OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

17428

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.484/2(SPEC.)
14 March 1989

ORIGINAL: ENGLISH

Global Preparatory Meeting in Preparation of the Consultation on the Food-Processing Industry with Emphasis on Fruit and Vegetable Processing

Vienna, Austria, 2-5 May 1989

PACKING MATERIALS AND TECHNOLOGIES AND SOME MARKETING ISSUES FOR THE FRUIT AND VEGETABLE PROCESSING INDUSTRIES*

Background Paper

Prepared by

Károly Lotz**

---

*The views expressed in this document are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO.

**Deputy Director, Institute for Packaging and Transport of Materials, Budapest, Hungary.

V. 89-52941
5499T

CONTENTS

Annexes

Tables

INTRODUCTION

1. Of the total world fruit crops, nearly 60 per cent come from subtropical and an additional 25 per cent from tropical zones. Citrus fruits are the most important species for the developing countries. They had a share of 50 per cent in the 1980 world crop, and this will probably be increased to 56 per cent in the 1990s. Some 95 per cent of tropical fruits are cultivated in developing countries.

2. Only 15-20 per cent of the fruit and vegetables from the developing countries are exported in preserved (processed) state, and juices represent 22-27 per cent of these exports. This amount is higher in Latin America, where the rate exceeds 30 per cent, 90 per cent of which is in the form of concentrated juices. In the last few years, the rate of processed produce has shown an increase owing to the increase of juice exports. The average rate of processing of genuine tropical fruits does not reach 5 per cent.

3. Immense losses and spoilage are caused by unsatisfactory handling, transport, storage and packaging methods in the developing countries. According to a study prepared by the Food and Agriculture Organization of the United Nations (FAO), losses are estimated at 40-45 per cent.

4. Packaging plays an important role in reducing losses and in increasing the processing rate and export volumes. The modernization of packaging, however, falls behind the required level in the developing countries.

5. The processing and packaging technologies for fruits and vegetables are interdependent: processing technologies determine the development of packaging and vice versa. While traditional heat-treating methods continue to play a leading role in the developing countries, new preservation and packaging techniques, which make it possible to maintain the original flavour, vitamin and ingredient content of the produce to an increased degree, are increasing. These new technologies (e.g. aseptic packing) are of importance in export trade.

6. Mechanization should facilitate the establishment of multi-purpose technologies instead of very specialized ones. Multi-purpose technologies make it possible for different kinds of processed fruits to be packed, using various techniques, into different types of packaging depending on consumer demands.

7. The degree of mechanization and automation should be based on economical considerations. High-scale and expensive mechanization is not worthwhile unless it is indispensable for the safety of production and the quality of finished products or it is needed to meet export packaging requirements (i.e. aseptic sealing of metallic cans or glasses as well as body welding). A number of operations (filling of packaging) can be performed manually; under certain conditions, it may be desirable to give preference to manual operations.

8. With regard to packing materials and packagings, it is advisable to continue to use tin cans, possibly with electrolytic, differentiated tinning and with a welded seam. Tin cans processed in this way meet hygienic safety requirements. Other advantages of tin cans are that their size limits are ample, the cost involved is not excessive and they are endurable under adverse transport and storing conditions. Depending on local circumstances, sources of purchase and product properties, aluminium and glass packaging can also be used, as could plastic packaging and plastic-metal-paper combinations that are coming into use along with new preservation technologies.

9. Economic efficiency analyses should be carried out before a developing country wishing to export its fruit and vegetable products decides on the extent and the form of processing and packaging. If the decision is to process and export semi-finished products, the investments and packaging material and transport costs can be reduced and processing can be carried out with less skilled labour. The investments involved in consumer packaging technology involve more risk, higher expenses and more professional skill, but in favourable cases more profit can be expected. Calculations should always be made based on a given situation, considering the advantages of international co-operation as well.

10. Exporters in developing countries encounter tariff and non-tariff barriers to both products and packagings, the former usually in the form of import duties or domestic taxation. In the developed countries, packaging regulations on the protection of environment, on food compatability or dosages etc. are increasing. Such problems as the migration grade, the recollection or recycling of packaging or the decomposition of packing materials require new experience and more information on regulations in importing countries.

11. It is highly advisable that developing countries should maintain close contacts not only with the FAO/WHO Codex Alimentarius Commission and the General Agreement on Tariffs and Trade (GATT) but, first of all, with government offices in the importer countries in order to get up-to-date information. It is expected that by 1992 the unification of requirements of the European Economic Community (EEC) will lead to a uniform system of packaging requirements.

I. BASIC CHARACTERISTICS AND PACKAGING OF FRUIT, VEGETABLES AND SPICES

12. The present study deals with the fruit and vegetables that can be cultivated and produced economically under tropical and subtropical climatic conditions.

A. Fruit

13. The consumption of tropical fruits has increased significantly in the last 10 years, owing to their variety, flavour, aroma and attractive colours as well as the nutritive value and vitamin content of some of them (see annex I). Consumers have shown interest not only in the fresh produce but also in processed and preserved products made from tropical fruits. Fruit juices and concentrates are the first on the list, but compotes of whole fruit or chunks (slices, dices), jams condensed from the sieved fruit flesh by cooking as well as dried or lyophilized products preserved by dehydration are playing an increasingly important role in the world market.

14. Although only a small part of the world fruit crop, about 15 per cent, is exported, fruits represent a considerable share of the export volume of several developing countries (bananas, for example, account for 50 per cent of the exports of Honduras and Panama).

15. There are several hundred tropical and subtropical fruit species and subspecies. The selection of the fruits dealt with in this study is based on the following:

(a) The priority list accepted by the Codex Committee on Tropical Fresh Foods (a subcommittee of the FAO/WHO Codex Alimentarius Committee) at its first session held in Mexico in June 1988. The Committee recommended the elaboration of world standards for the following fresh tropical fruits: pineapple, mango, papaya, passion fruit, carambola, guava, litchi, mangosteen and banana;

(b) The share of certain fruit crops in relation to the world fruit production (see annex II). The following fruits are also included: grape, citruses, avocado, cherimoya, date and fig.

16. Annex II also shows the classification of fruit species according to climatic zones. About 57 per cent of world production is in the subtropical areas. Citrus production is shown in annex III, and yields of some fruit species are shown in annex IV. In addition to the fruits listed, many other tropical fruits are cultivated in relatively small quantities, such as kiwi, Japanese persimmon, carambola, tree tomato and mangosteen.

17. Basic characteristics of the fruits are given in annex V. This can serve as a basis for choosing the most appropriate and economical processing technology. A list of the most important fruits and the most common methods of processing them are shown in annex VI.

18. The most important processed fruits are packed as follows:

(a) Compotes made from whole or chunks of fruit are packed in metal cans or jars and are ready for direct consumption;

(b) Chunky or sieved semi-finished pulps that are sterilized for further jam processing are packed in boxes, aseptic barrels or sacks;

(c) Marmalades and jellies are packed in jars or plastic packages;

(d) Natural and concentrated juices are packed in bottles, aseptic barrels or combined packagings;

(e) Fruit powders are in boxes or plastic packages.

B. Vegetables

19. The nutritional substances contained in some of the most important vegetables are shown in annex VII.

20. Vegetables are mainly preserved using condensation, acidification (fermentation), drying (lyophilization) and heat treatment in liquor. Packaging methods depend on the type of preservation: metal cans are used for tomato concentrates or, for aseptic technologies, barrels can also be used; acidified or heat-treated vegetables are packed in metal cans or glasses or, by aseptic technologies, in boxes manufactured from combined materials; and dried foods are packed in sacks made from plastics or aluminium foil.

C. Spices

21. Mustard-seed, pepper, paprika, chili, garlic, fennel, ginger and vanilla represent the majority of tropical spices. Their cultivation and processing are very labour-intensive.

22. Drying is the most widely used spice-processing technology, followed by cleaning, sorting and milling. The packaging of spices does not differ from that of other dried products. Some spices (such as mustard and pepper) are sold in consumer packaging (glass, box or tube).

23. The essential oils of some spices can be obtained by distillation; these oils are used in the food, cosmetic and pharmaceutical industries. The extraction of oleoresins has been introduced to satisfy the requirements of the food industry. There are also other methods, such as the oil extraction of spices and their compounds together with additives (salt, sugar, gum arabic or gelatine) and capsuled, dosed spice products.

II. STORAGE, PROCESSING AND PACKAGING TECHNOLOGIES AND PROBLEMS

24. In order to keep the rich nutritional and flavour value of the fruits and vegetables produced in the tropical and subtropical areas, careful storage, advanced processing technologies and suitable packaging methods are required.

A. Storage for processing

25. Tropical fruits and vegetables, because of their significant sap and sugar content, are inclined to both enzymatic and microbiological deterioration. Therefore the conditions for storing and transporting fresh fruits and vegetables to the place of processing must be chosen with special care.

26. The first condition for successful storage is careful harvesting at the required stage of ripeness; care must be taken to minimize mechanical bruises and contusions and, subsequently, damaged or rotten items must be sorted out. The crops destined for export or high-quality processing must be undamaged, defectless and at the same stage of ripeness.

27. The conditions for storing and transporting fresh fruits and vegetables are the following:

(a) Airy storerooms or transportation facilities, protected at least against direct heat or light (sunshine);

(b) For perishable produce, closed, air-conditioned storerooms;

(c) Convenient packaging (wood, corrugated cardboard, cases, wooden or plastic crates).

B. Processing and packaging technologies

1. Dried products

28. Drying is one of the most ancient and simple preservation methods. In principle, drying is dehydration which should be carried out such that neither the flavour nor the nutritional value suffer any change. The dried product should keep its water-absorbing (swelling) quality. The tropical and sub-tropical crops that are most commonly preserved by drying are figs, dates, grapes, Japanese persimmon, mushrooms, onions and spices.

(a) Drying techniques

29. The most simple way of drying is in the sun. When drying equipment is used, indirectly heated dryers are advisable.

30. Juices, purées and semi-finished products (orange juice powder, tomato pulp etc.) are dried through vaporization. The equipment transforms the liquid into a fine, mistlike spray; heat of the air causes the water to evaporate. This process protects quality, and the powder regains its original juice form when water is added to it.

31. The drying method that protects quality most effectively is freeze drying (lyophilization). The produce to be dried is frozen, and the water content that has turned to ice is sublimated under a high degree of depression (0.01 Hgmm). Fruits or vegetables dried in this manner retain their original shape. The water content of dried produce is reduced to 2-4 per cent, but it regains its original level when water is added.

(b) Packaging dried produce

32. Dried fruits and vegetables are very absorbent, especially in sliced form. They should therefore be packed in packages that are damp-proof, moisture-resistant and hermetically sealable. A wide variety of packaging materials (such as paper combined with aluminium foil or plastics) can be used.

33. Heat sealing is used to close bags made from the above-mentioned materials. This process can be manual (a prefabricated, hand-fed and mechanically sealed package) or fully automatic, with the material wound on a reel. The surface of the bags can easily be impressed, making the content look attractive.

34. Fruit and vegetable powders can be vacuum packed into cans (made from tin plates or aluminium). Lids should be provided so that the cans can be reclosed.

35. Damageable products (such as lyophilized foods) can be satisfactorily protected by a protective gas atmosphere. The use of inert gases such as

nitrogen and carbon dioxide extends the time of consumption. A mechanized technology is needed for this operation.

36. These processing and packaging methods satisfy the requirements of export markets and enable producers to realize foreign exchange returns, although they require major investment and professional skill.

37. The chunk or milled products (such as fig, date, raisin and some spices) do not require vacuum packing and can be packed in cans, combi-boxes or paper and plastic bags. The packing of dried products should be carried out in dry and, if necessary, air-conditioned premises.

2. Heat-treated products

38. Heat-treatment preservation is necessary when the produce in question do not contain any preservatives and their chemical composition facilitates the growth of micro-organisms (moulds, yeast-fungi, bacteria). Heat-treatment below 100 °C is called pasteurization and above 100 °C sterilization.

39. Heat-treatment parameters (temperature, length of time) have to be chosen according to the characteristics of the particular fruit or vegetable. As a general rule, acidic produce (below 4-4.5 pH value) have to be pasteurized while non-acidic produce (above 4-4.5 pH value) have to be sterilized. Compotes or tomato products are heat treated at a temperature of up to 100 °C while a temperature exceeding 100 °C is required for the heat treatment of all canned vegetables with a high protein content (sugar peas, string beans, egg-fruit, artichoke, bamboo-bud).

3. Juices

40. Juices can be obtained from coloured, loosely tissued, succulent and aromatic fruits that are storable in ripe condition for a number of days without being damaged. Tropical and subtropical fruits falling into this category are grape, citrus, pineapple, mango, papaya, guava, melon, passion fruit and pomegranate; tomatoes are also processed into juice. All of these could be cultivated in great quantities.

41. Special preparatory apparatus and traditional processing equipment are needed for juice production. There is special equipment for washing, selecting and separating stems, peels, stones and flesh. Traditional equipment can be used for the extraction, cleaning, heat treatment and, in some cases, condensation of the juice and for filling up the packaging units.

42. There are two different types of equipment for juice extraction: for the fruits to be filtered refined (such as grape and pomegranate); and for processing fibrous fruits (such as mango, pineapple, papaya, passion fruit and citrus). Special technology is needed for squeezing citrus juices to ensure that the oleaginous peel is not mixed with the squeezed juice.

43. The juices produced by these methods can be filled into consumer units or further processed (see below).

4. Fruit concentrates, syrups and jellies

44. Juices that are not filled directly into consumer units can be processed as concentrates, syrups or jellies.

45. Concentrates are dehydrated dry produce in which the conditions that facilitate the growth of micro-organisms that induce spoilage are limited.

Concentrates can be preserved by low-heat treatment, salting or an aseptic process. The fruit content of tomato purée processed by low-heat treatment is as high as 28-30 per cent, by salting 38-40 per cent and by an aseptic process (e.g. for orange concentrate) 45-60 per cent.

46. The basic methods for the production of fruit and juice concentrates are distillation, freezing and reverse osmosis.

47. The production and distribution of concentrates is profitable; this is mainly due to the fact that the concentrates are, according to the degree of concentration, much smaller in volume than the original juices. Therefore packaging and distribution expenditures are lower. A case study is presented in annex VIII.

48. Syrups (squashes) are made from filtered or fibrous fruit juices by adding sugar and edible acid to them. Syrups have a dry substance content of 65-68 per cent. This method can be applied to the processing of grape, citrus and date juices.

49. Jellies are produced from filtered, refined juices cooked with sugar, pectin and edible acids, resulting in a thick-flowing mass that coagulates and jells after cooling (dry substance content 50-70 per cent). Cooking can take place in open boilers or vacuum kettles. The filled, packaged jelly should be pasteurized.

5. Fruit pulp and paste

50. Pulp is the chunky, stoned and peeled (depending on the species) flesh of the fruit. In the past, pulps were preserved by sulphuric acid and stored in wooden barrels. This method has been banned in recent food health regulations. To a special, limited extent, the use of sorbic acid is still permitted.

51. Pulps of valuable fruits (such as mango, papaya and guava) are filled in metal cans of 10-15 litres and preserved by heat treatment. Pulps can be further processed, mainly as jam and pastes for fibrous juices or as marmalades.

52. Fruit paste is mashed, sieved fruit flesh (such as banana and mango) filled by aseptic methods into metal cans, barrels or plastic sacks of 20-200 litres.

C. Losses during harvesting, packaging, transport and storage

53. In the past two decades, there has been a growing demand for processed fruits and vegetables. If developing countries are to increase their exports of these products, however, the problem of losses must be tackled.

54. The losses can be seen from the data in annex IX, which are based on estimates of FAO. The average losses in the developing countries are 40-45 per cent of the crop, while in western Europe and the United States of America they are 8-10 per cent. Since the FAO survey, certain technical conditions have been improved, but, according to recent experience, there have been no significant changes.

55. Some of the reasons for losses during packaging, transport and storage are:

(a) There is insufficient knowledge about necessary packaging materials and methods, or they cannot be obtained in the required quantity, quality and price;

(b) Applied packaging. transport and storage technologies are inadequate;

(c) Suitable infrastructure is lacking for establishing the required cooling chain and performing the necessary testing and control.

III. MARKET DEMANDS AND PACKAGING REQUIREMENTS

56. The developed countries are the major import market for processed fruits and vegetables from developing countries, and the primary market requirement is for produce of good quality. It is thus very important for exporting countries to be well-aware of consumer demands and packaging requirements in importing countries. These two aspects are discussed below.

A. Market demand trends

57. Table 1 shows that exports of juices have increased at nearly twice the rate as those of fresh fruits. For oranges, which represent the greatest volume of all fruit, the difference is even greater: the volume of oranges exported in fresh form has fallen in every region over the period, whereas orange juice exports have grown by 45 per cent world-wide.

Table 1. Exports of fresh fruits and juices, 1982-1986
(Percentage of increase or decrease in 1986 over 1982)

	Total exports world-wide	Exporting region		
		Africa	Asia	Americas
Fresh fruits and nuts	17.4	8.9	-3.8	16.1
Fruit and vegetable juices	33.2	7.2	12.7	31.6
Fresh or dried oranges	-3.7	-25.8	-27.7	-19.8
Orange juice	44.7	69.7	4.0	55.7

58. Total demand for processed citrus products is estimated to expand by 16 per cent by 1990 to reach 19.4 million tonnes. Over 80 per cent of the total demand for processed citrus fruit would be for oranges, followed by grapefruit with a share of 11 per cent. Overall, the consumption of citrus fruits is expected to increase by 0.5 kg per capita in developing countries and 1.4 kg per capita in developed countries by 1990. The additional per capita demand would be mostly for processed citrus, mainly juices, in the developed countries. Total and per capita demand for processed citrus products are given in annex X; estimated citrus exports and imports up to 1990 are shown in annex XI.

59. This trend is supported by data on consumption in the main importer countries. For example, in France the consumption of juices has doubled in the last seven years; orange juice consumption has quadrupled. In most

western European countries and Canada, the yearly growth rate of juice consumption is about 5-10 per cent. In the United Kingdom of Great Britain and Northern Ireland, the distribution of juice consumption is as follows: orange, 63 per cent; grapefruit, 15 per cent; apple, 8 per cent; pineapple, 6 per cent; and other juices (apricot, peach, mango), 8 per cent. In Canada, citrus juices account for 52.6 per cent, apple juices 23 per cent and tomato juices 13.7 per cent of juice consumption; the structure of consumption in the United States of America is similar.

60. Information based on consumers' and wholesale traders' opinions seems to indicate that, subject to satisfactory product presentation, there should be a fair chance for success in marketing less known tropical fruits (mango, guava, cherimoya, papaya, kiwi and the like) in processed, mostly juice, form on these and other markets.

B. Packaging requirements

61. Transport and consumer packagings are providing the means for developing countries to ship their processed foods to distant external markets or to satisfy domestic demands.

62. Modern packaging is characterized mainly by paper-based and plastic packaging materials, their combinations (laminates) and metal-based materials; however, successful efforts have been made to improve traditional glass packaging, for example by reducing wall thicknesses or by using plastic coating on bottles. Modern wooden packaging is mostly used for transporting smaller packages. There is a wide range of wooden packaging methods in many developing countries. The major packaging materials and methods used in some countries is shown in annex XII. The volumes of materials in absolute and per capita terms are given in annexes XIII and XIV. Increases in the production of packaging materials is also shown in annex XV, expressed in terms of its percentage in gross domestic product (GDP).

63. At the international level, the choice of the applied packaging materials, methods and technologies depends on the processed fruits and vegetables, the characteristics of the end-products and the effects of the preservation technologies.

64. In the developing countries, hygienic requirements of the market and the often adverse climatic, transport and storage conditions should be taken into account. Thus, the most appropriate packaging would be metal-based (steel-plate, aluminium, chromium-plated steel plate) products, various combined plastic-metal-paper laminates and glass packaging materials. For juices, plastic bottles have now come into general use (depending on the properties of the fruit and the carbon dioxide content of the juice) and various polyolephines (PE, PVC, PP, polyester-based) packaging materials can be used. It is expected that, owing to more intensive use of the aseptic technology, combined packaging materials are likely to come to the front.

65. A decisive factor in the production of materials currently in use and those under development is economic efficiency. In the case of tin-plate, this could be achieved by a further reduction in plate and tin thicknesses and more efficient lacquering methods, in the case of glass materials by volume reduction and in the case of combined materials by more intensive use of sterilized materials.

66. For processed fruits and vegetables, the trend is towards high-grade mechanization guaranteeing hygienic safety and longer shelf-life. On the other hand, packaging methods that preserve the original aroma and vitamin and

ingredient content of products are being widely developed: for example, the application of additives to preserve freshness, together with a sterile technology in a vacuum or controlled microclimate provide a means of preservation without cooling.

67. As far as developing countries are concerned, it is advisable to base consumer packaging on semi-finished packing materials, for example lacquered or unlacquered tin plates and ready-made lids and punts, that can be purchased at reasonable prices from several sources.

68. Certain stages of packaging, for example the closing of bottles and cans and welding can superficies, must be mechanized to ensure safe production operations; in other stages, for example the filling of bottles, available labour-intensive technologies could be used.

69. Choosing the type of packaging, i.e. consumer or transport units, is of vital importance, and it depends on whether consumption or reprocessing is to take place at home or abroad. For satisfying the domestic requirements, larger consumer units are more economic.

70. In case of export, taking into account such factors as efficiency and minimizing production losses, the following possibilities could be taken into consideration:

(a) Aseptic packaging of semi-finished products (pulp and paste) and their transport for reprocessing and packing (for example as a bag in box system);

(b) Frozen concentrated fruit juices can be forwarded by sea tankers in large units for further processing and sale in consumer packages (see the example of Brazil in chapter VII).

IV. PACKAGING AND PACKING MATERIALS

71. The choice of packaging and packing materials depends not only on the stage of processing (i.e. whether the product is to be packed for direct consumption or for further processing) and the packaging requirements of the import market but also on the processing technique used, as described below.

A. Packaging heat-treated products

72. The heat treatment preservation method has special packaging requirements: materials should resist the temperature and pressure that may occur during the preservation process; they should be suitable for hermetic sealing and ensure air-tightness throughout the storage period; and they must have adequate chemical stability in order to ensure that the packaging, as a result of temperature changes, does not release chemical compounds into the canned products, which could endanger health or cause changes in the taste, flavour and colour of the fruits and vegetables. Metals, glass and combined packing devices (as for aseptic packaging) would satisfy these requirements.

1. Metal packaging

73. The most wide-spread types of packaging are metal-based because:

(a) They can be used for packing liquid, viscous and chunky (sliced, diced) produce;

(b) They can be shaped in a wide variety of forms, sizes and volumes, such as cylindrical and cubic cans with closing elements. The capacity of cans can range from 0.05 to 20 litres;

(c) By appropriate lacquering, the surface of the cans can be made resistant to corrosion caused by harmful components emanating from the atmosphere or from the produce itself;

(d) Reliable, mechanized technologies are available for manufacturing such packaging;

(e) They can be used under any climatic conditions;

(f) They are a relatively inexpensive way to preserve and pack produce simultaneously while satisfying all health and sanitary requirements;

(g) Wastes can be recovered efficiently and scrap materials can be recycled in an economic way. This process could have a favourable effect on the protection of the environment;

(h) The sealing methods are relatively simple and ensure easy opening by the consumer.

74. Tinplate, aluminium sheets and metallic chromium sheets are some of the different metals that can be used for can-making.

(a) Metal cans

75. Most metal cans are made from tinplate. For some products, aluminium cans and, recently, chromium steel cans are used as well.

76. For the canning of foods, tinplates are normally processed by electrolytic tinning, a method that has replaced, to a large extent, hot-dip tinning. So-called differentially coated electrolytic tinplates seem to be most economical. They can carry a heavier weight on one surface than the others; thus the heavier coating can better protect the inside surface of cans against the corrosivity of canned products.

77. The tinplates generally used in international practice have a tin content of 2.8, 5.6, 11.2 and 22.4 g/m^2, depending on the corrosivity of the produce, the corrodibility of the coating and the external atmospheric factors. The thickness of the sheets is determined primarily by their characteristics, the production technology used to make sheets, the technical standards of the can-making machines and the size of the cans to be used. In general, gauges from 0.18 mm to 0.40 mm make the selection of the most convenient plates possible.

78. Three-piece cans consist of a cylindrical body and two ends. Traditional can-making technology operates with soldered bodies. Soldering techniques have some detrimental properties, however. The greatest problem is caused by tin-lead solder and by lead reacting with the product.

79. Organizations and administrative bodies such as FAO and the World Health Organization (WHO) and the Food and Drug Administration of the United States are opposed to soldered seams because of the danger of lead contamination, and most importers will not buy food in cans with soldered seams. This fact must be taken into consideration by developing countries intending to export canned fruits or vegetables.

80. A new can-making technique that takes into account health requirements is rapidly developing. In this case, the body is made with a welded seam, and a deep drawing is applied. Such welding techniques have, in addition to the elimination of lead contamination, further advantages such as:

(a) Less material is used, since the overlapping of the seam is significantly thinner than that of the soldered seam;

(b) They are economical, because plates can be used with a coating thinner than 2.8 g/m^2;

(c) With appropriate lacquering, increased corrosion protection is ensured.

81. In spite of the advantages, this technology cannot be applied safely unless the following conditions are met:

(a) Special gauging accuracy regarding the size and the temper of the plates, which are determined by the manufacturers of the equipment, is required;

(b) Owing to the thin overlapping, the cutting of the plates requires special accuracy;

(c) Welding requires a clean metal surface. Therefore only pattern-lacquered plates should be processed;

(d) The welding seam must be properly protected after the can-making process by applying a film, a one-component epoxy-phenolic lacquer or liquid or solid sprayed seam stripe lacquers;

(e) The plates must be examined and controlled carefully, which requires trained workers and special equipment.

82. Metal chromium sheets are used widely all over the world. They have advantageous properties, a good appearance and good lacquer adhesion. Their disadvantage is that they cannot be soldered; therefore, cans that are to be pasteurized are adjusted by sticking and those that are to be sterilized by welding. The size, hardness and other characteristics of the sheets are like those of tinplates.

83. Metal chromium sheets cannot be used for packing without lacquer because chromium is harmful to the human organism. At the same time, metal chromium sheet is cost-saving: while the cost of the tin coating is 6-8 per cent of the tinplate price, the cost of chromium coating is not higher than 0.6 per cent.

84. Aluminium offers resistance to overstrain caused by heat treatment preservation. At present, three kinds of production technologies are applied: stamping; deep drawing and drawing; and wall-ironing (DW) processes.

85. Stamping is the simplest method, but its importance is decreasing in the developed countries, where deep drawing and especially DW techniques are considered to be up-to-date processes that should be further developed. Stamping is advantageous because of the relatively simple equipment involved, which consists of a press, a curler and a rotating disc. Small units can be produced. A disadvantage is that the soft cans require more careful and well-controlled technology and transport packing and the productivity of the production equipment is relatively low (25-60 cans per minute).

86. Deep-drawing equipment produces 160-200 cans per minute and it takes up little space. The cans have good mechanical strength and resistance.

87. The disadvantages of deep drawing are:

(a) The process requires tempered thin aluminium alloy strips of good quality and uniform thickness;

(b) The technological equipment is relatively expensive;

(c) Cans of large height cannot be produced.

88. Deep-drawn cans could also be produced from combined basic materials, consisting of ultra-thin aluminium strips and thick aluminium and plastic films. The benefits of this combination are the following:

(a) The cans are lighter (by 20 per cent) than tin cans of similar sizes;

(b) The good heat conductivity of the aluminium strip or film enables a more protective and less energy-intensive heat treatment;

(c) The polyolephine inside coating of the cans provides perfect anti-corrosion protection and protects canned foods from acquiring a by-taste or smell or from changing quality owing to the effect of the metal.

89. A disadvantage is that the size of the cans produced by this method is limited (up to 400 ml) and sterilization and transport packing is complicated because of their sensitiveness to mechanical effects.

(b) <u>Closing elements</u>

90. The simplest method of closing a can is by sealing it in such a way that the whole lid must be removed using a special can opener or tool for this purpose. The competitiveness of canned products and consumer demand have caused producers to develop easy-open methods. The closing elements have different forms according to the properties of the canned foods: for solid, chunky (diced) foods the easy-opener should allow the end of the can to be removed; for liquid products, the easy-opener consists of a pouring aperture. The easy-open ends can be made from tinplate or aluminium.

(c) <u>Lacquering, printing and labelling</u>

91. In order to protect the products and prevent corrosion, the inside and outside surface of the cans and ends should be lacquered. Epoxy-phenolic based lacquers are normally used for coating. Lacquering is carried out on roller-coating machines or by spraying. Lacquering must take place in a well-ventilated area, and safety and anti-burn precautions must be taken to eliminate dangers caused by solvents and vapours being released during the stoving process. After lacquering, the sheets are fed into a stoving oven with heating chambers; at the end of the stoving period, the sheets emerge from the oven.

92. Designs and labels can be put on the external surface of the cans using an offset printing process. Instead of printing, a label can be applied to the cans. Printing endows the can with a more attractive appearance, while labelling can be carried out using hand-operated technology.

(d) Manufacturing/purchasing alternatives

93. Deciding whether to manufacture cans or to purchase finished cans will depend to a large extent on economic considerations. Three alternatives are:

(a) Purchasing and processing of tin sheets or strips, with lacquering and the production of cans and closing elements being carried out in or near the food processing facility. This alternative is not economical unless the capacity of equipment can be fully utilized, and it requires significant investments (building, machines and other installations);

(b) Production based on the use of lacquered sheets or strips. This method is more advantageous than the first since it does not demand any expensive lacquering equipment;

(c) A technology utilizing finished cans and closing elements. This variable is perhaps the most expensive, if the production volume is small, however, it may prove most economical. Adequate storing capacity is also needed, as empty cans require a lot of space; this could create considerable expense.

94. In order to facilitate transport and sale, it is advisable to put the filled cans in transport packings or unit loads (palletized units or containers).

(e) Summary

95. When choosing the material and the shape of the cans to be used, the following aspects should be taken into consideration:

(a) Hygienic and sanitary safety;

(b) Anti-corrosive and mechanical properties;

(c) Production and application technology;

(d) Supply of basic materials;

(e) Field of application and utilization;

(f) Economic efficiency.

96. From a sanitary point of view, cans with soldered seams are already old-fashioned and cannot be sold in developed countries; welding techniques are preferable.

97. As far as corrosion-resistance, mainly resistance to atmospheric corrosion, is concerned, aluminium cans prove to be the best. At the same time, all types of metallic cans can be made corrosion-resistant by lacquering, in accordance with the properties of the products to be canned. Aluminium cans are the most sensitive to mechanical effects.

98. With regard to production and application technology, tinplates with welded seams have the most advantageous properties (flexible choice of sizes, simple and safe can making). The size of aluminium cans is limited but their weight is the lightest. Aluminium cans have very good heat conductivity, enabling them to be sterilized in a more protective and less expensive manner.

99. The question of the supply of basic materials should be decided by considering local possibilities and sources of purchase. Both tin and aluminium sheets can be obtained in a large variety in a number of countries; chromium steel plants are concentrated in a few countries.

100. Tinplate cans can be widely used as far as size and products are concerned. Aluminium cans can be used first of all in the canning of fruits, fish and meat, while chromium steel cans are used mostly for the canning of fish and meat products. Tin coats and lacquering gauges related to the most important fruit species are shown in annex XVI.

101. Considering all aspects and keeping in mind the relatively favourable price of tin sheets, it seems that tinplate cans with welded seams, with appropriate lacquering if required, are the most generally used and economical method of safe metallic canning for fruits and vegetables.

2. Glass packaging

102. Glass packaging has many advantages: it can be hermetically sealed, preventing the diffusion of gases and water vapour, aroma and liquids; it is resistant to chemicals; it can be heat-treated; and it is suitable for reuse. Glasses are easy to clean, and their transparency allows the product to be inspected.

103. Glasses can be manufactured in various forms and sizes, generally 0.1 to 5 litres, on standardized production lines. Depending on the construction and form, they can be used for packing powders, liquids and chunks (dices). The disadvantages of glass packaging are mainly fragility and a relatively heavy tara weight. As a result of recent technical developments, light-weight glass packaging has come into use; it is made less fragile through surface treatments.

104. Glass packagings are usually non-returnable. If recovered, they do not burden the environment, and recovered glass packagings can be used economically as a secondary basic material.

105. The filling of glasses can be carried out with fully automatic technologies or manually.

106. Metal lids or caps are used to seal glass packaging. Easy-open caps have been designed to meet consumer requirements; glasses can be opened and re-closed without any tools. Different types of screwed lids (twist-off, S-Omnia, T-Omnia) are made for jars. On certain markets, inexpensive closing elements such as NeOPHonix are also acceptable; these require more manual handling in order to open the glass.

107. Some products, such as canned foods for children, have to be sealed with increased safety, and the closing element must not be used for re-closing because of the danger of spoilage. Special closures (such as P-T jar) are used for this purpose. Bottles are usually sealed by crown caps made from metallic plates; they cannot be re-closed, however. Screwed caps (such as pilfer-proof caps) are needed for re-closing bottles.

108. The sealing operation is of major importance from the viewpoint of safety and perishability of the products. This process must be carried out mechanically.

109. Glass-packed products are labelled in order to make them attractive and to provide the consumer with necessary inscriptions and information. Labels can be applied mechanically or manually.

110. It is advisable to prepare transportation packaging (such as corrugated cardboard boxes) in order to avoid confusion during the distribution and endangering the glass-packed end-products or to make up an appropriate unit load (such as fixed palletized units or containers).

3. "MOBILE" processing and packaging technology

111. Experts have elaborated a special, heat-treated preservation and packaging technology called MOBILE which was developed to take into account the special conditions and facilities of developing countries. The technological system carries out processing, heat-treatment and packaging. It is installed and operates in mobile and transferable freight containers.

112. The main advantages of this system are as follows:

(a) The establishment of several stationary, expensive and uneconomical factories within the same region can be avoided;

(b) The system eliminates or reduces the transport distance between harvesting and processing, shortens the preparatory phase of processing and decreases losses during the production process;

(c) The mobile workshop can adapt to the place, quantity, period and seasonality of the harvested produce;

(d) Owing to the economy and hygienic safety achieved, the system contributes to improving the local food supply in tropical and subtropical countries.

113. Basic conditions for the mobile workshop include a water and energy supply and sewage disposal. A description of and conditions for such a mobile canning workshop are found in annex XVII.

4. Aseptic packing

114. The aseptic technique is a special packing method for products preserved by heat treatment. The product and packaging are sterilized separately, and packaging is filled and sealed under aseptic conditions.

115. This method is widely used throughout the world, owing to the following advantages:

(a) Liquid, viscous and chunky foods can be preserved using this method;

(b) Several types of packaging material can be used: glass, metallic, plastic hollow body, co-extruded plastic and aluminium foil;

(c) Both the taste and nutritional value of the foods preserved with this process are very favourable;

(d) The packaging process could be carried out on a continuous line;

(e) The distribution and sale of products do not require special conditions (such as a cooling chain);

(f) The method ensures more flexibility in adapting to the requirements of the markets;

(g) It is less expensive than other methods and materials that are not heat-proof could be used.

116. The general requirements of this technology are as follows:

(a) Reliable public utility service (electricity, water, steam, compressed air and vacuum supply);

(b) High-level technological and hygienic discipline;

(c) Relatively high investment costs.

117. Special conditions to be fulfilled in connection with the application of the aseptic process are:

(a) Pre-sterilization of the whole system, from the sterilizing and refrigeration units to the filling and sealing units;

(b) Pre-sterilization of the product to be filled;

(c) Keeping the product and the aseptic system under sterile conditions;

(d) Sterilization of the packaging and their storage under sterile conditions as long as the packaging is sealed.

118. A general requirement when using aseptic equipment is the clean-in-place (CIP) principle, that is, cleaning and sterilization should be performed "on the spot" without the disintegration of the system.

119. The three basic types of aseptic packaging are the consumer package, medium-sized transport packaging and the large unit container system. These are described below.

(a) Aseptic consumer package

120. The aseptic consumer package normally has a volume of 0.2-2 litres, depending on the properties of the produce and the current demands and habits of consumers. Glass bottles, metal or plastic boxes, combined plastic foils and, most of all, tempered cartons that are specially treated with plastic foil, aluminium film or waxes belong in this category. Cardboard-based packaging is very appropriate for export purposes, but it calls for a developed paper and plastic industry.

121. If an aseptic system is being set up, packing materials could be imported initially and local production could be subsequently developed according to demand. If all the packing material that might be needed is to be imported, it is advisable to use materials that have minimum transport and storage costs and favourable prices. The systems based on cardboard seem to be the most favourable.

(b) Medium-sized transport packaging

122. Transport packaging of medium size, with a capacity of 5 to 220 litres, normally satisfies the demands of large consumers and meets transit/storage needs. Metal cans, kettles and barrels as well as "bag in a box" and "bag in a barrel" systems are used for transport packaging.

123. In the "bag in a box or barrel" system, the products are fed directly into plastic foil sacks and are immediately put into plastic or cardboard boxes or barrels in order to facilitate the storage, handling and transport. This may be combined with aseptic technology. Using this method, tropical and subtropical developing countries will be able to export fruits that are normally perishable in semi-finished forms (pulp, purée) in large aseptic packaging. A case study on this subject is presented in chapter VII.

124. While tin can packing is non-returnable, kettles, barrels and external elements (barrels) of the "bag in a box" packaging may be reused repeatedly.

(c) Large unit container system

125. Containers of 20-50 m^3 (or greater) capacity are used, first of all, for aseptically storing produce and semi-finished products that will receive further processing. Produce stored in this way can be drawn off and filled into smaller, transportable containers or consumer packages. The containers are made of aluminium or stainless steel.

126. Medium-sized transportation packaging and container systems are mainly used for storing and transporting liquid and viscous foods.

B. Packaging products that do not require heat treatment

127. Products such as fruit purées and syrups with a high sugar content do not normally require heat-treated preservation. The same consumer packaging as that used for heat-treated products can be used. In a number of cases, however, it may be advisable to employ simpler and more economic packing systems, unless consumer demand calls for a certain type of packaging.

1. Products with high sugar content

128. Purées can be packed in vacuum-formed plastic foil boxes. The technology is very simple, with roll-based manufacturing, filling and sealing being carried out by the same production line. The equipment seals the filled packagings by welding, ensuring full airtightness.

129. The packaging technology using rolled basic materials has several technical and economic advantages:

(a) The rolls take up less storage space than finished but unfilled packaging;

(b) The tara weight of the packaging is insignificant in comparison with metal cans or glass bottles.

130. For products packed in large units, whether for consumption or further processing, metallic kettles, barrels and drums can be used.

131. Both metal-based and plastic-based packagings can be returnable and non-returnable. Plastic-based packagings have less tara weight; therefore, conditions for their handling, storage and transportation are more economical. Among the metal-based packagings, steel barrels are subject to corrosion inside and outside; therefore, their surfaces must be protected by lacquering. Aluminium barrels are corrosion-resistant and lighter than the steel-based ones.

2. Products preserved by quick-freezing

132. Quick-freezing ensures that the quality of almost all types of fruits and vegetables is maintained over a longer period. After the preparatory process (washing, selection, peeling, stoning, slicing or dicing, blanching), the produce is refrigerated at a temperature of -38° to -40 °C. In order to ensure good quality, the produce should be cooled quickly and uniformly. If large-sized ice crystals are allowed to form during freezing the frozen food will regain its original consistency when defrosted.

133. For this process, an economical freezing apparatus is located in a closed, air-conditioned workshop. The three main freezing methods are the tray, band and tunnel systems. Fluidization methods have the greatest efficiency and, at the same time, offer very high freezing protectiveness.

134. Quick freezing has a disadvantage compared to heat-treated preservation, in that it requires expensive heating energy not only in the processing factory but also throughout the whole cooling chain, i.e. a temperature of -20 °C must be maintained during storing, transportation, distribution and retail trade and even in consumers' households.

135. The simplest method of packing for quick-frozen foods is to feed them into pre-fabricated or manually produced plastic (such as PE) bags or sacks. The operation can be performed manually or by semi-automatic or full-automatic machines. Such machines first make the packagings from film rolls, then they fill and seal the packages. The films may be impressed or printed, but products packed in this manner can be sold mostly on the domestic or regional markets because of their modest external appearance. In addition, transportation packing is needed since sacks are sensible to mechanical effects.

136. Equipment for packing frozen foods in consumer units made of cardboard combinations is up-to-date and efficient, and products packed in this way can be sold on most markets with good results. This technology is expensive, however.

3. Products preserved by radiation

137. The preserving effect of ionizing radiation is due to its high energy content. Radiation destroys microbes living in foods. Radiation treatment is normally employed for preserving foods that are already packed.

138. The radiation energy needed for preservation may induce changes in the packing material (colouring, softening and gluing agents); depending on the radiation power, temporary or permanent structural changes may occur. Thus, metallic, glass and some of the combined packing are used most often for packing radiation-treated produce.

139. Some modern plastic and combined packagings are subject to structural change. Owing to these changes, the materials may harden or stiffen, and this might narrow their field of application. Degradation (the detachment of molecular groups) could also occur, both in the structures of the plastics and in those of the additives. This process reaches the preserved food and penetrates into it, which may damage the taste. Packaging must be thoroughly tested based on the preservation technology to be applied.

140. Preservation by radiation and the packing process are relatively expensive and require highly qualified specialists and instruments and great care. For those reasons, this technology is not expected to be widely used in the developing countries in the near future.

V. FACTORS INFLUENCING THE SELECTION OF APPROPRIATE PACKAGING AND PACKING METHODS

141. Before purchasing packaging and machines, a thorough study must be made of the following factors: prices and costs, place of purchase, possible utilization of national resources, distances to be covered, customs, restrictive duties and packaging regulations in the importing countries, the available labour force, and, in certain cases, the amount of hard currency needed for purchase. These factors are described below.

A. Costs

142. As a rule, packaging is determined by the habits and demands of the target or consumer country and not by the potential of the exporting country; therefore, more expensive packaging material and methods may be required for produce that is to be exported.

143. With regards to collective and transport packaging, the material and methods should be chosen based on mechanical and climatic transport conditions. For example, glass packagings generally require collective and transport packaging of higher mechanical resistance. The dimensions of transport packaging must conform to dimensions and standards of transport devices, pallets and containers used at the place of destination. This is usually neglected, causing problems, additional expense and often leads transactions to fail. It is particularly important to note that EEC uniform packaging and transport dimension regulations are to come into effect by 1992 and that exporters will need to conform to them.

144. Other important cost factors are shape, construction and flexibility as well as space requirements of empty packaging during storage and transportation. If folding or collapsible carton elements are used, transport and storage are less expensive because no unfilled packages have to be transported. On the other hand, the sellers have to be informed about the reaction of packaging materials to climatic and atmospheric effects, i.e. whether they require closed, roofed or possibly climatized storing places.

1.5. Before a decision is taken to mechanize packaging, a detailed study should be made of packaging equipment and material. Equipment must be suitable for the processing of the available packaging material and vice-versa. Careful economical calculations are needed to find the best possible equipment-material combination. An example is given in annex XVIII comparing three packaging systems for juices. The cost of well-trained, skilled and unskilled staff also has to be taken into consideration. If mechanization involves high costs and there is abundant local labour, labour-intensive technologies may be preferable to high-degree automatization. Energy and maintenance costs should also be taken into account when considering mechanization.

145. Complex cost calculations must be carried out before a final decision is taken. In certain developed countries an economical comparison was made in 1983/84 of aseptic technologies using different packaging materials and methods. Liquid food products, including fruit juices, were examined. The evaluations covered the total costs of the distribution system, including production and consumption costs, under well-defined conditions (price, availability etc.). (The results of the evaluation could also pertain to other food products.) The conclusions reached are shown in table 2.

Table 2. Comparison of costs of glass, metal and laminated-paper packaging as a percentage of total costs

Cost item	Glass	Metal	Laminated paper
Packaging			
Consumer	58-60	73	
Collective and transport	16	10	
Subtotal	74-76	83	70
Processing and filling	2.5-3.5	1.6	7.2
Storage of empties	0.8-1.3	0.3	1.1
Transport and storage	13.6-15.1	10.9	10.7
Handling	4.9-5.8	4.1	0.12

B. Other factors

146. In addition to costs, a number of other factors have to be taken into account, as follows:

(a) The properties, quality and quantity of the fresh product as well as the processing and preservation technology. The methods outlined in previous chapters show that fruits and vegetables with various properties can be processed into a range of products, which have quite different packaging requirements (such as orange juice versus orange jam);

(b) The market (domestic or export). Products for export have to be packed according to the parameters given by the importer, who often transfers not only the necessary technology but also the packing material. In the case of domestic consumption, products should be packed in accordance with the demands of the market and sanitary requirements. For domestic trade, products are normally packed in larger units;

(c) Distance of export markets and access to them. It is indispensable to be completely familiar with the transport and storage conditions and hazards that might arise in transit and in the country of destination as well as with climatic, mechanical, physical and chemical conditions. For sea transport, loading and unloading conditions will determine the type of transport packaging that should be chosen;

(d) Sources of packaging purchase. As far as possible, packing materials should be obtained from domestic sources. In many developing countries there are no appropriate raw materials or manufacturing units producing high-quality packaging suitable for export. In such cases, it is advisable to import semi-finished packing materials (such as bodies and ends already cut up for metal cans), which can be fit together at the place of processing. Thus, the costly import of finished packaging can be avoided;

(e) Losses and wastes. The location of and technology for the processing and packing facilities should be near the place of cultivation and harvest, particularly when processing highly perishable tropical fruits, in order to avoid losses and wastes;

(f) Environmental conditions and infrastructure necessary to establish a packaging line. Among others, energy, water supply, sewage disposal and storage capacity are needed for a packaging workshop. Water is indispensable for every preserving operation (preparatory washing, floating, pre-cooking, liquors, cooling, boiler feed-water). Sewage disposal cannot be overlooked either, since process water harms the environment;

(g) Labour force. Processing, preserving and packaging operations require different levels of professional knowledge. To produce high-quality products, a number of skilled specialists (engineers, skilled workers) have to be employed. Simpler tasks can be performed by semi-skilled workers, who should receive professional training prior to the start of operations.

VI. TARIFF AND NON-TARIFF BARRIERS

147. It is unlikely that there will be a significant increase in the market for processed fruit and vegetable products in countries with developed market economies or in higher-income developing countries. Better opportunities for export would be Eastern European countries and the Union of Soviet Socialist Republics, where per capita consumption is still modest in relation to income and where the easing of administrative controls would probably lead to faster increases in imports of fruits and especially of processed products (mainly juices).

148. Other export opportunities would arise if countries eased or lifted non-tariff or tariff barriers, i.e. the import restrictions on orange juice in Japan or import duties and/or domestic taxation on citrus fruits and their products in Western Europe, Oceania, Canada, Japan and the United States. In view of the high level of consumption reached in most developed countries, however, the lowering of these restrictions would be likely to have only a limited effect on the volume of trade.

149. The following foreign trade regulations are applied to processed fruit and vegetables in the European Communities:

(a) Import tariffs, e.g. tomatoes 18 per cent, asparagus 22 per cent, peas and green beans 24 per cent, peaches 22 per cent and pears 20 per cent;

(b) Variable import levies and export rebates on the sugar content to counterbalance the difference between the world price and EEC price of sugar;

(c) Import licenses, i.e. the importer has to post a bond, which is forfeited if the import has not crossed the border within a given time period. This regulation is applied to tomato concentrates, peeled tomatoes, tomato juice, peas, green beans, raspberries, pears, peaches and dried plums;

(d) Import embargoes or import quotas in the case of serious market disruptions. Up to now these measures have applied only to canned mushrooms;

(e) Voluntary export restrictions (canned mushrooms).

150. As regards the packaging requirements, conditions vary considerably from country to country, even within the European Communities. Most developed countries have numerous laws and decrees that regulate food packaging and labelling: Austria, for example, has about 250 different State rules regulating or influencing the use of packing material and packaging in general. The situation is similar in most industrialized countries, raising explicit difficulties for exporting countries.

151. Efforts made thus far to establish uniform or similar regulations that would be valid in both the developing and the developed countries have not been successful and do not seem to be realistic. Some comprehensive measures have been taken towards better co-ordination of the regulations in question, including the following:

(a) On a world-wide level, the subcommittee appointed by the FAO-WHO Codex Alimentarius Commission is observing and recommending instructions for food labelling, paying attention to the denomination, value, composition and additives of foods. It would be advisable if the member countries accepted the recommendations of this subcommittee and integrated them in their national legislation and regulations;

(b) GATT has begun drafting a code on the possible reduction of packaging restrictions. It also encourages member countries to participate in the standardization work of international organizations in order to develop national standards commensurate to existing international standards;

(c) EEC, the largest buyer's market for fruits and vegetables, plans to create by 1992 a uniform system of technological and economic requirements in this domain. The control of products and packaging, the interrelationship of foods and plastics (migration effects), product labelling, requirements for returnable packagings and material recycling as well as the liquidation of packaging waste will be made uniform within the EEC (some are already). Exporter countries have to begin preparing for these regulations.

152. As far as product denomination and labelling are concerned, the requirements of the industrialized countries differ only slightly. According to the present regulations, the following data must be indicated on the packaging of processed fruits and vegetables:

Product denomination
Total quantity of contents
Percentage of fruit and sugar within the full content
Additives and preservatives used in processing
Corporations (organizations) responsible to control authorities (identifiable production, packing or sales, enterprises, organizations)
Name of the country of origin

153. The environmental requirements for packaging are being extended and are becoming more rigorous all over the world. With the adoption of the European Single Act in 1985, environmental protection officially became an integral part of EEC policy. In the Act, fundamental principles were established, namely: the principle of prevention, the fight against environmental risk at source and the polluter-pays principle. From these principles, the following aims can be derived for waste management:

(a) Prevention of waste formation;

(b) Recycling and reuse of waste;

(c) Environmentally safe disposal of non-recoverable residues.

154. In the packaging sector, the EEC Directive on containers of liquids for human consumption (85/339/EEC) was adopted in 1985. The Directive includes fruit and vegetable juices, as well as refreshing drinks. It provides for a series of measures relating to the production, marketing, use, recycling and refilling of containers of liquids for human consumption and for the disposal of used containers.

155. EEC countries put the Directive into practice in somehow different ways, as follows:

(a) In Denmark, soft drinks may be put on the market only in refillable-containers, subject to a deposit and the obligation to accept returned containers;

(b) In France, in order to implement the EEC Directive on beverages, voluntary agreements with the affected industries, including glass, plastics, tin plate, aluminium and cardboard sectors, were entered into in 1988. Thus, a number of measures have been introduced to increase the use of refillable bottles, such as uniform deposit systems, marketing/labelling and a reduction in the number of bottle types and their standardization;

(c) In the Federal Republic of Germany, the Government is preparing a directive to introduce the uniform labelling of one-way and returnable beverage containers;

(d) In the Netherlands, the Government published a comprehensive programme for the avoidance, reuse and recycling of waste materials. Some of the objectives established in the programme extend as far as to the year 2000. A few figures on materials relevant for packaging have been compiled in annex XIX.

156. The above-mentioned requirements, the tendency towards unification and standardization, the aim of reducing the diversity of packaging material, new labelling and marking systems etc. should encourage the developing countries to adapt or develop their future policies and programmes accordingly.

VII. INTERNATIONAL CO-OPERATION

157. There is a need for international co-operation in the processing and packaging of vegetables and fruits, and possibilities for such co-operation exist.

158. Developing countries require convertible currency resources to obtain the necessary products and technology from developed countries. To achieve this, they have to sell their products on the international markets at good prices. This means that products must be sellable on the export market, which requires, among others, up-to-date packaging material, methods and technologies which promote the marketing of the products.

159. This could be achieved in several ways. First it is necessary to acquire know-how about international trade and licences. With the assistance of such international organizations as the United Nations Conference on Trade and Development (UNCTAD), FAO, the United Nations Industrial Development Organization (UNIDO), the International Trade Centre (UNCTAD/GATT) and others, developing countries should select the appropriate and indispensable technologies. They should build up the necessary infrastructure and industrial environment to accommodate these manufacturing technologies.

160. Optimally, the most advanced consumer packaging systems would have to be adopted. It would be necessary to export processed vegetables and fruits in high-quality packaging (such as TETRA PACK, PKL, or DOYPACK systems), thus gaining a maximum added value. This, however, gives rise to problems, such as:

Large investments for establishing the systems
Capacity building and the rate of utilization
Infrastructure, expertise and trained (skilled) labour force required for operation
Transport costs, in view of the distant consumer markets
Costs of marketing, market research sales etc.

161. To overcome these problems, international co-operation programmes can provide mutual technico-economic advantages, particularly for developing countries with a lower level of technology in this field and limited packaging material resources. Two examples of such co-operation are given below.

162. A canning factory in a central European country, in accordance with an agreement, assisted in establishing a fruit purée production unit in Viet Nam. With the aid of the technology provided, a large percentage of the tropical fruits which had previously been wasted (mango, banana, papaya) are processed for purée and filled into 220-litre laminated plastic sacks by aseptic technology and are transported in a "bag in barrel" system for further processing and consumer packaging to Europe. The European factory has developed advanced technology (easily convertible for consumer packaging), expertise and industrial infrastructure in Viet Nam and, in addition, ensured good foreign exchange income for that country. The co-operation will be profitable.

163. Another positive example of economic co-operation is the case of the frozen concentrated orange juice exports of Brazil. The growth of exports has been reinforced in the last few years by a change-over in the bulk shipment of a large portion of Brazilian frozen concentrated orange juice exports. The concentrate was previously shipped in 200-kilogram drums. For bulk shipment, frozen slush concentrate is now transported in special tank vessels with a capacity of 9,000 to 12,000 tonnes; it is discharged directly from the vessel into large tank farms at the ports of arrival. There the concentrate is stored in 1,000-tonnes stainless steel tanks and is kept at a constant temperature of -10 °C. Bulk handling of concentrate reportedly saves an estimated $US 80 to $US 100 per tonne and also improves product quality by reducing contamination and losses from heat. The Brazilian exporters make bulk shipments to Belgium and the Netherlands and to the north-eastern coast of the United States.

164. It seems that in the future similar international co-operation, based on mutual economic advantages and guaranteeing gradual technico-economic development, is realistic and lucrative for the developing countries.

Annex I*

Nutritive substances of some of the important fruit species as per 100 g edible share

Fruit	calorie Kcal	water g	protein g	carbo hydrate g	fats g	fibre g	vitamin A=I.E. C=mg	waste %
Pineapple	55	86	0,4	13	0,1	0,5	C:30	40
Apple	60	84	0,3	14	0,4	1		16
Avocado	50-220	60-86	0,8-4,4	1,2-10	5-32	1,5		30
Banana	110	75	1,2	20	0,3	0,3		33
Date /dried/	265	15	2	64	traces	8,7		13
Fig /fresh	50	85	0,8	12	0,2	2		0
dried/	225	17	3,6	53	0,9	18		0
Guava	60	80	1	13	0,4	5,5	C:200	20
Litchi	60	84	0,8	14	0,2	0,5		40
Mango	50	87	0,4	11	0,7	0,7	A:1000-3000	34
Orange	50	86	0,8	10	traces	0,2	C:55	25
Papaya	30	90	0,4	7	0,1	0,7	A:2500 C:50	30
Grape	75	80	0,7	18	traces	1		5
Musk-melon	20	95	0,5	4	0,1	0,4	A:0-2500 C:30	20

Source: Prof.Dr. Sigmund Rehm - Dr. Gustav Espig "Die Kulturpflanzen der Tropen und Subtropen", Institut für Tropischen und Subtropischen Pflanzenbau der Universität Göttingen. Verlag Eugen Ulmer, FRG.

*The annexes have been reproduced without editing.

Annex II

Production of some of the most important fruits according to climatic zones (in 1980, million tons)

1./ Tropical species

Banana	33,8	
Mango	11,5	
Pineapple	4,3	
Papaya	2,0	
Avocado	0,9	
Guava	0,4	
Granadilla	0,2	
Litchi	0,2	
Approx. total		54

2./ Subtropical species

Grape	51,4	
Citruses	39,2	
Water-melon	16,0	
Peach	5,6	
Musk-melon	3,6	
Date	1,9	
Fig	1,2	
Apricot	1,0	
Pomegranate	data not available	
Approx. total		120

3./ Species cultivated in temperate zones

Apple	20,0	
Pear	7,2	
Plum	4,2	
Cherry	1,1	
Strawberry	1,1	
Other berries	0,7	
Approx. total		34

The total world fruit crop production is estimated at 210 million tons.

Source: Ole Höst "Früchte und Gemüse aus Tropen und Mittelmeerraum". Kosmos, Gesellschaft der Naturfreunde - Franckh'sche Verlagshandlung, Stuttgart, FRG.

Annex III

Actual and Projected Production of Citrus Fruits

	ACTUAL			PROJECTED	GROWTH RATES	
	1970*	1980*	1982	1990	1970-80	1980-90
	thousand metric tons				percent per year	
WORLD	37621	54182	54242	64237	3.7	1.7
DEVELOPING	16267	27625	28559	35685	5.4	2.6
Africa	2171	2338	2221	2594	0.7	1.0
Algeria	524	413	323	197	-2.4	-7.1
Morocco	820	1006	974	1245	2.1	2.2
Tunisia	111	184	155	245	5.2	2.9
Latin America	8626	17181	17122	21510	7.1	2.3
Argentina	1425	1444	1374	1740	0.1	1.9
Brazil	3386	9880	10214	12760	11.3	2.6
Cuba	146	430	547	970	11.4	8.5
Mexico	1687	2511	2252	2850	4.1	1.3
Near East	2404	3362	3693	4451	3.4	2.8
Cyprus	218	263	276	309	1.9	1.6
Egypt	809	1105	1378	1918	3.2	5.7
Lebanon	263	322	309	300	2.0	-0.7
Turkey	649	1158	1203	1305	6.0	1.2
Far East	2078	3424	3566	4855	5.1	3.6
India	1370	2001	2010	2350	3.9	1.6
Pakistan	454	710	725	1490	4.6	7.7
Asian CPE	983	1358	1929	2275	3.3	5.3
China	935	1247	1794	2220	2.9	5.9
DEVELOPED	21354	26550	25813	28552	2.2	0.7
North America	10801	13196	12355	13405	2.0	0.2
U.S.A.	10801	13197	12355	13405	2.0	0.2
Western Europe	5318	6587	6650	8207	2.2	2.2
EEC	5316	6581	6633	8196	2.2	2.2
France	11	34	39	46	11.9	3.1
Greece	592	721	875	1030	2.0	3.6
Italy	2456	2868	2525	3255	1.6	1.3
Portugal	130	141	171	147	0.8	0.4
Spain	2127	2816	3024	3718	2.8	2.8
E.Europe and USSR	76	266	278	355	13.3	2.9
Eastern Europe	4	5	5	5	2.3	-
USSR	72	261	273	350	13.7	3.0
Oceania	368	529	514	730	3.7	3.3
Australia	360	507	486	695	3.5	3.2
Other Developed	4793	5973	6028	5855	2.2	-0.2
Israel	1442	1510	1804	1270	0.5	-1.7
Japan	2775	3760	3598	3850	3.1	0.2
South Africa	576	704	646	735	2.0	0.4

* three years average

Annex IV

Annual net yields of some of the important fruits (pro hectare)

Fruit	crop tons/ha/year	Edible parts %	net crop tons/ha/year
Grape	30	95	28,5
Orange	30	75	22,5
Banana	50	67	33,5
Mango	20	66	13,2
Pineapple	40	60	24
Papaya	60	70	42
Avocado	10	70	7
Guava	35	80	28

Source: See annex I.

Annex V

CHARACTERISTICS OF THE FRUITS

THE PROCESSING AND PACKING OF WHICH IS DISCUSSED

Sequence: according to the overall volume of the production

1. Grape
2. Citrusses
3. Banana
4. Mango
5. Pineapple
6. Papaya
7. Avocado
8. Cherimoya
9. Guava
10. Passion fruit
11. Litchi
12. Date
13. Fig

Fruits of lesser importance

14. Kiwi
15. Pomegranate
16. Japanese persimmon
17. Carambola
18. Tree tomato
19. Mangosteen
20. Melon

1. GRAPE /Vitis vinifera/

The vineplant itself is a deciduous shrub, their fructiferous branches climb through vine-shoots. The fruit is a grape-shaped juicy berry with a thin waxed skin enclosing 2-4 small, hard stones. The grape may be blue, red, green or yellow. The fructose and grape-sugar content of the grape range from 15 to 20 percent, in addition, the grape contains tartaric and malic acid.

The main cultivation areas are: the Mediterranean countries, California, Chile, South Africa, Australia. Yield capacity: max. 30 tons/hectare.

The grape must be gathered in the state of full ripeness, because no after-ripening is possible.

80% of the world crop is utilized for wine production, 10% is consumed as fresh fruit, 5% is converted into raisin, another 5% is destined for the preparation of juices, syrups and jams.

2. CITRUSSES

ORANGE /Citrus sinensis/, the most important citrus species, represents 15% /29 million tons/ of the whole world fruit crop. About 1100 orange subspecies are known as e.g. Valence, Nabel-orange, blood-orange, sugar-orange.

The second place in the world fruit crop statistics is occupied by TANGERINE /Citrus nobilis deliciosa/, another orange species, coming to 3% /6 million tons/ of the whole world fruit crop. Tangerine is cultivated chiefly in East Asia, and has more than 500 subspecies.

A share of 2% /4 million tons/ in the whole world fruit crop is represented by LEMON /Citrus limonia/ taking the third place in this respect, together with its subspecies /e.g. LIMETEE/.

POMELO and GRAPFRUIT crops are also significant, representing together 2% of the world fruit crop. Also BITTER ORANGE and CITRON have to be mentioned here.

Characteristics of the particular species

a./ ORANGE /Citrus sinensis/

The peel of the tropical subspecies is green, that of the subtropicals is orange-coloured. The fruit is succulent, having a sour-sweet, aromatic taste, with a high vitamin C content.

b./ TANGERINE /Mandarin orange, Citrus nobilis deliciosa/

A small, pressed globule-shaped fruit with thin, green- or orange-coloured peel. Its orange-coloured flesh is sweet-flavoured. Originates from South-East India.

c./ LEMON /Citrus limonia/

Has a thick light-yellow peel, is juicy with a high vitamin C content. The flesh is bright-yellow and tart to the taste. Coming from South Asia, lemon is wide-spread in California and in the Mediterranean area.

Beside putting it for eating use lemon can be utilized for the production of citric acid, ethereal oils and pectin.

d./ LIME /Citrus aurantifolia/

The tight-adhering peel is olive-green. The greenish flesh is very sour. Its fresh juice is utilized for flavouring fish dishes. Other products to be obtained: extracted juice, purée, jam as well as citric acid and ethereal oils.

e./ GRAPEFRUIT /Citrus paradisi/

The large-sized round fruit has a thin peel, with a slight albedo. Juice and syrup can be produced out of it. Coming from West Indies, it is cultivated chiefly in tropical and subtropical areas.

f./ POMELO /Citrus decumana/

A large-sized fruit with thick, yellow peel. The flesh is light-yellow or red, consumed in fresh condition having a sour-sweet flavour. From the peel sweetened nougat can be produced. Cultivated in Southeast Asia and other tropical areas.

g./ BITTER ORANGE /Citrus aucantium/

Is bitter-flavoured and not good for immediate consumption. Jam can be produced out of it, moreover the peel is utilized for the production of liqueur-essence, furtheron perfume can be distilled from the flower.

h./ CITRON /Citrus medica/

A long-shaped fruit with thick yellow peel. The flesh is sour-tasting and hardly good for consumption. Actually, it is cultivated for the peel which - after extraction - can be crystallized or processed for citric compounds.

The yield capacity of well-managed plantations amounts to approx. 30 tons/hectare as far as orange and tangerine, and 40 tons/hectare as far as lemon or grapefruit are concerned.

Citrusses can be utilized for the production of juices, purées, frozen concentrates or powders. Their peel is good for the preparation of pectin or animal feedstuff.

3. BANANA /Mu. sapientium/

The most important fruit growing in the tropics yielding 34 million tons, i.e. 16% of the world fruit crop the half of which is consumed in fresh condition or as dessert. A subspecies of the banana is the so-called meal-banana with a high starch content which is less sweet and - in cooked condition - serves for the daily alimentation of millions of people. Some other subspecies can be utilized for brewing. A banana-plant is 3-10 m high but cannot be regarded as a tree because has no trunk. The banana-fruit is seedless. Its "pseudo-trunk" has a lacunose structure, consisting of leaves wrapping around each other. The fruits form a garland-shaped string on the thickened leaf-stalks.

4. MANGO /Mangifera indica/

One of the most important fruit-trees. The fruit crop represents 12 million tons /5,5% of the whole world fruit crop/. MANGO is the food of millions of people. The riped fruit may be green, yellow or red. It is flat-shaped in very different sizes, weighing 50 to 450 g each. The peel is somewhat skinlike, and not edible owing to its high turpentine content. The flesh is succulent and full of aromas. In the middle of the drupe there is a large, flat and hard clingstone. The fruits grown in a plantation contain 20% sugar and many kinds of vitamins.

The yield capacity of a well-cultivated plantation amounts to 10-25 tons/hectare.

The ripe fruits are consumed in fresh condition or utilized for the preparation of juices, chutneys, jams, jellies, compotes and crystallized fruits which are exported mainly in form of frozen purée. The throw-outs originating from the proceeding as well as the stones are feedstuffs of high value.

5. PINEAPPLE /Ananas comosus/

The whole stem-part bearing many berries and small leaves transforms into succulent fruits /i.e. the socalled fruit branch/ in the second year after planting. The fruit weighs 1000-4000 g.
Yields: 30-50 tons/hectare.

The dead-ripe pineapple is good for canning, the early ripe fruit for consumption, the green half-ripe one for export.

Canned syrup with spiral or dice-shaped pineapple is preferred for export. Refuses resulting from processing (peel, interior parts, clipping) still can be utilized for the preparation of juices.

6. PAPAYA /Carica papaya/

This plant multiplied by seeds reaches the height of a tree. The flesh parts of the fruit are shaped in a characteristic roselike form, they contain latex from which papain can be obtained for the purposes of meat tenderizing and beer stabilization. The large, pear-shaped berry fruit weighing 1-10 kg each springs directly from the hollow stem. The peel of the fruit is originally green, but it becomes orange coloured in ripe condition. The substance of the fruit is soft as wax, and has an agreeable sweetish flavour.

Yield-capacity: 50-80 tons/hectare, depending on the subspecies in question.

Some time ago the whole fruit had been broken into small pieces, and - after sifting was frozen without any heat-treatment. This rather primitive method of processing resulted in obtaining a purée that got an unagreeable, pungent, sulfuric smell very soon. In order to eliminate this phenomenon new processing methods have been developed.

7. AVOCADO /Persea americana/

The pear-shaped fruit consumed also as a vegetable is essentially a large berry containing a single globular pit. The flesh of the riped fruit is soft as wax and tastes like nut. It contains 30% oil and vitamin B to a large extent. Its energy content exceeds considerably that of the succulent fruits. Its long-boled tree is evergreen.

The fully developed trees yield a crop of 5-12 tons/ hectare.

The dead-ripe, mellow fruits are gathered for local consumption. The semi-hard, half-ripe fruits are exported but no after-ripening can be achieved. The storage temperature varies according to the subspecies: some of them 5-7°C, others 12-13°C. In Europe this fruit is consumed in the form of pickles the demand for which would increase if the gathering time and the steady quality of the fruit could be optimalized. Oil of great value can also be squeezed from this fruit.

8. CHERIMOYA /Annona cherimola/

The green peel of the fruit may become brown under pressure, the flesh is creamlike, sweet-smelling and aromatic. The stones are dark-brown coloured.

The fruit is gathered just before being full-ripe.

At a temperature over 14°C it can be stored for two or three weeks. Easily damageable and perishable. Consumer in fresh condition or in form of salad, ice cream or juice.

9. GUAVA /Psidium guajawa/

The colour of the apple- or pear-shaped fruit varies from light-green to bright-red. Its inside part is divided into 4-5 cells where many small seeds are nested in the succulent, aromatic flesh. Has a very high vitamin C content. Weight: 30-100 g.

Yield capacity: 35 tons/hectare.

The fruit is hardly consumed in fresh condition. Preparation of juices, nectares, jams, jellies and consitent pastes is preferred.

Some time ago, the fruit had been cooked and thereafter it was simply sliced and squeezed. However, this method generated only a small juice output /25-30%/, besides, the vitamin C content dissolved and the aroma declined. Experiments made through a squeeze after refrigeration have shown that this operation is too expensive and does not increase the juice output. Nevertheless, in some countries a pectolytic handling has been applied by means of which - through simple packing-presses - an output over 75% can be achieved. The juice refining is carried out by passing the liquid mass through a precision sieve.

10. PASSION FRUIT /Passiflora edulis/

The small, globular fruit weighing 10-14 g has a rather hard, skinlike peel; the yellow flesh is jelly-like and very juicy with many small seeds. The fruit is the most aromatic when overriped and the peel has wrinkled. The sour-sweet aromatic flesh is consumed together with the seeds.

The full-ripe fruits can easily be separated from the stem, therefore they are picked or collected when fallen to the ground. The fresh fruits are consumed at the place, or fruit salads are made from them without picking out the seeds. A mass processing method is the preparation of juices which are - owing to the excellent and intensive aroma of passion fruit - mixtures of the original and other, less characteristic juices. The juice itself is an important source of carotene B.

Fresh fruits are not exported at all. All parts of the plant contain alkaloids inducing lowered blood-pressure and antispasmodic effect.

11. LITCHI /Litchi chinensis/

The fruit of a plum size has a skinlike peel of bright red colour. The single stone is enclosed in a fleshy, sour-sweet pericarp. Litchi is consumed in fresh or preserved condition. The dried fruit is similar to the raisin.

The fresh fruit can be cold stored through some weeks but in general it is preserved.

The yield capacity of a tree may be as high as 150 kg.

Storable through 5 weeks at a temperature of 3-4^{o}C, but over 20^{o}C it spoils quickly. It can be shipped by sea, but often reaches its destination in a damaged condition. The compote made from this fruit maintains the excellent aroma, therefore it is more suitable for export than the fresh fruit.

12. DATE /Phoenix dactylifera/

The 20 m high date-palm is the most important plant of Middle East and North Africa. There are more than 100 subspecies to be classed into three /soft, semi-dry and dry/ groups. The fruit serves for the daily alimentation in several Arabic countries and each of its parts can be utilized for different purposes. This stone-fruit of a plumlike size is of a colour varying between golden-brown and red-brown. The flesh is rich in sugar. The hard stone is covered by a silvery cere.

Dates are exported before being fully ripe, after which they are after-ripened in the sun or by artifical methods. The latter is carried out as follows: The fruit is plunged in a boiling 1% NaOH solution through one minute, then dried in a heater at a temperature of 50-55 ^{o}C.

Date is consumed in fresh or dried condition instead of bread or as a dessert. In addition, date can be processed for the preparation of jam or syrup. By the preparation of the syrup the ripe fruit is extracted by water, thereafter the liquid solution obtained is condensed. The stones serve as animal feedstuff.

13. FIG /Ficus canica/

The fig-tree is low and has an ample foliage. In order to maintain the conditions of the biological multiplication, also wild trees must be introduced among the cultivated plants. The number of the known subspecies is near 1000. In the course of the ripening all components of the flower are transformed into edible fruit-parts. The fruit itself is a soft formation blown up pyriformly.

Well cultivated plantations give an annual yield of 12 tons/ hectare which corresponds to a yield of 4-5 tons when taking dried dates into consideration.

The full-ripe but not too soft fruits can be consumed immediately. The fruit is - even by the most careful handling - easily damageable and must not be stored longer than through a few days. Hence, the sales possibilities are very limited, that is why a mass cultivation can take place only in the regions where the climatic conditions permit the drying in the sun or in driers. The fig jam is prepared with sugar by cooking the fresh fruits. The dried fig can be utilized for the preparation of fig paste suitable for the confectionery industry and sweet-shops.

FRUITS OF LESSER IMPORTANCE

14. KIWI /Actinidia chinensis/

A berry fruit of hen's egg size, with a thin and fuzzy brown peel. The flesh is delightfully aromatic and light-yellow coloured, containing many small seeds. KIWI has an overabundant vitamin C content. The treelike spiral trailer plant is a native of China, and has been cultivating to a large extent in New Zealand from the beginning of this century. Well storable and transportable.

15. POMEGRANATE /Punica granatum/

Red berry of apple size covered by a skinlike peel.

The hard flesh is not edible, but from the pericarps of the many small seeds a raspberry-red, highly aromatic sour-sweet juice can be obtained. Consumed in fresh condition or as a juice.

The 8 m high trees originate from the West Indies, later they have spread both in the Mediterranean area and in the tropics. The fruit is well storable and transportable.

16. JAPANESE PERSIMMON /Diospyros kaki/

Tomato-shaped and -sized, orange-coloured or yellow fruit. It is the most delicious in overripe condition when the flesh melts away. Native of East Asia, cultivated currently in the tropical highlands, in the Mediterranean area as well as in the southern regions of the U.S. The ripe fruit is consumed in fresh condition, but can also be cooked or crystallized and dried at the site, respectively. Spain and Italy export the fruit to other European countries.

17. CARAMBOLA /Averrhoa carambola/

A 10-12 cm long, light yellow and very succulent fruit with small brown seeds. There are sweet and sour subspecies. Utilized for the preparation of fruit salads, jelly-cakes and juices. The tree is 10-12 m high, the wild species is native of Indonesia, now cultivated all over the tropics.

18. TREE TOMATO /Cyphomandra betaceae/

Its egg-sized and -shaped yellowish-red or wine-red fruit is succulent and tomatolike. Originateu from Peru the tree has spread all over the Andes. Appears often in the gardens of the tropic area. Can be consumed either in fresh condition or after cooking as compote or jam.

19. MANGOSTEEN /Garcinia mangostana/

One of the most delicious tropical fruits. It is globular,wine-red and of small orange size. The peel is very thick, unfit to eat, and when pressed, easily breakable. Within the peel there are 5-7 seeds covered by edible, white, succulent, delightfully sweet pericarps. The fruit grows on a 15 m high tree the multiplication of which is very difficult.

It is consumed mainly in fresh condition. Can be prepared as salad or jam, the latter is mixed with other fruits.

20. MELON

Inside the glossy and hard rind there is a very succulent, sweetish, yellow, red or white flesh, with oleagineous small black seeds. Native of the African tropic and subtropic areas, now wide-spread in Europe and Asia as well.

Source: See annex II.

Annex VI

Important fruits and their most often processed products

Fruit	Juice, nectar	Concen-trate	Compote	Pulp	Jam, jelly	Syrup	Dried products	Sugat	Fermented product	Salad	Feed-stuff	Medicine and other	
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	
	Main products										By-products		
Grape	+	+			+	+	+		+		+	+	/tannin, tartar/
Citruses	+	+	+		+	+		+			+	+	/pectin, ethereal oils, flavonols/
Banana				+							+	+	/starch/
Mango	+	+	+	+	+			+		+	+		
Pineapple	+	+	+									+	/bromeline/
Papaya												+	/papain
Avocado										+		+	/edible oil/
Cherimoya	+		+							+			
Guava	+	+	+	+	+								
Passion fruit										+			/alkaloids/
Litchi			+										
Date					+	+	+						
Fig					+		+		+			+	/coffee substitute/
Kiwi										+			
Japanese persimmon				+			+	+					

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Mangosteene			+		+					+		
Carambola					+					+		
Pomegranate	+											
Tree tomato				+		+						
Melon	+							+	+	+		

Source: See annex I.

Annex VII

Nutritive substances of important tropical and subtropical vegetables

Vegetable	water %	protein %	carbo hydrate %	fats %	important vitamin A	B	concent C	Kcal / 100 g
sweet potato		3,5			+	+		32
string bean		2,2						44
tomato	95	1,0			+			22
egg-fruit		0,9						22
celery	93	1,2	3,6	0,2				
broccoli	89	3,3	4,4	0,2	+	+	+	
pumpkin	91	1,1	5,5	0,1	+			
artichoke	83	2,4	12	0,1		+		
bamboo bud	91	2,6	5,2	0,3		+		
green pepper	91	1,2	4,7	0,3	+		+	

Source: See annex I.

Annex VIII

A comparative analysis of the production costs of citrus fruit juices processed and packed by different techniques (exluding material costs)

/based on a case study/

Type of cost rate from total cost	Concentrated by freezing 200 g metal cans	Concentrated by freezing 4 litres metal cans	Natural juices 1,5 litre bottled
Packing materials	47	14	63
Wages and salaries	27	39	18
Storage, transport, sale	26	47	19
Totalling	100	100	100
Total cost /excluding materials/ defined in relation to each other	160	100	260

Source: Dr. Philip E. Nelson - Dr. Donald Tressler
"Fruit and Vegetable Juice Processing Technology"
AVI Publishing Company, Westport, Connecticut, USA.

Annex IX

Estimated loss account of the main fruits and vegetables cultivated in the developing countries (1980. percentage of the harvest)

	Production in 1000 tons	Estimated loss
Vegetables		
Onions	6,474	16-35
Tomato	12,755	5-50
Cabbages	3,036	37
Cauliflower	916	62
Carrot	557	44
Fruits		
Banana	36,898	20-80
Papaya	931	40-100
Avocado	1,020	43
Peach and apricot	1,831	28
Citruses	22,040	20-95
Grape	12,720	27

Source:

Food loss prevention in perishable crops. Food and Agriculture Organization, FAO of the United Nations. FAO Agriculture Services Bulletin 43-1981 I SNB 92-5-10 1028-5.

Annex X

Processed citrus: World consumption and projected demand, total and per caput

	Oranges	Tangerines	Lemons and Limes	Grapefruit	Total
	Million tons (or kg/per caput)				
Average 1979-81					
World	13,4 (3,0)	0,6 (0,1)	0,8 (0,2)	1,9 (0,4)	16,7 (3,8)
Developing	1,1 (0,3)	0,0 (-)	0,0 (-)	0,0 (-)	1,3 (0,4)
Developed	12,3 (10,5)	0,6 (0,5)	0,8 (0,6)	1,8 (1,5)	15,4 (13,2)
1990					
World	15,8 (3,0)	0,6 (0,1)	0,9 (0,2)	2.1 (0,4)	19,3 (3,7)
Developing	1,4 (0,4)	0,0 (-)	0,1 (-)	0,0 (-)	1,7 (0,4)
Developed	14,3 (11,4)	0 6 (0,4)	0,8 (0,7)	2,0 (1,6)	17,6 (14,1)
Growth rates	(..........................Percent per annum ....)				
Average 1970-80					
World	5,1	4,4	3,4		4,4
Developing	11,1	5,9	5,0		10,2
Developed	4,8	4,3	3,3		4,0
Average 1980-90					
World	1,6	0,[illegible]	1,0		1,5
Developing	3,0	4,8	2,9		2,9
Developed	1,5	-0,3	0,8		1,4

Numbers in parenthesis correspond to per caput consumption /in kg per year/.

Source: Citrus Fruit - Supply, Demand and Trade Projection
FAO Publication, Rome, 1986.

Annex XI

Fresh and processed citrus: World trade and trade projections

	1979-81		1990	
	Gross Exports	Gross Imports	Gross Export	Gross Imports
	(Million tons)			
Oranges				
World	13,2	12,2	17,0	16,3
Developing	8,3	1,4	10,9	1,8
Developed	5,0	10,8	6,2	14,4
Tangerines				
World	1,3	1,1	1,9	1,2
Developing	0,5	0,0	0,5	0,0
Developed	0,9	1,0	1,4	1,1
Lemons and Limes				
World	1,2	1,1	1,7	1,5
Developing	0,4	0,0	0,6	0,1
Developed	0,8	1,1	1,0	1,3
Grapefruit				
World	1,3	1,3	1,2	1,6
Developing	0,3	0,0	0,5	0,0
Developed	1,0	1,3	0,7	1,5
Total				
World	17,1	15,7	21,8	20,5
Developing	9,5	1,5	12,5	2,1
Developed	7,6	14,2	9,3	18,4

Note: Minor differences in the totals are due to rounding of figures

Source: **See annex X.**

Annex XII

Consumption by type of packaging materials, 1985

/%/

Country	Paper	Metal	Plastics	Wood	Glass	Textile and other	Totally
United Kingdom	36,8	26,1	24,0	1,4	9,2	2,5	100,0
Japan	45,6	14,8	22,8	7,2	4,3	5,3	100,0
USA	40,1	27,7	13,6	1,3	9,7	7,6	100,0
Federal Republic of Germany	39,8	21,6	27,8	3,0	7,6	0,2	100,0
Sweden	45,8	13,3	31,4	6,2	3,3	0,0	100,0
Austria	43,4	23,0	23,3	2,6	6,1	1,6	100,0
Hungary	62,1	16,1	6,1	0,0	14,9	0,8	100,0

Source: Dr. K. Lotz: Macro-Economic Analysis of Development of Packaging Industry between 1970-85. Paper for the IV. Congress of International Association of Packaging Research Institutes, JAPRI, Michigan, USA, 1986.

Annex XIII

World-wide Consumption of Packaging Materials
(1986)

1000 tons

	Europe	USA	France	World
Glass	13.000	14.000	3.322	35.000
Metal	3.200	3.600	575	12.500
Aluminium	376	1.200	51	2.500
PMC paper	470	3.500	56	
SGC paper	1.060		172	
Paper packaging	1.000		282	
Corrugated Cardboard	9.900	17.000	1.750	
Flat Cardboard	3.000	3.000	900	
Total paper/Cardboard	15.430	24.500	3.160	64.000
Wood	4.000	5.000	1.700	20.000
Plastics	5.300	5.000	880	16.000
Total	41.306	53.500	9.988	150.000
Sales /FF billion/	320	400	70	1.200
Population /millions/	351	234	55	5.000

Source: International Packaging Register of the Hungarian Institute of Materials Handling and Packaging. Budapest, 1987.

Annex XIV

Packaging material consumption per capita

(1986)

kilogram/capita

	Europe	USA	France	World
Glass	37,53	59,83	60,40	7,00
Metal	9,12	15,38	10,45	2,50
Aluminium	1,07	5,13	0,93	0,50
Paper/cardboard	43,96	104,70	57,45	12,80
Wood	11,40	21,36	21,82	4,00
Plastic	15,10	23,40	16,00	3,20
Total	118,17	229,80	167,05	30,00

Source: See annex XIII.

Annex XV

Packaging material production in the percentage of GDP

Country	1980	1983	1984	1985	1986
Austria	1,2	1,1	1,2	1,3	1,1
Denmark	1,6	1,8	1,9	1,9	-
United Kingdom	1,7	1,4	1,4	1,1*	1,1*
Finland	2,4	2,0	2,0	1,8	1,7
Japan	2,0	1,8	1,8	1,7	-
Norway	1,2	-	-	-	0,9
FRG	1,6	1,5	1,6	1,6	1,5
Sweden	1,4	1,1	1,1	1,1	1,6
USA	1,8	1,5	1,4	-	-

* Utilization

Source: **See annex XII.**

Annex XVI

TIN COATING AND LACQUERING
IN CASE OF VARIOUS CANNED FRUITS AND VEGETABLES

PRODUCTS	Body /Internal/		Lid /Internal/		Bottom /Internal/	
	Tin coating g/m^2	Lacquering	Tin coating g/m^2	Lacquering	Tin coating g/m^2	Lacquering
FRUITS						
Pineapple slices	12,5	No	25,0	Yes	12,5	Yes
Apricot	11,2	No	5,6	Yes	2,8	Yes
Fig	11,2	No	5,6	Yes	2,8	Yes
Fruit coctail	11,2	No	5,6	Yes	2,8	Yes
Grape	12.5	No	5,6	Yes	2,8	Yes
Pineapple juice	12,5	No	25,0	No	12,5	No
Grape fruit juice	11,2	No	22,4	No	11,2	No
Orange juice	11,2	No	22,4	No	11,2	No
Lemon juice	15,0	Yes	30,0	Yes	15,0	Yes
Grape fruit juice concentrated	2,8	Yes	5,6	Yes	2,8	Yes
Orange juice concentrated	2,8	Yes	5,6	Yes	2,8	Yes
Lemon juice concentrated	2,8	Yes	5,6	Yes	2,8	Yes
Jam Marmalade /bright/ except lemon and orange	12,5	No	5,6	Yes	2,8	Yes
VEGETABLES						
Artichoke	12,5	No	5,6	Yes	2,8	Yes
Beetroot	12,5	Yes	25,0	Yes	12,5	Yes
Cauliflower	12,5	No	5,6	Yes	2,8	Yes
French been /green/	12,5	No	5,6	Yes	2,8	Yes
Potato	12,5	No	5,6	Yes	2,8	Yes

Carrot	11,2	No	5,6	Yes	2,8	Yes
Pumpkin	11,2	Yes	22,4	Yes	11,2	Yes
Pepperoni	12,5	No	5,6	Yes	2,8	Yes
Rhubarb	15,0	Yes	30,0	Yes	15,0	Yes
Spinach	12,5	No	5,6	Yes	2,8	Yes
Whole tomato	11,2	No	5,6	Yes	2,8	Yes
Cabbage	12,5	No	5,6	Yes	2,8	Yes
Onion	12,5	Yes	25,0	Yes	12,5	Yes
Tomato juice	11,2	No	5,6	Yes	2,8	Yes
Chili souce	12,5	Yes	25,0	Yes	12,5	Yes

Source: The Present Situation of the Vietnamese Canning Industry and the Can-Making Facilities. UNIDO Technical Report prepared by Ottó Horváth, 1986.

Annex XVII

"MOBILE" PRESERVATION TECHNOLOGY

Mobile canning workshop includes can-making, produce processing, packaging, preservation as well as infrastructure.

In the centre of the workshop for food processing and packaging there are freight containers of 40 feet. They receive on the one hand the washed, cleaned and prepared basic row material coming from the conveyors, on the other hand the finished cans rolling in directly or by interposition of a transitory storer. After the filling and sealing process, the cans packed for consumer use are conveyed - through the pasteurizer and/or a turning-table, then by a manual feeding operation - to the autoclave consisting of 6 baskets at both sides.

On the basis of an annual production volume of 50 million cans, the processing requires steam of 1000 m^3/h, the sterilization 1500 m^3/h, the pasteurization needs 200 m^3/h. The electric energy demand is 34+1+5 kW/h.

The labeling and groupage packing /in corrugated cardboard boxes/ can also be mechanized if necessary. For the packaging process, it is reasonable to choose three pieces tin cans with welded body seams. In order to fit together the cans, the bodies are cut up /if needed, lacquered or printed/ in advance. The semi-finished bodies as well as both ends can be easily purchased.

The production line consists of the following elements:

- body welding automatic equipment
- inside /outside/ seam coating machine

- lacquer drier with gas-burner
- folding machine
- closing machine
- conveyors

The production capacity is verv flexible as far as can sizes are concerned. 150 cans/min can be made by an energy demand of 50 kW/h. From water 10 litres/min, from propane 6 kg/h are needed.

Material demand: The production of 1000 cans of 99 x 119 mm size, marked 1/1 requires cca 120 kg tinplate. Taking an annual production of 50 million cans, the total demand comes to 6000 tons of tinplate annually.

In order to keep moving the containers, a traction-engine with trailer is needed, wanting a daily Diesel gas oil supply of cca 500 litres.

The price of the packing material to be purchased ranges from 210 to 310 DM/1000 can units, depending on their quality and destination.

The manpower demand consists of 63 persons specified in the following.

MANPOWER DEMAND OF THE MOBILE CANNING WORKSHOP

Post	to be appointed	
	skilled worker	unskilled worker
Can-making	2	2
Preparation	1	2
Processing bench		max. 8
Conveyor		max. 8
Cleaning bench		max. 8
Turning table		1
Filling bench		4-8
Fluid filler		1
Belt-conveyor		1
Closing machine		1
Boiling pan		4
Pasteurizer	1	1
Sterilizer	1	4
Labeling and groupage packing	1	7
Infrastructure	2	1
Total demand	8	about 55

Investment costs of mobile canning workshop in conformity with the given conditions:

	DM
Can-making	1.100.000
Canning and pasteurizing	600.000
Labeling and groupage packing	100.000
Infrastructure	650.000
Means for displacement	620.000
Sterilizer /if necessary/	700.000
Total	3.770.000

Source: "Dosen für die Dritte Welt", Packaging Report, 2, 1985.

Annex XVIII

Comparison of investment and material costs of different packaging systems for juices

in French Franc /FF/

	System TETRA-BRIK	System ALUPAK	System DOYPACK
Total cost of ready-made consumer packaging units of 20-25 cl per 1000 pieces	285,86	527,15	320,23
Total investment costs of equipment with fittings	1.888.994	394.774	540.000
/Fittings from this:	533.144/		

Comment: This comparison was made for a packaging investment planned in a North African developing country, taking into consideration the characteristic conditions of the country in question (for example the availability of raw materials, the level of transport costs) on the basis of information given by manufacturers.

Conclusions:

a/. In case of the TETRA system, the cost of materials is the lowest but the investment is very high. The capacity exceeds the needs of the country, if carried out over a long period. Most probably a significant long-term under-utilization of the machines would result.

b./ ALUPAK requires the lowest investment but demands higher material costs. This type of packaging is suitable for food products which have a more viscous physical state than fruit juices. This packaging however would be unsuitable for the particular country in question.

c./ The DOYPACK system does not require costly investments and the material costs are not much higher than those of the BRIK system. The manufacturing possibilities and resistance seem to be satisfactory.

The most expedient and economical packaging method should be chosen on the basis of the above, and on the understanding that additional, detailed information on these packaging methods is at hand of the decision-makers.

Source: Taken from a UNIDO technical study prepared by the Agro-based Industries Branch.

Annex XIX

Reduction of Wastes from Packaging Relevant Materials in the Netherlands
(Planned Measures)   x 1000 t

Material / Measure	Glass		Plastic		Paper		Tinplate/Iron		Packaging *	
	1986	2000	1986	2000	1986	2000	1986	2000	1986	2000
Recycling/Reuse	215	430	55	145	1200	1500	50	125	500	1200
Other material reclamation	-	-	-	55	-	-	-	-	-	-
Incineration	90	-	160	240	400	600	-	-	500	800
Disposal	125	-	325	100	600	100	75	-	1000	-
Total	430	430	540	540	2200	2200	125	125	2000	2000

* Inclusive double countings

Source: Hans-Jürgen Oels, "Packaging and the Environment: European Regulations". Paper prepared for the International Packaging Congress, JFEC, Paris, 1988.

Bibliography

Codex Alimentarius Commission. Report of the CODEX Committee on Tropical Fresh Fruit and Vegetables. Mexico City, 1988.

_____ Report of the First Session of the CODEX Committee on Tropical Fresh Fruits and Vegetables. Mexico City, 6-10 June 1988.

Die Kulturpflanzen der Tropen und Subtropen. Verlag Eugen Ulmer, Federal Republic of Germany.

Dosen für die Dritte Welt. Packaging Report, No. 2. 1985.

Food and Agriculture Organization of the United Nations. Citrus fruit fresh and processed. Annual Statistics 1988. Rome.

_____ Citrus fruit-supply, demand and trade projection. Rome, 1986.

_____ Compendium of customs tariffs affecting trade in fresh and processed citrus fruit as of 1 January 1986. Rome.

_____ Trends and prospects in the market for citrus juices. Rome, 1986.

Früchte und Gemüse aus Tropen und Mittelmeerraum. Stuttgart, Kosmos Gesellschaft der Naturfreunde, Franckh'sche Verlagshandlung.

Fruit and vegetable juice processing technology. Westport, Connecticut, AVI Publishing Company.

Horváth, Ottó. The present situation of Vietnamese canning industry and the can-making facilities. United Nations Industrial Development Organization, 1986.

Lotz, Károly. Macro-economic analysis of development of packaging industry between 1970-85. Paper for the IAPRI Congress, Michigan, 1986.

Madi, Luis F. C. Situación de envase y embalaje en America Latina y el Caribe. Paper for the ALIMENTEC'82 Packaging Conference LANFI, Mexico City, 1982.

Oels, Hans-Jürgen. Packaging and the environment: European Regulations Paper for the International Packaging Congress, Paris, 1988.

United Nations International Trade Statistics Yearbook, 1986.