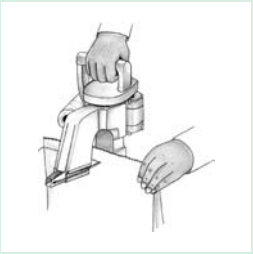
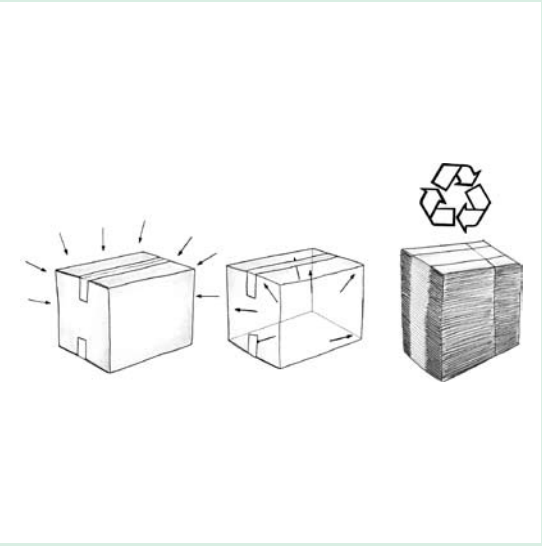
Agrodok-series No. 50

Packaging of agricultural products





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Agrodok 50

Packaging of agricultural products

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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.

I would like to thank the following people for their contributions to the production of this Agrodok booklet: Marieke Mutsaers for information on honey, Roy Keijzer of Agromisa Foundation, Piet Scheepens and Barrie Axtell for critically reading the booklet, Catharina de Kat-Reynen for editing the text, and Marinette Hoogendoorn-Meijer for the new illustrations.

Peter Fellows

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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 unpackaged 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, micro-organisms 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.

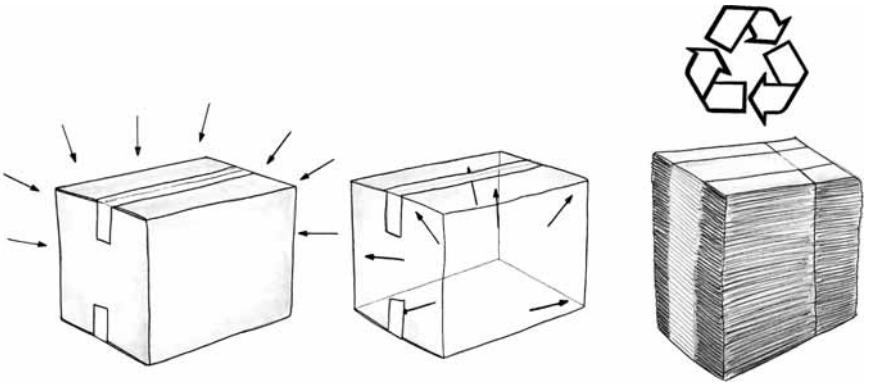

Figure 1: Protecting, containing and disposing

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% × 250 fruits × 3 times per month × 4 months × 2 seasons × 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)
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