for high-value foods such as honey, oils and essences, especially in countries that have a glass-making factory. However, their disadvantages and the high cost of imported containers in other places mean that they are steadily being replaced by plastic containers.

Plastic bottles, pots and jars

Plastic bottles, pots and jars are used for cooking oil, honey and milk. They are made from a number of different plastics, including high-density polythene, polyvinyl chloride and oriented polypropylene. Each material has specific advantages and limitations, and producers should consult packaging suppliers or local agents to find out which is the most cost-effective option for their product. See section 9.3 on heat sealing plastic pots and jars.

Ceramic retail containers

Ceramic retail containers are not widely used because they break easily.

Types of caps

There are a large number of different types of caps available for sealing bottles, jars, pots and tubs.



Figure 22: ROPP cap, Crown cap and screw-on lid

Common caps for glass bottles are the Crown type and the roll-on-pilfer-proof (ROPP) type.

Plastic bottles are sealed manually using screw-on plastic caps. Plastic pots are sealed manually using push-on plastic lids, or a heat sealer is used to seal plastic or aluminium foil membranes.

8.4 Cartons, tubs and trays

There is a wide range of retail cartons, tubs and trays made from cardboard or plastic.

Retail cartons

Cardboard cartons are used to contain smaller packs of foods, to display them on retailers' shelves, and to give protection against crushing during transport.

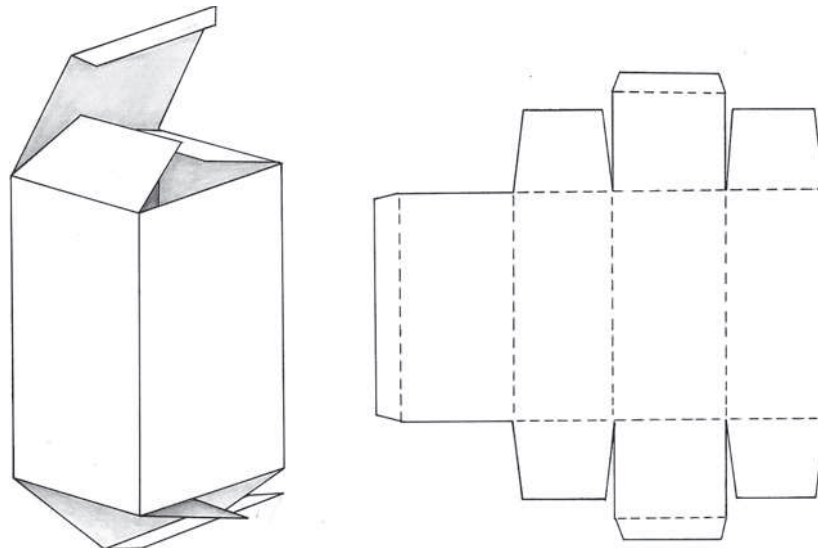


Figure 23: Pre-cut cardboard carton

The cartons can be supplied as flat ‘blanks’ already printed and cut into the correct shape. The blanks are scored along the places to be folded so that they can be easily assembled at the production site.

Tubs and trays

Tubs and trays are tapered (they are wider at the rim than the base) so that they can be easily stacked when empty, thus reducing the space needed for transport and storage. Plastic tubs and trays can be moulded into a wide range of shapes and sizes and they can be coloured to give protection to foods against light. Paperboard tubs and cups are used for example to pack dried foods. Plastic tubs and pots are used for honey, and plastic trays are used for fresh or dried meat and fish. Different types of plastic include high-density polythene, polyvinyl chloride (P.V.C.) and polypropylene. Producers should obtain advice from a packaging supplier to find the most cost-effective type that is suitable for their product.

8.5 A note on labelling

The label gives information to customers about the type of product and how it is used, but it also gives an image of the product to the customer. A well-designed label can give an impression of high quality or exciting taste, whereas a poor label can suggest low quality or a cheap product that is only eaten by people who cannot afford anything better. Producers may wish to have a ‘logo’ to help customers identify their products from those of competitors when on display in shops. However, the package and particularly the label must compare favourably with the others before customers will choose it. In general, a simple image on the label is better than a complex design. The brand name or the name of the company should stand out clearly. If pictures are used, they should accurately show the product or its main raw material.

Colour can be used to produce either a realistic picture (full colour printing) or blocks of one or two colours to emphasise a particular feature. Because labels are so important, producers should invest the

most that they can afford to get the best possible quality, using graphic artists at universities, art schools or in commercial agencies.

Food labelling is a complex area, which cannot be described in detail in this booklet. Professional advice should be obtained from graphic designers who are experienced in label design, or from the local Bureau of Standards or equivalent organisation. In some countries there are legal requirements on the design of the label and the information that is included, with the following being the minimum required in most countries:

- name of the product
- list of ingredients in order of weight
- name and address of the producer
- net weight of food in the package
- a 'use-by', 'best-before' or 'sell-by' date.

The producer may also include:

- any special instructions for preparing the product
- storage information or instructions on storage after opening
- examples of recipes in which the product can be used
- a bar code for sales to larger supermarkets

8.6 Tamper-resistance and tamper-evidence



Figure 24: Examples of tamper evidence for bottles

The main use of tamper resistance/evidence is for bottles, pots and jars that need to be re-closable in order to allow consumers to use the contents a little at a time. Although it is not possible to completely prevent people from opening packs before they are bought, tamper-resistant packaging makes it difficult to open a pack, and tamper-evident packs show whether tampering has been attempted or has occurred. Examples of tamper-evident or tamper-resistant closures are shown in the Table below.

Table 1: Tamper-evident/resistant packaging

Type of packaging	Tamper-evident or tamper-resistant features
Glass or plastic bottles and jars	Foil or membrane seals for wide-mouthed plastic pots and bottles
	Heat-shrinkable plastic sleeves for bottle necks, or bands or wrappers placed over lids. Perforated plastic or paper strips that must be cut or torn to gain access
	Breakable rings or bridges to join a bottle cap to a lower section (the container cannot be opened without breaking the bridge or removing the ring)
	Roll-on pilfer-proof (ROPP) caps for bottles (during rolling, a tamper-evident ring in the cap locks onto the bottle neck. A seal breaks on opening and the ring drops slightly)
	A breakable plastic strip that shows if a jar has been opened
Flexible films	Film must be cut or torn to gain access
Metal cans with re-closable lids	Paper strip glued across lid or plastic strip around lid - both must be broken to gain access.

8.7 Re-use and recycling of retail containers

Re-use

The only types of retail container that are routinely re-used are glass bottles and jars, which should be fitted with new caps each time they are re-used. Glass is expensive and in some countries larger food companies, such as breweries and soft drinks manufacturers, have collection systems in place to return empty glass containers. In other countries, informal collection and resale operations exist to supply small-scale producers with bottles and jars.

Glass containers must be thoroughly cleaned and sterilised before being re-used to package foods because they may have been used in the home for temporary storage of other materials, including poisons such as pesticides or kerosene. Glass jars and metal containers are also re-used in some countries for a number of non-food applications, including making them into kerosene or oil lamps, or handicrafts and toys.

Recycling of packaging materials

Recycling of packaging materials to make new containers is underdeveloped in most countries for two reasons: first there are few packaging manufacturers in developing countries, and so the demand for recycled material is small; and secondly, there are not systems in place to collect, clean and sort used packaging materials to supply pure raw materials that are suitable for making new food-grade packaging.

The exception is glass-making, and in countries where a glass factory exists there is usually a system in place to collect used containers and broken glass to mix in with newly-made glass. Metal from steel or aluminium cans is valuable and may be collected for recycling, but few developing countries have can manufacturers and the metal is then recycled into other uses. Similarly, paper may be re-used as food wrappers for dry foods but its collection for recycling into new food containers is not developed because there are few papermaking factories.

Of the many different types of plastics, the only one that is currently suitable for recycling into new food containers is PET (used to make soft drinks bottles in industrialised countries but less common in developing countries). Other plastics cannot yet be recycled into food containers and the difficulties of separating the different types of plastic mean that there is little use for them. A variety of suggested uses to avoid putting them in landfill dumps, including incineration in power stations and using them to make furniture, kerbstones or rubbish bags, has yet to be established in developing countries.

9 Filling and sealing

This chapter deals with several filling and sealing machines or equipment. First the filling and sealing of shipping containers is described: sacks, boxes and stretch and shrink wrapping. Second the filling and sealing of retail containers is described: bags and sachets, bottles, pots and jars.

9.1 Filling and sealing of shipping containers

Bagging machines

Grains and flours are packed in sacks that are sealed and used as shipping containers or for bulk sales. Smaller paper or polythene bags are used for retail sales. Most small-scale millers fill bags and sacks by hand and then check the filled weight on scales.

However, this is time-consuming and faster filling can be achieved using a manual bagging machine. Flour is released from a hopper into a weighing section, which is adjustable for different fill-weights. The correct weight is then dropped into the bag or sack. Typically a machine can fill and weigh bags in the range of 0.5 – 10 kg. Larger machines are available to fill 50 kg sacks.

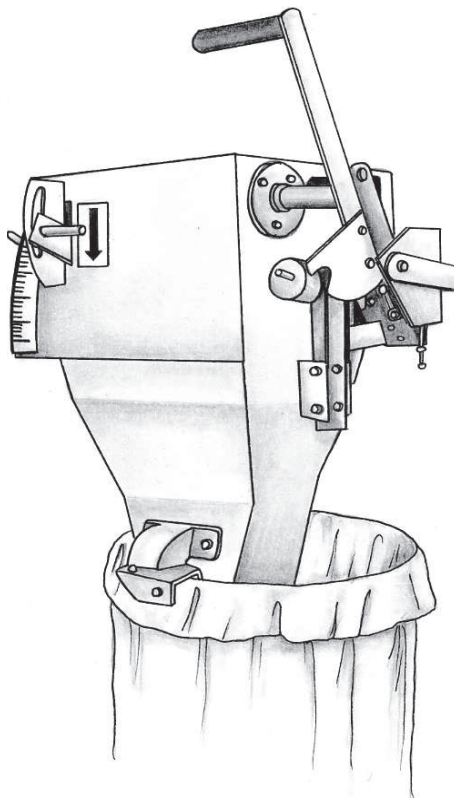


Figure 25: Small bagging machine

Sack-stitchers

At small scales of production, sacks are hand-stitched, but an electric sack-stitcher is more commonly used at higher production rates. The machines sew a double layer of stitching across the top of textile or paper sacks to seal them.

Carton sealers

Cardboard cartons or boxes that contain packaged foods are usually sealed with either glue or adhesive tape. Simple tape dispensers are available, which make carton sealing faster and more efficient.

Stretch-wrappers and shrink-wrappers

In stretch-wrapping, thin polythene film is wrapped under tension around boxes on a pallet. The dispensing equipment for the film is simple and low-cost.

Thin polythene film shrinks when heated by either hot air or a radiant heater. Bottles, jars, etc., that are to be shrink-wrapped are placed on a cardboard tray and covered with film. The film is then heated and shrinks around the containers. Alternatively the film can be shrunk using hot air from a hair dryer or similar hot-air blower.

Shrink-wrapping machine

The food to be shrink-wrapped is placed in the chamber of the machine and the film is pulled over it. When the lid is lowered, the film is cut and heated to shrink it over the food.

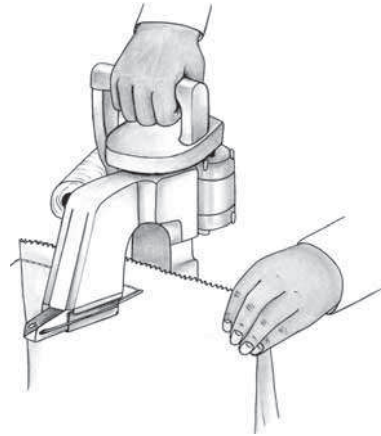


Figure 26: Sack stitcher

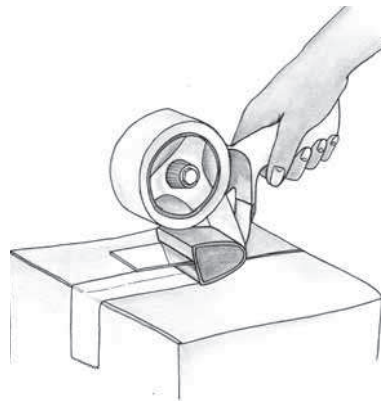


Figure 27: A tape dispenser is an easy tool to seal cardboard boxes

For more information on purchasing a shrink-wrapping machine: see Useful Addresses

9.2 Cleaning and filling of retail containers

Steam steriliser for bottles and jars

Re-used glass jars and bottles require cleaning with detergent, rinsing with clean water and then sterilising. One method to sterilise containers is to invert them over a steam pipe, connected to a steam generator. Steam is fed from the boiler through a rubber hose, supported on a stand. Bottles and jars are inverted over the pipe using tongs or thick gloves to hold the container. The heat of the steam kills micro-organisms.

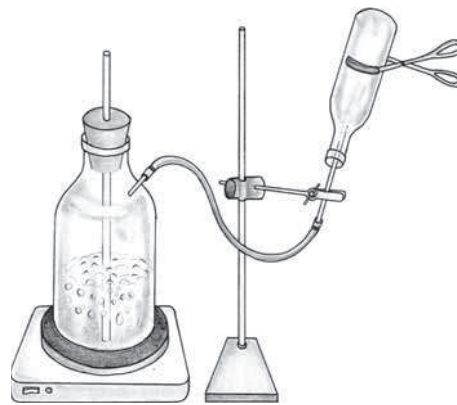


Figure 28: Steam steriliser

A steam steriliser can be constructed locally from a suitable glass or metal can to make a water boiler, with a long pipe fitted to the top to act as a safety valve

Liquid fillers

Liquids can be either thin, such as milk, or thick (viscous) such as honey. No one type of filling machine is suitable for all types of liquids. The selection of suitable equipment depends on the thickness (viscosity), temperature and presence of particles in the liquid, and whether the liquid foams during filling. Different sizes of equipment are also available depending on the production rate required.

Manual filling

The cheapest and simplest method of filling liquids is to use a jug and a funnel. This is a useful way for filling viscous (thick) liquids but this is often too slow for low-viscosity (thin) liquids. A rod is used to stop the flow of liquid when the container is full.

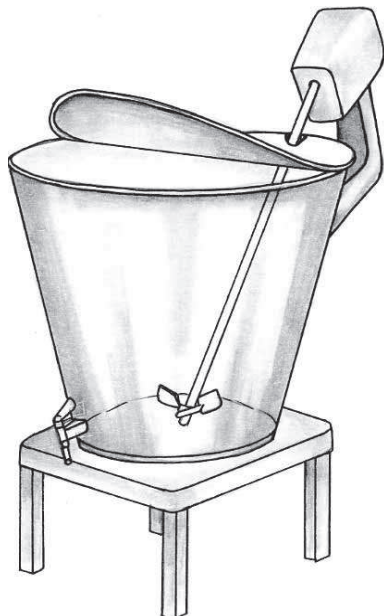


Figure 30: Manual liquid filler for thin liquids, made of bucket with taps



Figure 29: Filler for thick liquids

A simple manual filling machine for thin liquids can be constructed locally by fitting taps to the base of a large stainless steel or food-grade bucket or tank. A stirrer is optional and more than one tap can be fitted to the stainless steel/plastic bucket.

The taps should be 'gate-valve' types and not domestic water taps, which are more difficult to clean. Operators should be trained to ensure that the same volume is filled into every container.

Dispensing machines

Dispensing machines ensure that the same volume is filled into each container and so do not rely on the judgement of an operator.

Two types are shown below: The liquid dispenser and the gear pump filler.

Liquid dispenser

The **liquid dispenser** has a 3-way valve. In the first position the liquid fills a chamber in the dispenser from a tank above. When moved to the second position, the valve empties the food into the container. The volume of liquid in the dispenser can be adjusted to fill different sized containers.

Other types of liquid dispensers have a moving piston to pump viscous products such as honey into the container, rather than allowing them to drain by gravity.

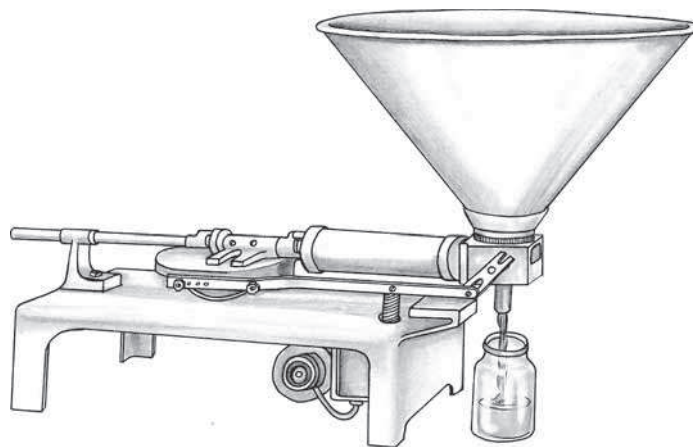


Figure 31: A liquid dispenser

This electric machine has a piston that moves backwards and forwards inside the horizontal cylinder. Liquid from the hopper is drawn into the cylinder by the piston and a valve then moves so that it is pushed into the container when the piston returns. The volume of liquid in the cylinder can be adjusted for different sizes of container.

Gear pump filler for viscous liquids

A gear-pump filler can be adjusted to dispense viscous liquids at pre-set volumes from 20 - 999 ml. It has an anti-drip outlet that prevents food contaminating the sealing area of the container. Two plastic gear wheels rotate towards each other and pump the viscous liquid from the hopper into a container below. The time that the gear wheels operate can be adjusted to fill different sizes of containers. For more information on purchasing a gear pump filler: see Useful Addresses

9.3 Capping and sealing equipment

Different types of caps for sealing bottles, jars and pots are described in section 8.3. Each type of cap has its own equipment to fit it:

Crown caps

Small manually operated capping equipment is available for Crown caps. The Crown cappers flatten the edges of the cap around the lip of the bottle to hold it in place. Two crown cappers are shown below.



Figure 32: This simple crown capper is placed on the cap and hit with a hammer to bend the cap over the rim of the bottle.

ROPP

A roll-on-pilfer-proof (ROPP) cap is shown in figure 19. ROPP cappers force the metal cap into the thread of the glass bottle, thus forming a thread in the cap. The bottom of the cap is perforated so that it breaks when the cap is opened, leaving a ring of metal around the neck of the bottle. This is used to indicate whether the bottle has been opened.

Plastic bottles are fitted with plastic caps by hand, by screwing the cap onto the bottle.

Corking machines

Corking machines simultaneously squeeze the cork to reduce its diameter and insert it into the neck of the bottle. A bottle is placed on the platform and a cork is inserted into the hole in the upper part of the machine. When the handle is pulled down, a mechanism squeezes the cork to make the diameter smaller and the spike pushes it into the bottle. The cork then expands in the bottle to make a tight seal.

Capsule sealer for bottles

A capsule sealing machine heats plastic capsules that are used as tamper-evident seals on bottles. A bottle is placed on a tray with a capsule placed over the neck of the bottle. The thermostatically controlled heater then shrinks the capsule onto the bottle.

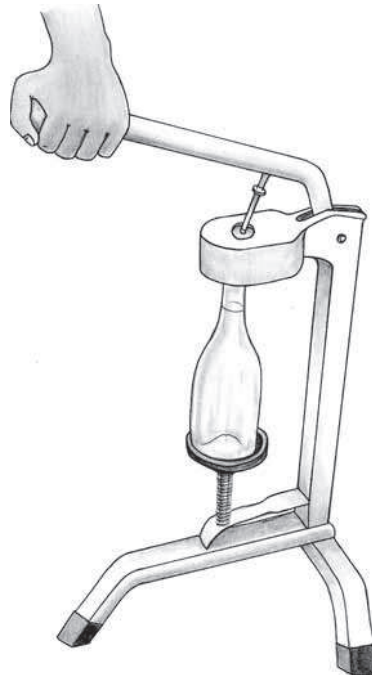


Figure 33: Corking machine

Heat sealers for plastic pots

Plastic pots are sealed using either a push-on plastic lid, or a plastic or aluminium foil membrane that is heat sealed. Manually operated electric heat sealers are available, or an electric iron can be fitted to a drill-stand as a cheaper alternative. The heater is lowered onto the pot with the membrane in place and pressed down for sufficient time for the seal to form.



Figure 34: Sealing foil lids with a domestic iron

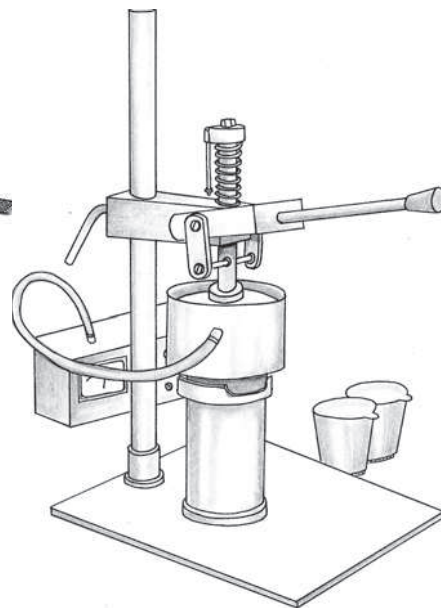


Figure 35: Electric pot sealer

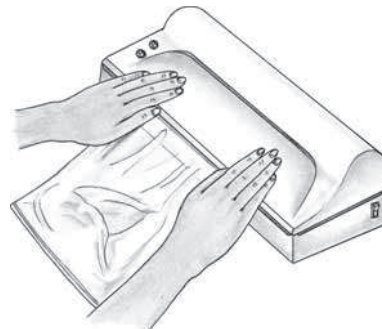
Heat sealers for plastic bags and sachets

These machines seal the open end of plastic bags, sachets or sacks, by pressing the two surfaces of the film together and heating them until they partly melt. The pressure then welds the two layers of film together. The strength of the seal depends on the temperature, pressure and time of sealing. Hot-wire sealers have a metal wire that is heated to red heat to both form a seal and cut the film, whereas a bar sealer holds the two films in place between heated jaws until the seal is

formed. A relatively wide seal (3-5 mm) is required for packing dried and liquid foods and for this bar-type sealers are preferable to wire-types. It is important that foods do not stick to the inside of the pack where the seal is made because this would prevent a proper seal from forming or reduce its strength.

Sachets can be made by buying film in the form of a tube and cutting it to the correct length. Alternatively, flat film can be cut to the correct size and sealed along the long side to make a tube. The base of each sachet is then sealed before filling and then the top seal is formed.

If electricity is not available, it is possible to seal plastic bags by folding the film over a used hacksaw blade and welding it with a flame. However, the quality of the seal is variable and less attractive than using an electric heat sealer.



An impulse sealer clamps the films between two cold jaws, and then heats them. After the films have been welded together they remain in place until the seal cools and sets.

Rotary (or band) sealers are used for higher production rates. A continuous belt passes the sachet or bag between heated rollers that press and weld the two films together.

Bags of food are placed on the conveyor. As each bag moves through the machine the open end is pressed against a metal band by heated metal rollers to make a seal. The temperature of the rollers, the pres-

Figure 36: Electric heat sealer. The sealer has thermostatically controlled heated bars. A bag is placed between the bars and when the handle is pulled down the heater operates for a pre-set time to seal it. Both the temperature and time of heating can be adjusted for different types of plastic.

sure and the speed of the conveyor can each be adjusted for different types of plastic.

For information on purchasing electric heat sealers: see Useful Addresses.

Tape sealers for plastic or paper bags

Small manual machines are available to seal retail plastic or paper bags with adhesive tape. The bag opening is twisted and passed through the machine where the tape forms a seal around the bag, sticking to itself.

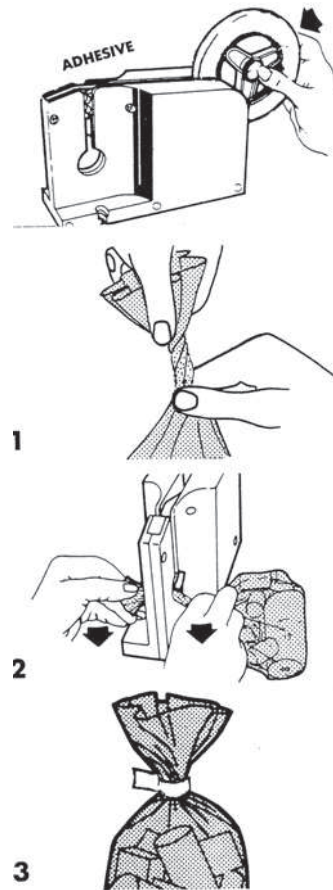


Figure 37: Sealing bags with tape: 1) the bag is twisted, 2) the twisted end is pulled through the machine and the self-adhesive tape wraps around it, 3) the sealed bag.

9.4 Ensuring minimum fill-weight

Scales are used to ensure that the minimum fill-weight is achieved. Scales can be either mechanical or electronic. When mechanical scales are used, the heaviest empty container is used to ensure that the minimum fill-weight is achieved by placing the container on the right-hand scale with a weight that is the same as the intended fill-weight. Electronic scales can be 'tared' with the maximum container weight.

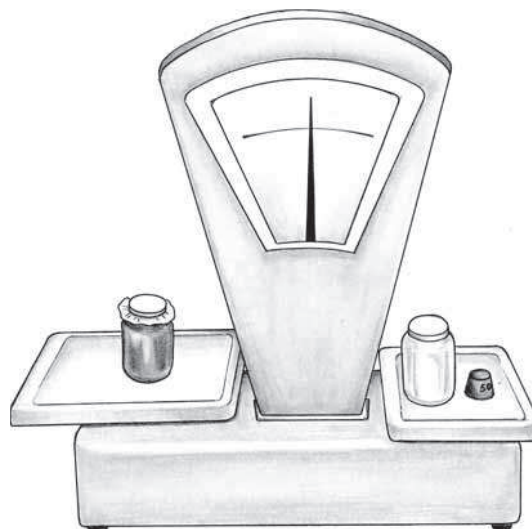


Figure 38: Mechanical check-weighing scales. An empty jar or bottle, together with a weight that equals the amount of food in the container, is placed on the right platform. A filled jar or bottle is placed on the left platform and the scale shows whether it is over-weight or under-weight.

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Useful addresses

Packaging suppliers

A comprehensive list of worldwide packaging suppliers and support institutions is provided by Packaging International at: www.packaging-int.com/companies/

Agents for packaging companies in a local capital city are the best source of information on what is available locally. Websites of packaging manufacturers provide technical information on the range of products that they produce:

- Glass container information from Johnsen and Jorgensen, available at www.jjpack.com
- Metal container information from the Can Manufacturers' Institute, available at www.cancentral.com/toc.cfm. Further information on metal cans is available through the Metal Packaging Manufacturers Association at www.mpma.org.uk
- Information on paper and polythene food packaging from packaging2u, available at www.packaging2u.co.uk
- Information on polypropylene packaging from Total Petrochemicals, available at www.totalpetrochemicalsusa.com

More specific information can be obtained from:

Asian Packaging Federation, c/o Sri Lanka Institute of Packaging, 290, D.R. Wijewardena Mawatha, Colombo 10, Sri Lanka,
E: slip@sltnet.lk

Ghana Institute of Packaging, PO Box 2234, Tema, Ghana,
T: +233 20 81906867, E: iopghana@yahoo.com, W: www.iopg.org

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Technology Manuals, available at: www.unido.org/index.php?id=7710
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E: iaenvase@infovia.com.ar , W: www.packaging.com.ar
World Packaging Organisation, c/o STFI-Packforsk, Box 5604, S-
114 86 Stockholm, Sweden, F: +46 8 4115518,
E: info@stfi.se, W: www.packaging-technology.com/wpo/
Zimbabwe Association of Packaging, 17 Coventry Road, Working-
ton, Harare, Zimbabwe, T: +263 4 753 800, F: +263 4 882 020.

Glossary

Aflatoxins	Poisons produced by moulds in grains, nuts and pulses, which can cause liver damage, cancer and other illnesses. They can't be seen or tasted in foods. Moulds prevention is therefore essential in grains, nuts and pulses.
Barrier properties	Resistance of packaging material to moisture, air, light, micro-organisms or physical damage (crushing or puncturing).
Biodegradable	Breaking down of material, due to the natural action of micro-organisms, water, light or air.
Contamination	Materials such as dirt, wood or glass splinters, micro-organisms, etc., that are accidentally included with a food.
Enzymes	Natural proteins in foods that can change the colour, taste, texture or nutritional value of the foods.
Fill-weight	The weight of food placed in a package (also net weight).
Hazards	Influences such as heat, light, crushing or micro-organisms that can damage a food.
Heat seal	Two layers of plastic film melted together.
Humidity	The amount of moisture in air.
Impermeable	Prevents the passage of fluid or air (e.g. a film is impermeable to air if it prevents air from passing through it).
Laminate	A package made from two or more materials that are glued together.
Micro-organisms	Very small creatures that are invisible until large numbers are grouped together. Different types include bacteria, yeasts and moulds.
Paperboard	A general name given to different types of cardboard.

Polymers	A polymer is a large molecule (macromolecule) composed of repeating structural units. While polymer in popular usage suggests plastic, the term actually refers to a large class of natural and synthetic materials with a wide variety of properties. (from wikipedia) The term 'oriented' refers to the way the molecules are aligned.
Polyethylene/polythene-	is the cheapest type of plastic film in developing countries. It is widely used to package foods. It stretches and also shrinks when it is heated, and so it is also used for stretch-wrapping and shrink-wrapping. High-density polythene is a strong, thick (500-gauge) plastic that is a good barrier to air and moisture.
Polypropylene	looks similar to polythene but it is a stronger, clearer film and a better barrier to moisture and odours. It does not shrink like polythene. It is becoming more widely available, although it is usually more expensive.
Polyvinyl chloride (from 8.3)	P.V.C. is rigid plastic, which can be made flexible by certain treatment. In packaging it is used for boxes and bottles, and other uses where strong plastic is required.
Rancidity	Development of off-flavours in fatty foods that result in spoilage.
Retail container	A container that is used for retail display and home storage (also called a consumer unit).
Shelf life	The length of time a product can be stored before changes to its flavour, colour or safety make it unacceptable to consumers.
Shipping container	A container that protects foods or smaller containers during transport and distribution.
Shrink wrapping	Making thin polythene film shrink tightly around other packages when it is heated.

Stretch wrapping	Using special polythene film that sticks to itself but not to other packages or foods to tightly wrap other packages (also called cling film).
Tamper-proof or tamper-evident	A device on a package that resists opening the pack or shows whether an attempt has been made to open it.
Viscosity	The "thickness" of a liquid or the resistance to flow. Thus, water is "thin", having a lower viscosity, while honey is "thick", having a higher viscosity