Opportunities in food processing

Setting up and running a small fruit or vegetable processing enterprise

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CTA's tasks are to develop and provide services that improve access to information for agricultural and rural development, and to strengthen the capacity of ACP countries to produce, acquire, exchange and utilise information in this area. CTA's programmes are designed to: provide a wide range of information products and services and enhance awareness of relevant information sources; promote the integrated use of appropriate communication channels and intensify contacts and information exchange (particularly intra-ACP); and develop ACP capacity to generate and manage agricultural information and to formulate ICM strategies, including those relevant to science and technology. CTA's work incorporates new developments in methodologies and cross-cutting issues such as gender and social capital.

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Preface

This handbook is the result of a collaborative effort by small business owners and advisers who support small-scale food processors in ACP countries, supported by the Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA). The information contained in the handbook was gathered by the researchers below, who surveyed local fruit and vegetable processing enterprises and prepared reports that were then edited by Midway Technology consultants. The following specialists reviewed the draft publication and made valuable contributions to the text from the perspectives of their own countries:

- Dave Harcourt, Council For Scientific and Industrial Research (CISIR FOODTEK) Pretoria, South Africa.
- Jane Nabawanuka, Kawanda Research Institute, National Agricultural Research Organisation (NARO), Uganda.
- Richard Beyer Consulting (Food Science), PO Box 363, Pacific Harbour, Republic of the Fiji Islands.

We hope this handbook will meet the needs of small-scale enterprises and the agencies that support them by providing technical and business information that was previously difficult to find, and by helping entrepreneurs to update and improve their businesses for the benefit of their consumers and, of course, their own profitability.

If you find this handbook useful, please take a few minutes to complete the feedback form at the end of the book. Your comments and suggestions will be used to improve the later books in this series.

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About the authors and researchers

Barrie Axtell is a British food technologist with 30 years' experience working in Africa, Asia and Latin America. His particular interest centres on small-enterprise-based drying of fruits and vegetables and processing high value crops such as medicinal plants, spices and essential oils. He has co-authored 15 books and more than 20 articles on the role of appropriate technology in food processing.

Peter Fellows is a consultant food technologist and a Director of Midway Technology. He is Visiting Fellow in Food Technology at Oxford Brookes University in UK and has held the United Nations Educational, Scientific and Cultural Organization (UNESCO) Chair in Post-Harvest Technology at Makerere University, Uganda. He is an experienced author and has published 19 books and more than 30 articles on small-scale food processing. He has had practical experience of working with the food processing industry and the institutions that support it in 20 countries.

Joseph Hounhouigan is a Professor of Food Science and Technology at the Faculty of Agricultural Science of the University of Abomey–Calavi, Benin. He has been the Head of the Department of Nutrition and Food Science for more than 10 years. Scientific Adviser and member of the Food Science Advisory Committee of the International Foundation for Science (IFS), he has over 20 years experience in research, development and transfer of food technologies for micro- and small-scale enterprises. He has co-authored 6 books, more than 30 articles in international journals and more than 25 scientific communications on traditional and improved African food processing and quality assurance.

Peggy Oti-Boateng of the Technology Consultancy Centre of Kwame Nkrumah University of Science and Technology (KNUST), Ghana, is the Director of the Centre and a member of the UNESCO Expert Group on Technology and Poverty Reduction. She has over 24 years' experience in research, development and transfer of food technologies for micro-, mini- and large-scale enterprises, with a particular interest in enterprise development for women. She has also developed nutritious and affordable foods for vulnerable groups such as

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children and people living with HIV/AIDS using locally available foods. She has written several books and journal articles on food processing and storage, nutrition, packaging, sustainable bio-energy for rural development and policies for enhancing the technological capability of micro- and small-scale enterprises through micro-finance.

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We also wish to thank the following small-scale industrialists in Africa, the Pacific and the Caribbean for sharing their experiences of the problems and successes of operating their fruit or vegetable processing enterprises and, in doing so, contributing to the success of others:

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Kenneth Gyan-Kesse, Ken Farm Fresh Products Limited, UPO Box 199, Technology Consultancy Centre of Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana

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July 2007

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How to use this book

This book is intended to be a practical guide to help improve the operation of a small fruit and vegetable processing enterprise – with each different aspect covered in separate chapters. It is intended to be read alongside the umbrella publication Opportunities in Food Processing, which gives an overview of the different aspects described here in more detail. If you have an area of your operation that is a particular problem, we recommend that you first read the relevant Chapter and act on the recommendations.

If you are starting a new business or simply want to achieve an overall improvement in your operations, we suggest that you read the whole book and make notes on what you need to do in the space provided at the end of each Chapter in the **READERS' NOTES**.

However, operating a small business is a full-time job and you may not have the time at the moment to read the whole book. We have therefore included a number of ways that you can use to quickly get the main points in each subject area.

First, you can look at the **TIPS FOR SUCCESS** at the start of each Chapter. These are ideas provided by successful fruit and vegetable processors in ACP countries that you can use to improve a particular aspect of your business.

Next, important points and ideas are highlighted in the text by using this bar and in bold type. This indicates where common mistakes are made, or where you need to consider something that you may not have thought about before.

If you want to get the main points from a Chapter, there is a **SUMMARY** of the important aspects at the end of each one.

Finally, again at the end of each Chapter, there is an **ENTREPRENEUR'S CHECKLIST** that you can use to tick the main actions you need to take to improve that aspect of your business.

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Introduction 1

This book covers the important aspects of running a fruit or vegetable processing business, including choosing products, preparing a feasibility study, finding and developing suitable markets, selecting equipment, choosing a site and setting up the premises. Developing new products, processing and quality assurance, and managing the finance and business operations are also described. The case studies provide practical examples showing how others have built a successful business.

Tips for success

✔ Don't skip this chapter

The selection of suitable products for small-scale manufacture and the processes chosen to make them, require very careful consideration. It is not sufficient to assume, as many 'advisers' do, that simply because there is a surplus of a crop each year, a viable fruit or vegetable processing business can be created to use up the excess. There must be a clearly identified demand for the processed fruits or vegetables, or otherwise nobody will buy them and they will remain unsold on retailers' shelves instead of rotting in the field.

In general, products for which there is a high demand and a high added value are suitable for small-scale processing. Typically, these include snack foods, dried foods, juices, pickles, chutneys etc. (Figure 1.1) made from fruits and vegetables that have a low price at harvest. Their high added value means that a relatively small amount of food can be processed to earn a reasonable income. In addition, the size and type of equipment needed to process at this scale is affordable to most small-scale entrepreneurs.

However, an important consideration in nearly all fruit and vegetable processing is the relatively short harvest season for each crop. This means that processors have to buy crops for the entire year's production and store them properly until they are processed. Alternatively they process a succession of crops as they come into season. Both approaches require more careful production and financial planning than some other types of processing to

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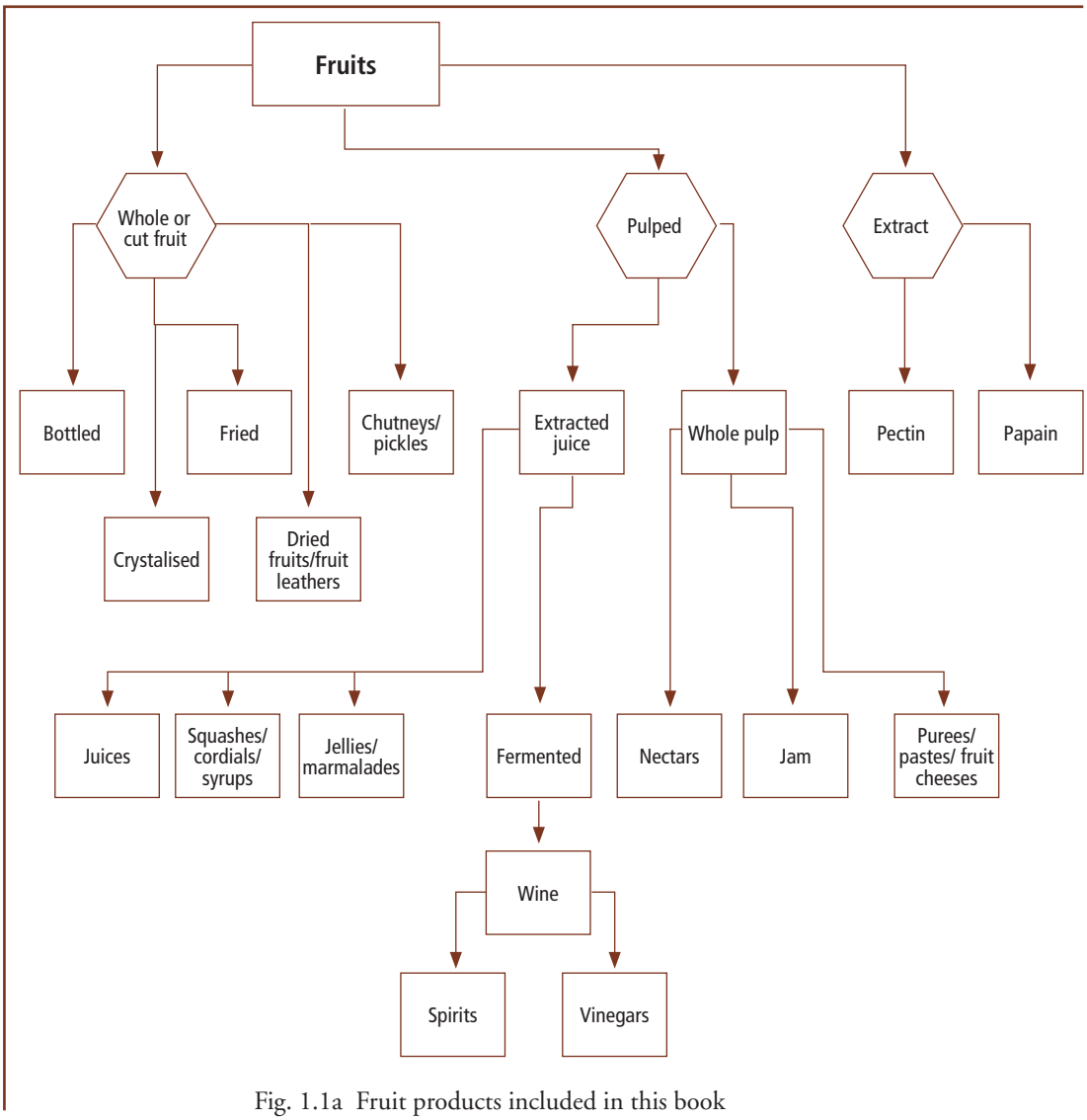


Fig. 1.1a Fruit products included in this book

maintain a positive cashflow. In addition, there are unpredictable supplies and large variations in prices for raw materials because crop yields vary considerably according to the weather, rainfall patterns, and plant diseases. The colour, flavour and texture of fruits and vegetables rapidly change after harvest and it is also therefore necessary to process them quickly to prevent spoilage and avoid financial losses.

A further consideration is the safety of processed fruit and vegetable products. Most fruits are acidic and their acidity prevents the growth of food-poisoning

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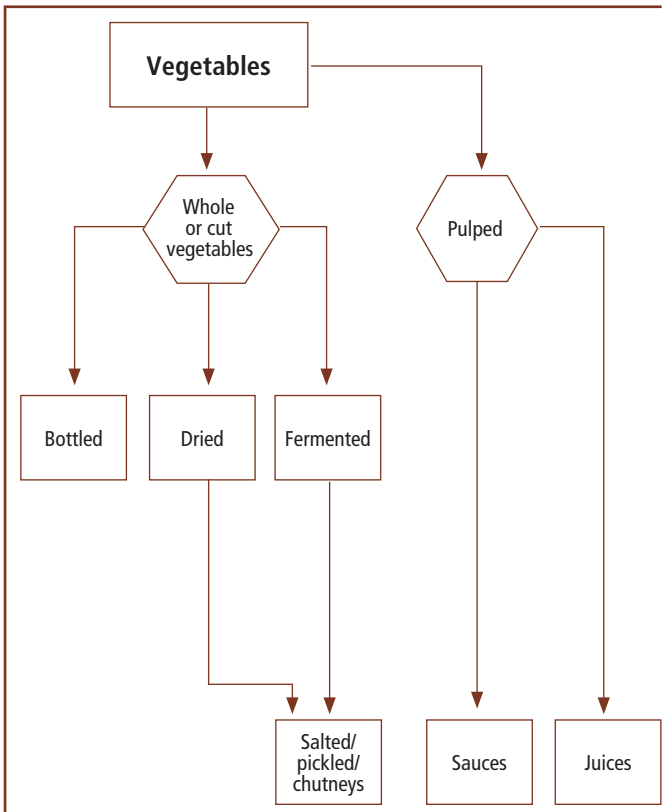


Fig. 1.1b Vegetable products included in this book

bacteria. Moulds and yeasts are able to grow in processed fruit products, but they produce obvious signs of spoilage that deter consumers from eating the food. Even if contaminated fruit products are eaten, yeasts and moulds rarely cause severe food poisoning. Vegetables are less acidic than fruits, and food-poisoning bacteria are able to grow in vegetable products. This is particularly dangerous as certain types of bacteria release poisons (or 'toxins') into the food, but do not produce signs of spoilage. Consumers may not be aware that the bacteria have contaminated the products and eat the poisoned food. Careful control of processing conditions and attention to hygiene are therefore essential when processing less-acidic vegetable products.

The above aspects are described in more detail in the companion publication: *Opportunities in Food Processing, Volume 1*. The fictional conversation in Table 1.1 shows the kind of answers that a new entrepreneur might give to some important questions about fruit and vegetable processing, and indicates the chapters of this book that contain the information they need to answer them.

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Small business adviser	Potential entrepreneur	Aspect to consider	See Chapter
Why do you want to start a fruit processing business?	Because I think people really like juices	Market	2
Who else sells juices?	My friend Beatrice	Competition	2
Where will you set up your business?	At home in the kitchen	Premises	3
What equipment will you need?	Same as Beatrice uses	Equipment	3
Have you thought about making a different product?	No	Product development	4
Will the equipment and room be clean?	I'll get my own special table and use bleach to clean it	Hygiene	5
Will the quality be OK?	Well I hope so	Quality	5
Are the water and electricity supplies OK?	Sometimes	Services	6
How many will you produce?	Maybe as many as I can sell	Production planning	6
Will you employ others?	It all depends on how much money I can make	Staff planning	6
Have you done this before?	No, but I watched Beatrice	Experience	6
Have you been trained at all?	I told you, I watched Beatrice	Expertise	6
How much will the juices cost?	I haven't a clue	Pricing	7
Where will you get the capital?	What's that?	Finance	7

Table 1.1 Aspects potential entrepreneurs should consider, and where help can be found

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Markets for processed fruits and vegetable products 2

2.1 The need for a feasibility study

The first step towards operating a successful fruit or vegetable processing business is to have a good idea – but this alone is not enough. You also need to find out whether the idea is feasible, and if necessary to convince financial backers (friends, family members, banks or shareholders) to support the idea. A feasibility study (*Opportunities in Food Processing, Volume 1*, Section 3.1) is used to find out about the different components of the proposed business. When this information is written down, it is known as a business plan (Table 2.1).

It is not always easy to get started, but with persistence, help and determination, almost anyone can start a small processing business. Case study 2.1 illustrates the value of conducting a thorough market and feasibility study before getting started.

2.2 Selecting suitable products

Once potential producers decide that they wish to start a fruit or vegetable processing business, the first thing they

Tips for success

- ✔ Do a proper feasibility study – don't take any short-cuts
- ✔ Make sure you know that the demand exists before introducing a product
- ✔ Advertise using media that your customers will see and hear
- ✔ Aim to please: customer satisfaction is very important for the growth of the business
- ✔ Always put your customers first
- ✔ When carefully planned, new product development can increase your profits
- ✔ Target different market sectors to satisfy different spending abilities
- ✔ Do not simply copy others, be creative and enter the market with unique products
- ✔ Failing to plan is planning to fail
- ✔ Keep a close watch on sales and be in regular contact with your key customers
- ✔ If you can, visit other people in the same type of business
- ✔ Only supply quantities that will sell within their shelf life
- ✔ Pay as much as you can afford for the label
- ✔ Read Sections 3.1, 3.3, and 9.1–9.4 in *Opportunities in Food Processing, Volume 1*

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Component	Examples of aspects to include	See Section
Background to the business	Name, address and contact numbers of business owner, type of product(s) proposed. Any relevant experience of the owner	–
Market analysis	Overview of the type(s) of market for the fruit or vegetable products, estimated present and potential demand, market segments that will be targeted, competitors, proposed market share. The main assumptions that have been made	2.2
Site, factory layout and services	Location of proposed processing unit and conditions at the site. Building plans and construction work required, construction timetable. Description of plant layout and service requirements (power, water, fuel etc.). Any environmental impacts (waste production, air/water pollution, noise etc.)	3.1–3.3
Facilities and equipment	Proposed production capacity, sources and costs of equipment, production inputs (raw materials, ingredients, packaging), other equipment (e.g. vehicles, office equipment). Machinery commissioning plan and timetable	3.4+3.5
Staff	Production and administration staff (number of people and skills required) and training to be given. Staff recruitment plan/timetable	6.4
Production plan, marketing plan	Production rates to meet identified demand, advertising and promotion required, distribution methods, sales outlets, projected increase in demand	2.3+6.3
Financial plan	Cost of site, equipment and buildings, working capital, (total investment cost), total production costs, sources of finance, cash-flow analysis, balance sheet, profitability calculations (rates of return, break-even analysis, sensitivity analysis)	7.1–7.4

Table 2.1 Main components of a business plan

should do is to find out what products are in high demand. Alternatively if they have identified a product that they wish to make, what is the likely demand for it? This can be determined by conducting a short market survey. There are market research companies in many ACP countries that are able to do this type of work, but it is better for producers to do it themselves because they will then properly understand their customers' needs. If necessary,

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Case study 2.1 The need for a feasibility study

Examples of experiences from Africa and the Caribbean on the value of doing a feasibility study are described below.

"We engaged the services of a business consultant to advise on how best to achieve the company's objectives. The consultant, having conducted market research, presented his findings and the management and workers developed a business plan that clearly stated the company's vision, mission and objectives and the strategies required for achieving the objectives. We also did a strengths, weaknesses, opportunities and threats (SWOT) analysis to review the strengths, challenges and opportunities of the business. For example, we had to upgrade our technology and improve our staff's capacity by recruiting more people. We had to locate additional sources of raw materials and re-locate the enterprise to enable us to meet the new production targets. We also set new quality assurance (QA) and marketing targets, and introduced branding of products to make them more competitive and profitable".

Despite most of them being illiterate, the women engaged the services of a non-governmental organisation (NGO) to conduct a feasibility study for them and provide them with vital information on the *gari* and soybean market. This is a prerequisite for accessing a credit facility from the development bank. The Food Crops Development Project of the Ministry of Food and Agriculture has also provided them with results of their market/baseline studies of the acceptability of soy-*gari* by households, schools and hospitals as well as its export potential. This enabled the women to expand their market.

Prior to expanding the company, the owner engaged a marketing consulting company that carried out a feasibility study and conducted market research on product preference and size of market. The consulting firm travelled countrywide putting up exhibitions and surveying the public and restaurant owners with questionnaires. Products were displayed and taste testing by the public was carried out to find consumer preferences. In this way they determined the size of the market and the changes that were needed to take advantage of the market. Customer complaints were also carefully analised, but in fact they have hardly had any complaints from customers since the company was re-equipped and upgraded a year ago.

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processors can obtain assistance from advisers or university marketing staff on how to conduct a survey (see *Opportunities in Food Processing, Volume 1*, Section 3.3). It is important that when seeking information about preferences for particular products processors remember that a customer is the person who buys a food and a consumer is the person who eats it – these are not always the same people. Customers can also be wholesalers or retailers.

The best way to conduct a market survey is by asking a selection of people for their views on:

- the product and its quality
- how much they will buy, how often and for what price.

Product quality

This should be a short exercise to keep the costs low and a convenient way is to use simple questionnaires (Tables 2.2 and 2.3). Questions can focus on the things that customers like or dislike about existing (competitors') products or samples of a new product that a producer has made.

Question					
1 Which type(s) of juice do you buy most often?	*Write types of juice(s)*				
	1 Very good	**2 Good**	**3 Average**	**4 Bad**	**5 Very bad**
	Tick the appropriate box				
1 What do you think about the colour of the juice you buy?					
2 What do you think about the taste?					
3 Is it sweet enough for you?					
4 Do you think that the quality is good for the price you pay?					
8 Is there anything else that you think is good about the juice that you buy?	*Write answers*				
9 Is there anything else about the juice that you would like to see improved?	*Write answers*				

Source: Adapted from Fellows, 1997.

Table 2.2 Example of a survey questionnaire on the quality of competitors' juices

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Case study 2.2 Market research

The company has developed very interesting products using local raw materials. "We have pure pineapple, orange, ginger, ginger-pineapple, watermelon, mango, orange-mango, lemon and multi-fruit juices, pineapple jam and marmalade". They have based the development of these products on needs assessment of consumers such as housewives, students, pupils and restaurants. "For example, the preparation of *agushi*, a high-protein cucurbit vegetable that is often used by housewives, restaurants and schools, is so labourious that most people avoid using it. Producing it commercially, we have made it convenient for all users. The *agushi* is used all across West Africa, and hence has a big market".

The management team makes decisions about the company in consultation with the company's consultant, who advises on food business, marketing and food services. The company also funds research and makes informed decisions backed by credible data and findings from the research when processes have to change or a new product is introduced. Invariably this is done in consultation with the workers. Last year they spent over ¢40 million (Ghanaian cedis, equivalent to US$4,500) on research to improve the quality of their products. This is not a usual practice for small- or medium-scale manufacturers.

Mr K got his business idea when he visited an orchard in California when he was a student there and was struck by the small-scale businesses producing orange juice concentrate for local American and export markets. When he returned home, he carried out a feasibility study and was convinced about the economic potential of an orange juice processing industry in the Ashanti Region of Ghana. He then went ahead to acquire an initial 30 acres of land for the cultivation of oranges and gradually cultivated it. He can now boast of a 100-acre orange plantation and 45 acres of mango. It took 10 years from the conception of the idea to implementing the project. Mr K also uses university contacts to undertake student projects on feasibility studies, product development and customer preferences at the School of Business, Departments of Biochemistry and Food Science, Chemistry, Sociology and Graphic Design.

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The results of this type of survey can be analysed by adding together the numbers of answers such as 'very good', 'bad' etc. In the example below, the answers to questions about fruit juice show that 65% of people (22 out of 60) found the colour of the juice to be good or very good, 43% (24 out of 60) did not like the taste of the juice and 35% (21 out of 60) did not like the sweetness. Half of the people interviewed did not think the quality of the juice they bought was good value for money. Results like these show that a potential market exists for a new product that is of better quality, or of a similar quality but with a lower price.

Question	Results from 60 customers					
	1 Very good	2 Good	3 Average	4 Bad	5 Very bad	Total
What do you think about the colour of the juice you buy?	17	22	21	0	0	60
What do you think about the taste?	7	8	19	24	2	60
Is it sweet enough for you?	7	10	22	21	0	60
Do you think that the quality is good value for the price you pay?	2	8	20	21	9	60

Table 2.3 Analysis of a survey on the quality of competitors' juices

Market size and value

A different set of questions is needed when assessing the size and value of a market for a particular product. (Size is the total weight of product bought per month or per year, and value is the amount of money spent on that product each month or year). An example of a how to calculate market size and value is shown in *Opportunities in Food Processing, Volume 1*, Section 3.3.

The more people that are interviewed, the more accurate is the information retrieved, but a balance is needed between the time and cost of interviewing large numbers of people and the accuracy of the data obtained. As a guide, 50–75 interviews should produce good information about the market for a product in a particular area.

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Competing products

Entrepreneurs should recognise that there are different types of competing products: for example, someone wishing to make fruit juices might think how consumers view the available products when they are thirsty. They have a choice of:

- hot drinks (tea, coffee etc.)
- cold soft drinks (such as milk, juices, squashes)
- alcoholic drinks.

These products are all 'general competitors' that are able to satisfy the consumers' thirst. If a consumer chooses cold soft drinks that can be drunk straight from the bottle, they then have a choice between carbonated (fizzy) soft drinks, bottled water and juices. These different kinds of soft drink are known as 'type competitors'. Finally, on choosing juices, there are different juices and different brands of the same type of juice, which are known as 'brand competitors'.

Producers also compete with the profit margin and level of service that they offer to retailers and with special offers or incentives to customers. New entrepreneurs must therefore assess each of these factors when deciding what the competition is and how to deal with it. This is conveniently done using a strengths, weaknesses, opportunities and threats (SWOT) analysis. Details of how to conduct a SWOT analysis are given in *Opportunities in Food Processing, Volume 1*, Section 3.3.



Fig. 2.1 Passion fruit drinks from three competitors (Photo: Peter Fellows)

Entrepreneurs can get information about competitors by:

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1. Discussing with retailers the amount of sales of different brands and any seasonality in demand. Which products are becoming popular and which are losing favour? What types of customers buy particular products and how often? Does the retailer put on any special displays for some suppliers? What do they think about the idea for a new product and do they think they will sell a lot of it?

Case study 2.3 Competitors

A number of examples of how to deal with competitors are described below:

Mr K has several competing orange juice processors in the country but his company is the only one that produces fresh orange juice in the Ashanti and northern regions. His major competitors are foreign companies such as Ceres, Don Simon etc. and a local Ghanaian company that produces diluted orange juice and has a very effective distribution chain with outlets covering the breadth and length of the country. They advertise on television and in the print media. He competes effectively by selling to niche markets and maintaining a reasonable selling price.

Competitive products are produced by small anonymous enterprises but Mrs L's chips are the only ones regularly seen in the shops and supermarkets.

The main competitors of Mrs O's company include multinational companies such as Unilever, imported fruit juices and three Ghanaian companies. She is aware that she cannot compete with big multinational companies when it comes to packaging, so she sells fruit juices in bulk to them.

She has developed a new recipe using cassava and wheat composite flour as a means of reducing raw material costs for her fried chips. For many years she had only two or three competitors, but she now has to compete with others from neighbouring towns and Kumasi. She has labelled her chips to distinguish them from those of her competitors and she supplies the chips to retail shops on either credit or cash basis.

From 6,600 litres of fruit juice produced in 2002, Mrs L increased her production to 10,545 litres in 2003 and 30,648 litres in 2004, which shows the great potential of the market. One competitive enterprise is known to produce similar product, but its market share is unknown.

In Ghana Mr M commented: "Many people are now going into this business so it is important to target the right market and sustain it through constant innovation and by adhering to strict quality assurance".

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2. Looking at advertising and retail displays of competing producers and obtaining copies of their price lists.
3. Asking the local Employer's Federation or Chamber of Commerce for any information they have on the market for similar products.
4. Visiting trade fairs and talking to other producers and their customers.
5. Looking in trade journals, manufacturers' association magazines and newspapers for information about the market and the activities of competitors.

When the SWOT analysis is completed, an entrepreneur should be able to answer the following questions:

- Who is producing similar products and where are competitors located?
- What is the quality and price of their products?
- What can I do to make a new product that is better than those of competitors?
- Why would customers want to change to a new product?
- What offers or incentives do competitors give to retailers?
- What are competitors likely to do if a new product is introduced?

The answers to these questions are then used to create a marketing strategy (Section 2.3).

It is important to be honest and realistic when doing these evaluations. Even excited and very positive entrepreneurs should remain realistic while making sure they are not put off by the difficulties. They should remember there is no benefit in developing a view that is too optimistic, even if it convinces the bank, because it could mean that the business is unable to reach its targets and has to re-plan and re-finance, or worse still is forced out of business.

Many small-scale processors and processors who were interviewed for this book complained about the activities of their competitors. For example, they considered that some competitors use underhand practices to win customers, make false allegations, or make substandard products to increase their profits (see Case studies 2.5 and 2.6). It is difficult in a book of this type to describe in detail the ways in which small businesses can compete effectively and honestly but, in summary, the following actions can assist a genuine small-scale processor:

- develop good relationships with customers, treat them with respect and deal with them honestly

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- deliver what is promised and on time
- do not make false claims in promotional materials
- do not spread rumours about competitors
- find out from consumers and trade associations what competitors are doing and saying
- identify competitors' strengths and weaknesses
- use this information to be 'one step ahead' of competitors.

By developing good relationships with customers and 'staying above' any arguments with competitors, a small-scale processor is likely to continue the business and make it grow. Customers will ignore false information and may even pass on information about competitors' dishonest activities that can benefit the business. Other ways in which the relationship with customers can be strengthened include:

- agreeing contracts with retailers/wholesalers and suppliers
- preparing a product guarantee that is written on the label and
- accepting liability for any substandard products.

Details of contracts, product guarantees and product liability are described in *Opportunities in Food Processing, Volume 1*, Section 4.7.

2.3 Developing a marketing and selling strategy

Some processors confuse marketing with selling, but the two are very different. Marketing is deciding what to do to meet customer's needs and how a product can be made more competitive. Selling is the action that results in a customer buying a product (e.g. taking telephone orders, delivering to customers, selling from a factory shop, visiting shops and taking orders or providing vendors at sports events).

Good marketing paves the way for successful selling by making a customer ready to buy a product.

Market segments

This term describes different identifiable groups of customers. There are different types of markets for fruit and vegetable products that can be categorised into four groups (Table 2.4). Within each group there are

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Case study 2.4 Benefits of a marketing plan

The marketing consultant worked with the management and the Board of Directors to develop a comprehensive marketing plan that has strategies and targets for short- (6-month), medium- (2-year) and long-term (5-year) periods. They now have a production plan that takes advantage of bumper seasons to product certain products (e.g. when oranges are in season, the company produces fruit juices, marmalades and jams at full capacity, whereas these products are produced at 50–70% capacity during the lean season). During this time, production of other products such as dried onion and ginger, and shito sauce (a rich hot sauce often added to meals to provide an extra spicy taste) is undertaken. This arrangement has worked very well to ensure all-year-round production and use of the machinery.

sub-divisions that may have different and specific needs. For example, in institutional markets the segments may include food for children in rural schools, foods that are used in meals for patients in district hospitals, or for soldiers in military barracks. However, for fruit and vegetable processors the retail and food service markets are likely to be the most important in the majority of ACP countries.

Within the retail sector, there are different types of outlets and different groups of consumers are likely to prefer a particular type. For example, in Table 2.4, supermarkets in ACP countries are usually only located in large urban centres where they are mainly used by relatively wealthy urban consumers. Shops can be located in urban centres, rural towns and larger villages, and kiosks are found almost everywhere. Fruit and vegetable products are mainly consumed as:

- foods for use in meals prepared at home (e.g. dried fruits and vegetables, jams, pickles, sauces and chutneys etc.)
- foods that are also consumed away from home (e.g. fruit snacks, juices).

The importance of identifying these different segments to be able to better understand market size is three-fold: firstly it is possible to tailor the product to suit a particular group of customers; secondly to target the product promotion and sales methods to a particular segment; and thirdly to choose distribution and sales outlets where people in the particular segment usually buy their food. This market information may include the following items:

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Types of customer	Examples of fruit and vegetable products
Retail	
Supermarkets	All products
Shops	All products
Kiosks	Juices, dried fruits and vegetables, fried products (e.g. banana chips)
Food service businesses	
Tourist hotels/lodges	Juices, jams/marmalades, pickles. chutneys, sauces, wine, tomato paste, wines, vinegar, spirits
Take-aways	Tomato sauce/paste
Cafes	Juices, sauces, fried products (e.g. banana chips), tomato paste/ sauce, squashes and cordials
Institutional	
Schools	Dried fruits and vegetables, tomato sauce, squashes and cordials
Hospitals	
Military barracks	
Other food businesses	
Bakeries	Jams for cakes and doughnuts
Wine makers	Fruit juices for fermentation

Note: This table does not include export markets. If small-scale manufacturers wish to export fruit and vegetable products they should consult the international standards described by the *Codex Alimentarius* Commission (also Chapter 5, Section 5.1)

Table 2.4 Examples of market sectors for processed fruit and vegetable products

Customers:

- Who will be your customers (businesses, institutions, private individuals)?
- Where are your customers (urban, rural, which towns, nearby to production site)?
- What are the average income levels of your intended customers?

Promotion and sales methods:

- How will your product be packaged?
- What promotion or advertising do you intend to do?
- Who will sell your product?

Distribution and sales outlets:

- Where are the sellers located?
- How will your product be distributed?

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Case study 2.5 Examples of choosing market segments

The group of processors, under the leadership of Madam M, have carved a niche for themselves and their soy-fortified *gari*. They do not have any formal advertising but they insist that the quality of their product promotes it, both in Ghana and overseas. Their product is in high demand and has a large market. They supply schools and hospitals in the Brong Ahafo Region in Ghana as well as Kumasi and Accra. The *gari* is sought after by both Ghanaian and Nigerian exporting businesses, which have on many occasions offered to pay in advance so that the women would only sell to them, although the such offers have been refused because they would limit sales prices.

Mr K established his business in 1997, producing 50 litres of fresh orange juice a day. He currently employs 10 people with a daily production of 1,500–2,000 litres during the orange harvest season. He supplies hotels, Shell Shops and Mobil Marts at petrol stations and other institutions, predominately in Kumasi, Takoradi and Accra as well as other parts of the country. He has recently increased his market by selling to restaurants and the university community in Kumasi. He sells over 1,000 litres of orange juice a day to nutrition-conscious university students and cannot meet the demand.

Mrs E's main customers for plantain chips are schoolchildren, teachers, neighbours, street vendors and retail shops. She supplies 150 students in her own school, and those in other schools, 300–500 children in all. She supplies three retail shops in town and six street vendors, which is a sizeable market by her town's standard. She does not advertise formally but the quality of her product sells it – and the children love her chips.

The customers for Mrs L's plantain chips and her baobab drink are exclusively retailers. Chips are sold to the supermarkets or superettes and the baobab drink is sold to restaurants, hotels or drink shops. The customers buy on credit and ensure payment when the stock is replaced.

In many ACP countries it is mostly women who shop for family foods, and sales of fruit and vegetable products to men and children may be confined to juices and snack foods. A marketing strategy is therefore likely to focus on women customers. Alternatively, fruit and vegetable products that are eaten outside the home may have a broader range of customers. Taking fruit snack bars as an example, these can be made to compete with alternative products such as sweets. The consumers in both rural and urban areas are likely to be children

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but the customers may differ depending on the location. In rural areas where there may be less disposable income, mothers may buy an individual sweet for a child from a village shop or at weekly markets as a reward or for a special occasion. Or a father may buy sweets as a special treat when he returns home from a period away from the household. Although only a small proportion of poor rural people may buy snacks each week, the large numbers in rural areas mean that the market size can be large. If the price is competitive and the packaging is attractive, fruit-based snacks can compete with sugar-based sweets. In urban areas, families may have more disposable income, more knowledge about dental problems caused by excessive sweet consumption and a desire to eat more 'healthy' foods. These mothers may therefore prefer to buy a fruit bar, as they perceive that it will be better for their children's health. In cities wealthier mothers may buy larger bags of such bars from supermarkets, which are given to children over a period of time. Alternatively, people may give money to children to buy their own sweets from local kiosks. In some countries, children in rural areas buy products from hawkers who buy bulk packages and sell individual items. In this example there are therefore a number of market segments that a fruit snack producer may wish to target:

- rural mothers who buy individual sweets from village shops or weekly markets
- rural fathers who buy individual sweets from kiosks at bus stations or village shops
- urban mothers who buy packets of sweets from supermarkets or local shops
- urban mothers who would prefer to buy fruit-based sweets rather than sugar-based sweets
- urban children who buy individual sweets from local kiosks.

A fruit bar producer can therefore develop a marketing strategy that targets the product to the largest market segments.

Marketing mix

When the information about who the main consumers will be, where they are located and how they buy their foods is added to that about the quality and price that consumers expect, the result is known as the 'marketing mix',and is often described as the '4Ps' – Product, Place, Promotion and Price. Examples of components in a marketing mix are described in Figure 2.2.

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Product	Place
Better quality Better appearance More attractive packaging Clearer labels More nutritious More varieties Different colours Better flavour Available in required amounts	Longer opening hours Better decoration Cleaner environment Popular location Delivery service Fast and friendly service Good range of stock Ease of supply
Promotion	**Price**
Advertising Free samples Competitions and shows Articles in newspapers Special promotions In-shop displays	Lower prices Discounts for higher quantities Special offers Credit facilities

Fig. 2.2 Examples of factors to take into account in a marketing mix

Using this information, producers can then refine their product to meet customers' needs. This involves:

- creating or modifying a product that has the appearance, flavour, size etc. required by the customers
- developing an attractive package
- negotiating with wholesalers, retailers, distributors, hotel and restaurant owners etc. who will sell the product to target customers
- using methods of promotion that reach the intended customers
- setting a suitable price (pricing is described in chapter 7) and
- producing and supplying a uniform quality product in the amounts required.

Marketing therefore involves putting in place systems that will both make consumers believe that they are buying something special that meets their needs and also supplying the right amount of product at an acceptable price when the customer wants to buy it.

However, customers' perceptions are not just about price and quality, but may also include status, enjoyment, attractiveness, convenience, health or nutrition. Producers should decide which factors are special for their product and emphasise these in their promotion.

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As the retail chain in a country becomes stronger and looks for larger suppliers, the production of different niche products for particular market segments may actually become the basis of a market strategy for small-scale food manufacturers.

The development of a marketing strategy is not a single exercise that is done when a business starts. It should be continually monitored, to see if planned sales are taking place and the expected customers are actually buying the product. The strategy should be constantly reviewed to improve it or even to change it completely. The actions of competitors are critical and it is unlikely that they will do nothing when a new product is promoted. They may react by, for example, offering loyalty bonuses to retailers who continue to promote their products, or introducing special offers and increased amounts of promotion. A new producer should therefore be constantly aware of the feedback from customers and retailers, the changes that competitors make to their businesses as well as any feedback they receive from customers.

Packaging and brand image

At an early stage in the development of a new business, processors should decide on the image that they wish their products to have and a 'logo' to help customers identify their products and make them recognisable among those of competitors. This logo is used on all products in a producer's range and helps to develop a 'brand image'. The appearance of a package is the first point of contact between a customer and the producer, and it is therefore part of the marketing strategy. If first-time buyers are attracted by the label and enjoy the product, they will continue to buy the same brand and develop a loyalty to it, provided it is affordable and considered to be value for money. These repeat buyers are the type of customer that are essential to build up sales of a product.

The label not only gives consumers information, such as what type of product it is and how it is used, but through the design and quality of printing it also gives an image of the product to the consumer. For example, a well-designed, printed label can convey an impression of high quality, exciting taste or a reliable company. In contrast, a poorly produced label can suggest low quality, lack of care in its production, or a cheap product that is only eaten by people who cannot afford to buy anything better. When a product is displayed

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in retail stores alongside those of competitors, including imported brands, the package and particularly the label have to compare favourably with the others on offer before customers will choose it.

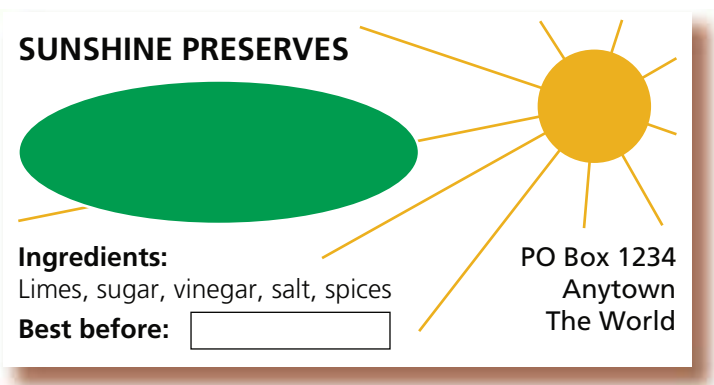
The products in Figure 2.3 show different quality labels, from a hand-written label giving only the name of the product, a black and white label printed using a computer, and full-colour professionally printed labels. In view of the importance of labels, producers should pay the highest price that they can afford to obtain the best possible quality.



Fig. 2.3 The importance of labelling
(Photo: Peter Fellows)

In general a simple, uncluttered image on the label is better than a complex design. The brand name or the name of the company should stand out clearly. If pictures are used, they should be an accurate representation of the product or its main raw material. An example of a simple label design is shown in Figure 2.4.

Colour can be used to produce either a realistic picture (full colour printing) or in blocks of one or two bold colours to emphasise a particular feature. Care is needed when choosing colours as they are culturally very significant and have a direct effect on peoples' perceptions of the product. For example in some areas, browns and greens are associated with



Source: Fellows (1997).

Fig. 2.4 A simple design for a label

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'nature' or natural unprocessed products, with an image of health and good quality. In others, bright oranges and yellows can either mean excitement or cheap, low-quality products.

In some countries there are legal requirements on the design of the label and the information that is included (see Chapter 5, Section 5.8). The following information is the minimum required in most ACP countries:

- name of the product
- list of ingredients (in descending order of weight)
- name and address of the producer (to allow consumers to return the product to the manufacturer in case of problems)
- net weight or volume of product in the package
- a 'use-by', 'best-before' or 'sell-by' date.

In addition, the producer may wish to include:

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

Professional designers or graphic artists may be located at universities, art schools or in commercial agencies and where they are affordable, they should be employed to produce a range of ideas. These can then be discussed with the Bureau of Standards or other relevant government department (e.g. Department of Health) to ensure that they comply with food regulations, and then with a printer to obtain quotations before a final decision is made. Most printers require a print run of several thousand labels and great care should be taken to check the design for errors before printing, as these would be very costly and time-consuming to correct after the labels have been produced.

Promotion and distribution

Each market segment may require different types of distribution and promotion. For example, in urban areas a processor may be able to supply several retail outlets directly from the factory, or use a wholesaler/distributor to supply more distant retail stores. In rural areas, retail distribution is via wholesalers who transport the product to rural towns (together with all the other goods that are sold in village shops). The owners of village shops and

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kiosks then visit the towns to buy stock, often using public transport. Products increase in price each time they are handled by a distributor or trader, and a price mark-up of between 10% and 25% can be expected at each stage (see Figure 2.5). The retail market for tourists includes hotels, kiosks and restaurants along the tourist routes, and supermarkets in towns.

Case study 2.6 Selling

Mrs L's processing company has a large distribution network and sells on a wholesale basis to large marketing companies, petrol stations (e.g. Mobil Marts and Shell Shops), the armed forces, hotels, restaurants, shops, schools and hospitals all over the country. She has an estimated 40–50% share of the juice and preserves markets. The company also has a market in Austria and it is developing the Nigerian market. It advertises on television, radio and the newspapers, both locally and abroad, and it has billboards along important roads and at strategic places in the country.

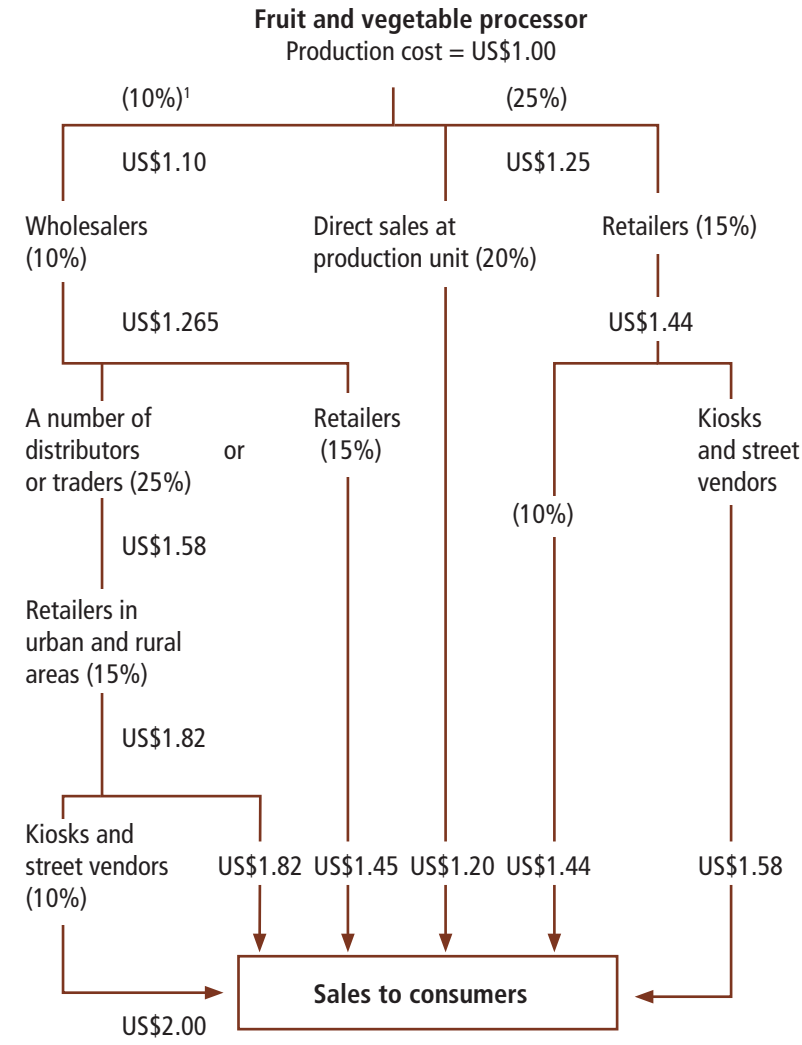
The types of promotion that are available to producers include:

- newspapers and magazines
- trade journals
- radio and television
- signboards, posters and leaflets
- personal contacts
- special promotions
- free samples in retailers' shops.

The types of promotion selected differ for each market segment. For example, rural customers are unlikely to have access to television, but may have access to a radio or to newspapers. Posters or signboards in villages and special poster or leaflet promotions in retailers' shops are likely to reach more people. Tourists are unlikely to use radio, TV or newspapers, but may see signboards or kiosk poster advertisements along tourist routes. In urban retail markets, personal contacts with shop and supermarket owners and promotions in their stores may be more effective.

Decisions by processors on how to sell their products, and to whom, are part of the marketing strategy and these decisions may therefore be different for each product in a range. For example a jam manufacturer may make

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1. Percentage figures are profit at each stage, prices are unit sale price to each group
Source: Fellows (1997).

Fig. 2.5 Examples of sales routes from a processor to the final consumers

one range that is sold to wealthy urban consumers and another that is sold to bakers as an ingredient in doughnuts and cakes. Whatever type of sale is envisaged, it is necessary for processors to understand the market in which they operate and know the way in which products move through the market and gain value.

As each seller requires a profit for handling, stocking or transporting the foods, it is clear from Figure 2.5 that the less-direct routes from producer

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Fig. 2.6 Attractive promotion materials (Photo: Joseph Hounhouigan)

to consumer result in substantial increases in the cost of the product. Other points to note are that: a producer's profit may be lower when supplying wholesalers who have control over a large part of the market, distributors add a higher percentage than other groups to account for the high transport charges in most ACP countries, whereas street traders and kiosk owners usually have the lowest profit of any group.

The simplest form of selling is directly to customers from the processing unit and this method also results in the lowest cost for consumers. Direct selling is common.

Case study 2.7 Promotion and advertising

Mrs L in Benin has developed her own advertisement system, producing advertising announcements on posters, participating in commercial exhibitions and giving taste panel shows in public places.

Her success is being recognised as a key producer of baobab fruit drink at the national level. She has gained a good reputation from different national institutions, which promote her products at business training courses. This gives her products very good promotion.

Mr K is quick to provide fresh orange juice to delegates at international meetings organised by the university and other companies. He promotes his products using printed and electronic media, and at workshops, conferences and local trade fairs. The company has also targeted students, affluent individuals, executives, civil servants, lecturers, doctors, lawyers and business people who are conscious about their health and want to eat healthily. He also provides freshly squeezed bulk orange juice, orange juice concentrate, pine-orange and orange-mango juice for hotels and restaurants, and 300-ml or 500-ml bottled juices for retailers.

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Exceptions include sale of pickles and chutneys from bulk containers into customers' own pots, a small 'factory shop' selling packs of dried fruit at the front of the processing unit, and sales of fresh, un-pasteurised juices in cafes or tea rooms that are adjacent to the production unit and also owned by the processor.

Case study 2.8 Direct selling

In a small town in Northern Tanzania, Mr P, a café owner, found that trade increased significantly when he introduced freshly prepared passion fruit juice on the menu. In fact after a short time he had to ration each customer to one glass in order to have sufficient stock for all his regular customers. He rose at 4 a.m. each day and spent 4 hours manually extracting the juice in his kitchen behind the café. Eventually the demand for juice and his profits from juice sales increased to the point where he was able to invest in a small mechanical pulper. This increased the volume of juice that he could prepare each morning and allowed him to stop rationing his customers.

Sales plan

The real plan of action that implements the marketing strategy is the sales plan – how much food is going to be sold, to whom, and how it is going to be distributed. This is often overlooked by people who like the theory and promotional activities, but fall short of getting out of the factory and into the market to meet their customers.

2.4 Customer care: how to find and keep customers

The main concept of customer care is that every fruit or vegetable processor should recognise that their customers are the most important people in their business. A business will only survive if its customers are satisfied with the product and the service. To achieve this, business owners must develop attitudes, ways of thinking and actions that reflect the importance of their customers and they must focus on satisfying them.

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For example:

- talk to customers and find out what they like and dislike about each product
- develop customer-orientated attitudes so the customer feels valued when the processor deals with them
- make sure that all actions taken by staff reinforce the idea that 'the customer comes first'.

Further details are given in *Opportunities in Food Processing, Volume 1*, Sections 9.1–9.3. Case study 2.9 gives examples of different approaches to customer care by fruit and vegetable processors.

Case study 2.9 Customer care

The company has good relationship with customers by keeping in touch often, giving out test samples, giving away diaries, calendars and souvenirs each year, and keeping customer complaint records. Mrs A, the founder and proprietor, said: "I have the philosophy of 'the customer is always right' and I always ensure that I keep good customer relations". Above all she is able to retain her customers by producing and supplying high-quality foods, timely deliveries and affordable products.

Feedback from customers contributes greatly to improvements to the product. Consumers can directly phone the manager to complain about quality problems. Mrs L sees the complaints as highly profitable to the enterprise because they are used to detect a defect in the raw material or equipment, or to improve the packaging.

They have had no complaints about the quality of their products from their customers. The main complaint was from wholesalers who travelled from far away to buy their products and had to return with little or none. This was a problem in the past because they could not be reached by telephone, but has now been solved by buying a mobile phone.

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Summary of the chapter

- ✔ A feasibility study is essential to help you plan the business properly
- ✔ Conduct market research to find information about what consumers want in a food
- ✔ Consider all four types of markets for fruit and vegetable products (retail, food service industry, institutions and other food businesses)
- ✔ It is important that your products, methods and places of selling, prices and types of promotion all match your intended customers
- ✔ Pay as much as you can afford for an attractive package and label
- ✔ Always take account of competitors, but do not let them distract you from your own business aims
- ✔ Decide what makes your product different from those of competitors and emphasise the benefits in your promotional efforts
- ✔ Prepare a marketing plan to guide the development of your business
- ✔ Choose your retailers or distributors carefully and check to make sure they are doing their jobs properly
- ✔ Always put the customer first and develop work practices that focus on meeting customers' needs
- ✔ Keep in regular contact with customers and make sure they are satisfied with your products.

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Entrepreneur's checklist

- ❑ Have you done a feasibility study?
- ❑ Do you know precisely what type of customers and consumers you are targeting?
- ❑ Have you done a SWOT analysis?
- ❑ Does your product meet their needs? If not, what do you need to change?
- ❑ Do you sell your products at places where your intended customers will find them?
- ❑ Do you have an attractive label?
- ❑ Are your prices competitive?
- ❑ How can you improve your promotion and reach more customers?
- ❑ Do you know who your competitors are and what are they are doing with their businesses?
- ❑ What changes can you make to your business to improve customer care?
- ❑ Have you got the most effective promotion and distribution to reach your intended customers

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Readers' notes

Please use the space below to write your own notes on this chapter

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Setting up production 3

Details of the location and construction of food processing units, together with information on the provision of services are given in *Opportunities in Food Processing, Volume 1*, Section 5.1. In this section, the specific requirements of fruit and vegetable processing are described in more detail.

3.1 Selecting the location

The best location for a fruit and vegetable processing unit is determined by the following factors:

- closeness to the source of crops
- closeness to customers
- closeness of a suitable site for disposal of solid and liquid wastes
- availability of services (especially potable water and electricity).

Many processors choose to locate their production facilities in a rural area close to the source of crops. This has advantages because bulky raw materials do not need to be transported long distances, which is not only less expensive but also reduces the risks of damage to the crops. Also, the level of rent, cost of land and labour costs are generally lower in rural areas, and disposal of wastes is usually easier or cheaper than in urban centres.

Tips for success

- ✔ Choose a building with enough space for workers to move around easily
- ✔ Make sure the site has good-quality water, reliable electrical supplies and good road access. If these are not satisfactory they should either be provided or another site considered
- ✔ Seal up any cracks in walls and floors and ensure all windows and doors are insect-proof
- ✔ Seek advice and look at other businesses to find the best sources of equipment, packaging and ingredients
- ✔ Train operators to use equipment safely
- ✔ Do not pay for big equipment when your capacity to sell is low. It is better to increase the production capacity after getting the market
- ✔ Site the plant in a clean area away from polluting industries
- ✔ Read Sections 5.1–5.4, and 6.1 in *Opportunities in Food Processing, Volume 1*

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However, these benefits need to be balanced against a number of disadvantages of a rural location. In particular the poor quality of rural roads may often create difficulties for:

- access to markets and cost of distribution of finished products
- ease of access for production staff (poor public transport, long distances down access roads)
- quality of the road (dry-season access only, or potholes that may cause damage to products, especially when glass containers are used). These also increase the costs of access to repair services, spare parts for equipment and other supplies.

In addition, the provision of services in rural areas is often substandard or intermittent. Large volumes of clean water are needed for all fruit and vegetable processing, and it may be necessary to drill a borehole for factory use and/or install water-treatment facilities. Electricity is required for most fruit and vegetable processing and the additional costs of a generator, plus the cost of transporting fuel to operate it, are additional expenditures that would be less likely in an urban location. Many processors therefore choose to set up their operation in a peri-urban area or rural growth centre in order to obtain the benefits of ease of access, better provision of services and lower costs than urban locations.

There are also potential marketing disadvantages of processing in a remote area, which depend on the marketing mechanisms and customer contacts that are built into the business. For example, supplying through wholesalers can be handled from a remote processing plant whereas direct sales to customers require closer and more frequent contacts that would be better based in a semi-urban area.

3.2 Design and construction of the building

Many very small food-processing enterprises start in the family home. However, as the business grows, there are several features that are needed in a food-processing plant. This section outlines the type of facilities that an owner should try to achieve.

In general, a building for fruit and vegetable processing should have enough space for all production to take place without congestion, and for separate

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Case study 3.1 Choosing a location

Equipment for juice processing was imported and that needed for processing groundnuts, peppers, onions, ginger and pumpkin seeds was produced locally. The consultant recommended relocation from the residential area to new premises in an industrial area. This was to conform with Environmental and Food and Drug Board laws, and also to enhance the image of the company. The new premises are strategically located and have a well-designed waste management facility, regular electricity and water supplies, good access road and close proximity to Tema port, the second largest in West Africa.

The cost of raw materials varies with the season. The cost of a truckload of cassava bought at the farm gate can cost as little as 10% or as much as 30% of the production cost. The location of the business in one of the country's largest cassava-producing districts is a great advantage. During the bumper season, *gari* production is increased by 50% and the women roast *gari* all day and for the greater part of the night. On average they process two truckloads of cassava per week.

storage of bulky crops, packaging materials and finished products. However, the investment should be appropriate to the size and expected profitability of the enterprise to reduce start-up capital, the size of any loans taken out, and depreciation and maintenance charges. The features required in all food-processing buildings are described in *Opportunities in Food Processing, Volume 1*, Section 5.1, and below the specific features required for fruit and vegetable processing are highlighted.

Roofs and ceilings

Fibre–cement roof tiles offer greater insulation against heat from the sun than galvanised iron sheets This is particularly important when processing involves heating, for example in jam and chutney production, to make working conditions more comfortable. High-level vents in roofs screened with mesh to prevent insects entering, allow heat and steam to escape and encourage a flow of fresh air through the processing room. If heat cannot be removed by natural air circulation, the entrepreneur should fit electric fans or extractors. Panelled ceilings should be used to prevent contamination of products by dust falling from rafters.

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Walls

Large amounts of water are needed to wash down equipment and surfaces after production of nearly all fruit and vegetable products. All internal walls in the processing room should be rendered or plastered. The lower area of walls (to at least one metre above the floor), which is the part most likely to get dirty, should be either painted with waterproof white gloss paint or tiled with glazed tiles. In some countries there is a legal requirement for specified internal finishes and this should be checked with the Ministry of Health, Bureau of Standards or other appropriate authority.

Windows and doors

Flying insects are a particular problem in fruit processing as they can readily contaminate products. Windows should therefore be fitted with mosquito mesh to allow them to be left open to provide a flow of air through the room. Normally doors should be kept closed, but if they are used regularly there is again a tendency for them to be left open, with similar consequences of insects entering the plant. Thin metal chains or strips of material that are hung vertically from the door lintel may deter insects while allowing easy access for staff. Alternatively, mesh door screens can be used. Rodents are a particular problem because they feed on stored crops, and all storeroom doors should therefore be close-fitting and kept closed.

Floors and drains

It is essential to ensure that the floors of processing rooms and storerooms are constructed from good-quality concrete, smooth finished and without cracks. Over time, spillages of acidic fruit products react with concrete and cause it to erode. There are special floor coverings that resist acids, but these are expensive and rarely available in ACP countries. A cheaper option is to pay careful attention to cleaning up spillages as they occur, and to regularly monitor the condition of the floor, repairing it as necessary.

The floor should slope to drainage channels so that all water drains away after equipment has been washed down. This prevents pools of stagnant water forming and risk contamination of equipment and foods. The drainage channels should be fitted with an easily removed steel grating so that the

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drain can be cleaned. Where the drain exits the building it should be fitted with wire mesh to prevent the entry of rodents and crawling insects. This mesh should also be easily removed for cleaning. All drains should carry wastes away from the building to either a soak-away or water-treatment plant to prevent stagnant pools forming nearby.

Water supply and sanitation

Water is essential in fruit and vegetable processing to wash crops, as a component of some products, and for cleaning equipment. An adequate supply of safe (potable) water should therefore be available from taps around the processing area. Two high-level covered storage tanks can be filled alternately from boreholes or with mains water when it is available. The capacity of each tank should be sufficient for at least one day's production. While one tank is being used, any sediment settles out in the other tank. The tanks should have a sloping base and be fitted with drain valves at their lowest point to allow any sediment that has accumulated to be flushed out.

Water that is included in a product should be carefully treated to remove all traces of sediment and if necessary, it should be sterilised. This is particularly important if the product is not heated after water has been mixed in as an ingredient. Small-scale water treatment can be achieved by filtration, by heating, by ultra-violet light or by chemical sterilants, such as hypochlorite (also called 'chlorine solution' or 'bleach'). Details are given in *Opportunities in Food Processing, Volume 1*, Section 5.2.

Case study 3.2 Water supplies

The water used by the enterprise is in principle potable, but because of defects in the local pipework, it can contain metal particles. To solve this problem, the enterprise installed a water filter in the pipeline to ensure the water is more potable water.

Electricity

All electric power points should be placed at a sufficiently high level above the floor so that there is no risk of water entering them whilst the floor or equipment are being washed. Ideally, waterproof sockets should be used.

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It is important to use each power point for one application only and not use several plugs in a single socket, since this risks overloading a circuit and causing a fire.

3.3 Layout of equipment and facilities

The different areas required for fruit and vegetable processing are shown in Figure 3.1. Perishable raw materials should be stored separately from non-perishable ingredients and packaging materials, and the different stages in a process should be physically separated wherever possible. The layout shows how raw materials move through a process and through the room without paths crossing. This helps to prevent contamination of finished products by incoming, often dirty, crops. It is particularly important to prevent contamination arising from bottle washing where any breakages produce glass splinters that could contaminate a product. For this reason all washing and sterilisation of bottles should be done outside the processing room.

Toilets should either be housed in a separate building or two doors should separate them from the processing area. Laboratory facilities are generally not needed in fruit and vegetable processing, although a separate table for conducting quality assurance checks or check-weighing packages of finished product (Section 5.6) should be located in the office or in a separate area of the processing room.

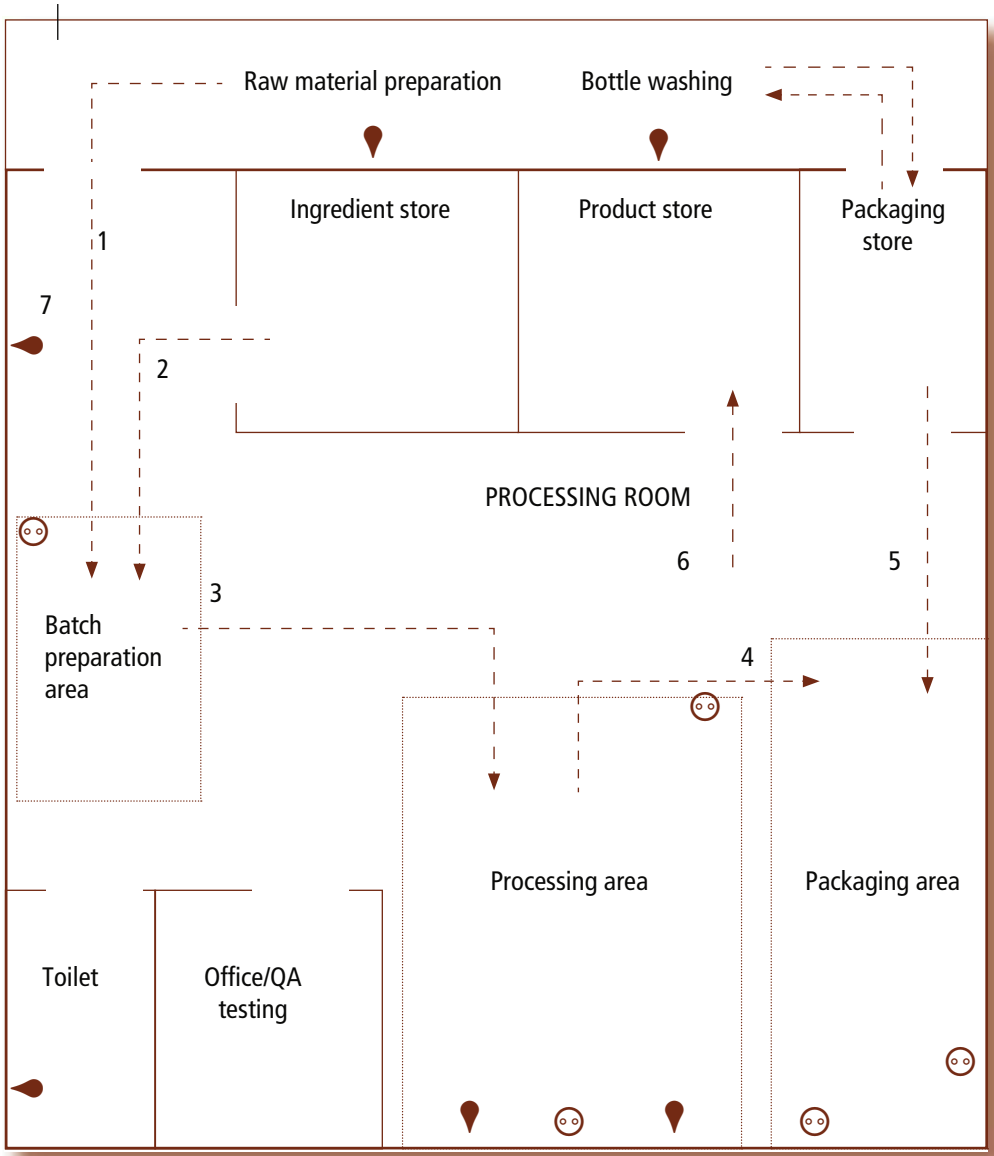
Case study 3.3 Layout of equipment

The manager is highly open to scientists' recommendations and advice she has developed the factory layout herself, with the help of different food science and technology experts.

3.4 Selecting equipment

Many small-scale entrepreneurs in ACP countries have little choice when selecting equipment and must buy what is available at the time they wish to purchase. However, this can result in overspending if the equipment is too large for the intended purpose, or can create 'bottlenecks' and inadequate

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Key

1 Prepared raw materials in
2 Ingredients from store
3 Prepared batch to processing area
4 Processed food to packaging area
5 Packaging from store
6 Packaged product to store for distribution
7 Hand washing

= power point

= water tap

Source: Fellows (1997)

Fig. 3.1 Layout of a building for processing of fruit and vegetables

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production rates if it is too small. Equipment should be the correct size for the intended scale of production (obtained from the Feasibility Study, Section 2.1). The capacity or throughput (in kg or litres per hour) of each piece of equipment should be matched to the others.

It is worthwhile to look at other businesses and to research suppliers to find out what equipment is available before making a decision on what to buy.

In some countries there are import agents in the capital city who can supply equipment, or information can be obtained from overseas suppliers or manufacturers' associations, international development agencies, university food technology departments or trade sections in embassies of other countries. In some countries, development agencies and trade associations allow access via their computers to the Internet to locate equipment. When ordering imported equipment, it is important to specify the capacity, single or three-phase power supply, the number and types of spares required, and the specific application for which the equipment is to be used. Where possible the model number of a machine should also be given.

Case study 3.4 Finding suitable equipment

A common problem is expressed by this processor:

"The biggest problem facing our enterprise is how to find good equipment at affordable prices. Imported equipment is generally too expensive and has a capacity that is too high for small enterprises. Locally made equipment is less expensive, but the maintenance cost is high and the efficiency is doubtful. The choice is hard to make when the size and share of the market is difficult to evaluate"

A West African processor found some solutions to the problems:

The equipment includes knives for peeling, a mechanical slicer, a pasteuriser, a capsule sealer and a gas stove. The slicer was imported from Europe and the pasteuriser and the capsule sealer are imported from suppliers in Nigeria and Ghana. In a near future, more efficient equipment will be imported from China to replace the locally made pieces or to mechanise operations that are now done manually.

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Calculating the size of equipment

Before buying equipment a fruit and vegetable processor should calculate the required size of each piece. An example of how to do this is shown in Case study 3.5.

Case study 3.5 Calculating the size of processing equipment

From sales data, the demand for pickles was found to be 200 kg per day. Mixing takes place for 3 hours each day, so the required throughput of the mixer = 200/3 = 67 kg per hour.

Each batch of pickle is mixed for 15 minutes and so three batches per hour are possible. The required capacity of the mixer = 67/3 = 22.4 kg. Therefore, a mixer with a bowl size of 25–30 kg is required.

All types of fruit and vegetable processing require basic equipment such as buckets, tables, knives and scales to handle, weigh and prepare raw materials. Wooden tables are cheaper than metal ones, but they are more difficult to keep clean. If wood is used it should be covered in a sheet of thick plastic, aluminium or a 'melamine' type surface, and legs should be painted with gloss paint for easier cleaning.

Scales are needed to weigh crops, ingredients and finished products. Ideally, two sets of scales should be used: one set of small battery- operated or mains-powered scales (0–5 kg with an accuracy of +/–1 g) to accurately weight small amounts of ingredients, and a second set of mechanical scales (0–50 kg with an accuracy of +/–100 g) for larger amounts of crops. However, scales are expensive in most ACP countries and a cheaper alternative is to calibrate scoops, jugs or other measures, so that they contain the correct quantity of material when filled level with the top. In operation, scoops are faster than weighing, but operators should be carefully trained to ensure consistent measurements.

Because of the acidic nature of fruits, food-grade plastic, aluminium or stainless steel should be used for equipment that is in contact with foods. Other metals, such as mild steel, brass and copper should not be used because they react with fruits and cause off-flavours or colour changes in the product.

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Because of its high cost and difficulties in fabrication in many ACP countries, stainless steel is often only used for cutting blades, boiling pans etc. and plastic is used for other parts that are not heated.

Principles of hygienic design and methods of construction for food processing equipment are described in *Opportunities in Food Processing, Volume 1*, Section 5.3. The following section describes commonly used equipment in fruit and vegetable processing.

Airlock

Airlocks are made from glass or plastic tubing. They are filled with clean water or sodium metabisulphite solution to prevent air and spoilage micro-organisms from entering the fermentation vessel.

Blanchers

On a small scale, hot water blanchers are made from aluminium boiling pans with a stainless steel mesh basket to contain the vegetables in the hot water. Steam blanchers have a removable mesh base to hold vegetables in the steam above boiling water. Larger-scale purpose-built blanchers use the same principles and are constructed from aluminium or steel tanks. This type of equipment (made from stainless steel) can also be used to 'melt' soft fruits such as melons and papaya to extract their juice.

Boiling pans/pasteurising kettles

In small-scale production, a stainless steel (or less desirably aluminium) pan is placed directly over a heater. However, this type of equipment heats unevenly and may cause thick products (e.g. chutneys, jams/marmalade, sauces, and syrups) to burn onto 'hot spots' unless they are continuously stirred and heated slowly. More sophisticated 'double-jacketed' stainless steel boiling pans are heated by steam in the space between the outer jacket and inner pan. These give more uniform heating and avoid localised burning of the product. These pans and associated steam boilers are expensive to import, and local fabrication in ACP countries may be difficult because of lack of skills and facilities for stainless-steel welding of the pans, or fabrication of steam

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boilers. In most ACP countries steam boilers require regular inspection and certification. A badly made or poorly maintained boiler is a potential bomb!

The most appropriate type of heater depends on the cost and availability of different fuels in a particular area. In urban centres, gas or electricity are the preferred options because there is no risk of contamination of products by smoke or fumes from combustion. They also provide more controllable heating than pans over open fires. In rural areas, these may not be available or the supply not sufficiently reliable, and other types of fuel (e.g. charcoal or kerosene) may have to be considered. Generally, wood is not favoured because of the risk of product contamination by ash.

Case study 3.6 Reducing the cost of equipment

Mr O in Uganda said: "I needed a large stainless pan for pasteurising my juices, but they were far too expensive. So I bought a large, cheap aluminium pan and used this to heat the sugar syrup to just under boiling point. This big pan was kept on the heat all day. I then used a small 5-litre stainless pan to make each batch. The fruit pulp (25% of the product) was put in the small pan and the hot syrup added. The temperature shot up to 70–75°C and all that was then needed was to quickly heat it to 80°C to pasteurise it."

Bottle cooler

This equipment is used to increase the rate at which containers cool, by allowing them to roll down an inclined water bath (Figure 3.2). There is a flow of cooling water in the opposite direction from that of the containers. Jam jars are held vertically in frames to allow the preserve to set.



Fig. 3.2 Bottle cooler (Photo: Peter Fellows)

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Bottle washer and steriliser

In many countries small- and medium-scale enterprises have to use recycled jars or bottles to pack their products. It is very important that these are inspected because they may have been used to store liquids such as oil or even pesticides. Any suspect bottles must be rejected. The next step is to wash the bottles with a detergent using a manual or rotary bottlebrush (Figure 3.3)



Fig. 3.3 Manual rotary bottle-cleaning brushes (Courtesy of Sanbri Ltd.)

A bottle washer (Figure 3.4) is used to rinse detergent from re-used bottles and jars. They are inverted over vertical pipes that are welded or soldered onto a larger-based pipe, which is connected to a water supply.

After washing, bottles should be sterilised with steam, hot water or hot air. A simple steam generator, consisting of a metal can fitted with a safety pipe and a pipe to the bottle steamer, can be made locally. Alternatively, bottles can be boiled in a large pan of water for 10–15 minutes, or heated in an oven at 100°C for a similar time.



Fig. 3.4 Bottle washer (Photo: Peter Fellows)

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It is strongly recommended that all bottle washing and sterilisation should not be carried out in the processing room. Some bottles will break and glass splinters must be avoided in the production room. If the quality of water is in doubt, it should be chlorinated for use in both bottle coolers and washers (*Opportunities in Food Processing, Volume 1*, Section 5.2).

Corers

Manual or motorised corers remove the core from pineapples before the fruit is processed. Some types of equipment also simultaneously peel the fruit. The equipment consists of sharp blades that are pushed through the fruit (Figure 3.5). This equipment substantially increases the rate of production compared to hand coring/ peeling, but because the blade size is fixed, it is necessary to have uniformly sized fruits to avoid excessive waste.

Deep fat fryer

The simplest fryer is a pan of oil heated over a fire, but this has poor temperature control and there is a risk of burning both the oil and the product. Thermostatically controlled electric deep-fat fryers are available from catering suppliers in most ACP countries.



Fig. 3.5 Pineapple corer (above) and slicer (below) (Photo: Barrie Axtell)

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Distillation apparatus

Simple stills can be bought or made locally. Essentially they comprise a steel or copper drum that is heated over a fire and is fitted with two pipes. One is a long safety pipe that extends from the bottom of the drum for several metres above the still. This prevents the pressure in the drum becoming too high, risking an explosion. The second pipe carries the alcohol/water vapour mixture from the top of the drum to a section that is cooled by water to condense the vapours. There is then a vessel to collect the condensed vapours. Modern stills are made of copper or stainless steel and larger ones are fitted with thermostatically controlled heaters. These are too expensive for most small-scale producers, but small copper stills for making essential oils have been used for making small amounts of spirits.

Dryers

There are many different types of dryers described in books listed in Appendix I. The size of dryer needed to dry a given weight of food per day can be calculated by assuming that a drying area of 1 m^2 is needed to dry the following types of product:

- 2 kg of low-density products such as shredded cabbage
- 4 kg of moderate-density products
- up to 6 kg of dense products such as chopped fruits.

Provided that they are correctly designed, solar dryers have faster drying rates than sun drying because the air is heated to 10–30°C above the ambient air temperature. Faster drying reduces the risk of spoilage and improves product quality. Solar dryers also have the advantage of providing protection from dust and insects. The main problems with solar dryers are that drying rates are slower on cloudy days and dryers cannot be used at night. To overcome these problems a heater can be fitted to the drying tunnel. This increases both the capital and operating costs, but it may still be economically viable if the sale price of the dried fruits is sufficiently high.

In recent years large tunnel solar dryers have been developed with a capacity of 200–600 kg of fresh material per day. Some, such as the Hohenheim dryer, have fans powered from solar photovoltaic panels and the option of added heating by gas at night (Figure 3.7)

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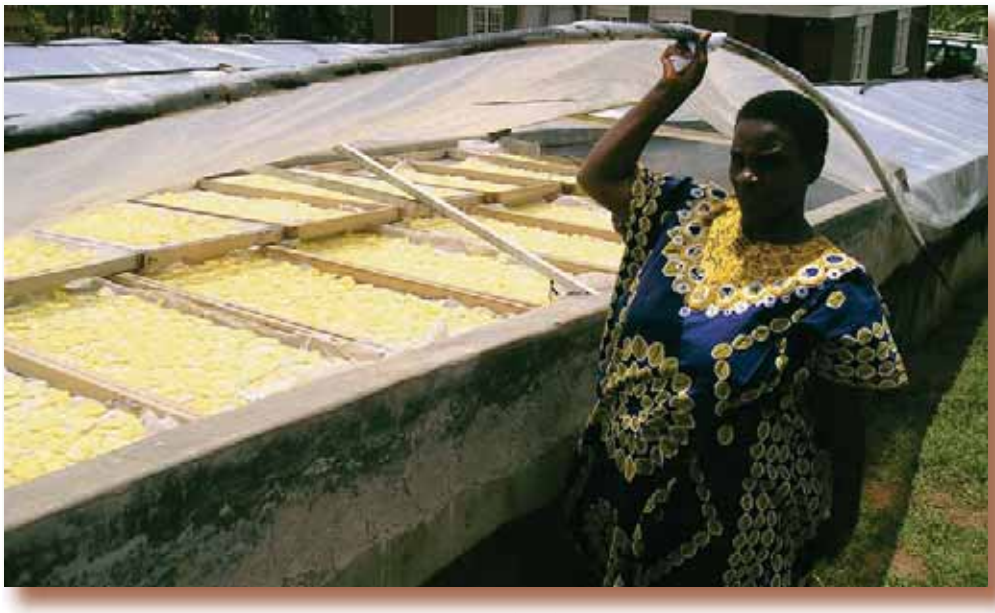


Fig. 3.6 Solar dryer



Fig. 3.7 A Hohenheim dryer (Photo: Barrie Axtell)

Most solar driers are covered in plastic because glass is too expensive and easily broken. Ultra-violet (UV) light causes polythene sheeting to deteriorate so it must be replaced each year or two depending on the strength of the sunlight. Special UV-resistant polythene can be replaced every 2–3 years, and UV-resistant polyester every 3–5 years.

Mechanical dryers use electricity or fuel-fired (gas, charcoal or diesel) heaters to supply air at a constant temperature to the drying chamber. Fans are

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used to increase air-flow rates. If diesel or wood are used, the system must incorporate a heat exchanger to avoid contaminating the products with combustion products. The simplest mechanical dryer has trays filled with product in the drying chamber, and air at 50–60°C is passed through the chamber until the entire batch is dry. A typical design is shown in Figure 3.8. Batch dryers become very energy-inefficient during the later stages of drying as very little moisture is being removed, but the heat input remains the same. Semi-continuous tray dryers have been developed to overcome the problems of batch dryers. Trays nearest the heat source dry first and are removed, the remaining trays are lowered and new trays of fresh food inserted above them.



Fig. 3.8 A batch tray dyer (Photo: Barrie Axtell)

Fermentation tanks

Fermentation tanks should be made from food-grade plastic or stainless steel, and not from coloured plastic containers that contain pigments and plasticisers, which could contaminate the wine. They should have a wide neck or removable lid that allows easy access for cleaning. The airlock is fitted into a hole in the lid using a rubber or plastic bung.

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Filters

Simple filters for juices, wines etc. are made from muslin or fine cotton bags. These bags should be sterilised after use by boiling for 10–15 minutes and fully dried by hanging them in the air (not on the ground or on bushes). Specialist gravity filters or pressure filters for wine use a filter agent such as bentonite, perlite or isinglass. Details of filter agents are given in Chapter 4, Section 4.5.

Fruit press



Fig. 3.9 Manual fruit press (Photo: Peter Fellows)

Manual fruit presses consist of a stainless steel cage and a press plate that is raised and lowered inside the cage using a screw and bearing (Figure 3.9). The screw should be made from a harder grade of steel than the bearing to prevent the more expensive screw from wearing down (i.e. the bearing wears and is replaced more cheaply than the screw). A muslin or cotton bag is placed in the cage and fruit pulp is poured in. The bag is closed and the press plate is lowered to press out the juice. The screw is then raised and the bag is removed. In larger presses it may be necessary to use layer plates, made from stainless steel, plastic or painted mild steel, which are placed between bags of pulp to reduce the thickness of layers and give more efficient pressing.

Hydrometers

Different types of hydrometer are used to measure the concentration of sugar in syrup, alcohol in wine (alcometers) or salt in brine (salometers), by

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measuring the 'specific gravity' of the liquid. They are glass or plastic tubes that have a graduated scale and float in the liquid contained in a measuring cylinder (Figure 3.10). Readings should be made at 20°C. Conversion tables supplied with the hydrometer are used to convert the specific gravity reading to percentage sugar, alcohol or salt (see also Chapter 5, Section 5.4).

Jam thermometer

This is a special thermometer that has readings up to 120°C and is strengthened to withstand sudden changes in temperature when it is placed in boiling jam or marmalade. The reading is used to decide when jam boiling should be stopped (also Chapter 5, Section 5.4). Alternatively, electronic thermometers (Figure 3.11) may be used, which are a little more expensive but unbreakable.

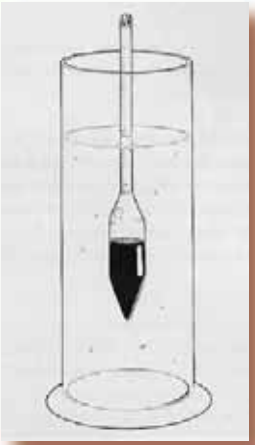


Fig. 3.10 Hydrometer



Fig. 3.11 Electronic thermometer
(Photo: Peter Fellows)

Peelers

There are a number of different types of small mechanical peelers that can be used to speed up processing of fruits and vegetables. Fruit peelers are suitable for apples, pears and other thin-skinned fruits. Root crops are usually peeled using a rotating drum that is lined with an abrasive material such as carborundum.

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pH meter

Hand-held, electronic pH meters are gradually becoming less expensive and hence affordable by small-scale processors. They can be obtained from scientific equipment suppliers.

Pressure cooker

These are pans that have a securely fitting lid that allows the pressure inside to increase to above atmospheric pressure. They heat foods to either 110°C or 121°C, depending on the setting of the pressure-relief valve. The pan is heated until steam escapes from the pressure valve when the heat is then reduced to maintain this pressure.

NB: It is dangerous to use a pressure cooker with a faulty seal or pressure relief valve – it risks an explosion and injury.

Pulper finishers/fruit crushers

Powered machines are used to pulp soft fruits. There are a number of different designs including those that have rotating brushes or a screw inside a perforated cylindrical steel screen (Figure 3.12). The pulp passes through the screen and seeds and skin are separated. Different-sized machines can process between 100 kg and several tonnes of fruit per hour. Fruit crushers have rotating 'jaws' or toothed wheels that crush pineapples, apples or other hard fruits.

On a small scale of production, a hand-operated 'mouli-legume' or liquidiser can also be used to pulp soft fruits.



Fig. 3.12 Pulper finisher
(Photo: Peter Fellows)

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Reamers

There are two types of reamer that are used in fruit processing: one extracts coconut meat from the shell (Figure 3.13) and another, the rotating 'rose' extracts juice from halved citrus fruits (Fig. 3.14). A typical system has two roses driven by an electric motor to extract the juice, which then flows to a holding tank.

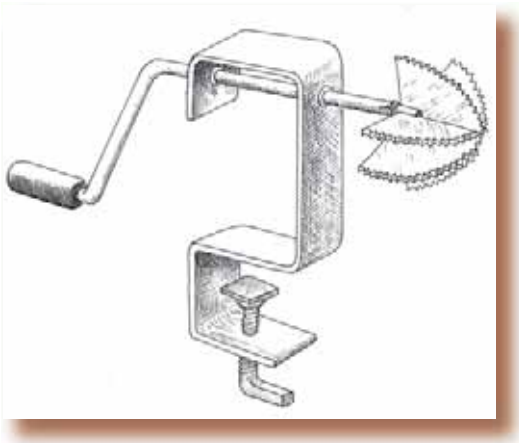


Fig. 3.13 Coconut reamer

Refractometers

A refractometer measures sugar concentration as °Brix, which corresponds to percentage (%) sugar. Some manufacturers supply a single-range instrument (0–80° or 0–90°Brix), while others supply two instruments with ranges of 0–50°Brix for juices, sauces, syrups etc. or 40–80°Brix for jams and other concentrated preserves. The instruments are expensive but they give an accurate measurement of sugar concentration.



Fig. 3.14 Double-headed citrus juice extractor (Photo: Barrie Axtell)

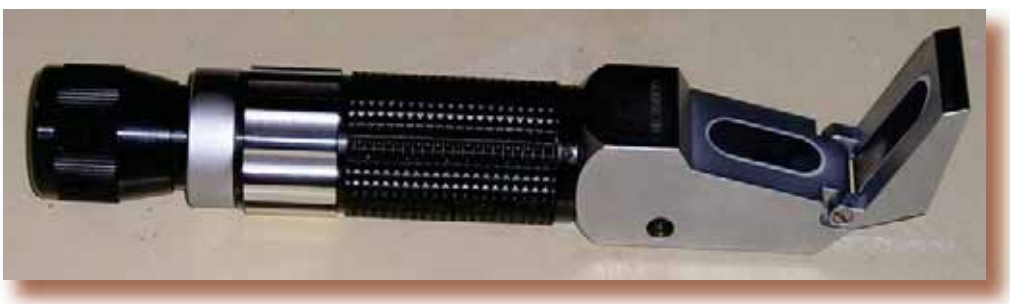


Fig. 3.15 Refractometer (Photo: Peter Fellows)

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Slicers and dicers

It is difficult to produce uniformly sized slices or cubes of fruit using a knife, and small slicing or dicing machines are able to achieve more uniform products and increase production rates. Stainless steel fruit slicers can be of one of two designs: either a fixed blade that removes a single slice each time the fruit is pushed over the blade, or alternatively a frame of thin sharp blades or wires that are pushed through the fruit. Manual dicing machines first cut the material into strips and then, cutting at 90°, into uniformly sized cubes.

Spray gun

A spray gun, fitted to a hose, is used to wash down equipment, floors etc. and is adjustable to spray a single jet or a wide spray. Spray guns have the advantage of saving water because they automatically switch off when not in use, compared to a hose that is left running.



Fig. 3.16 Spray gun (Photo: Peter Fellows)

Sulphuring cabinet

Sulphur dioxide is used to maintain the natural colour of dried fruits. A cabinet made from a wooden frame covered in either plywood or polythene, is fitted with mesh trays to hold the fruit. It retains sulphur dioxide gas from burning sulphur inside the cabinet so that it can penetrate the fruit.

3.5 Selecting packaging materials, filling and sealing equipment

There is a very wide range of packaging materials that can be used for fruit and vegetable products and these cannot be described in detail in a book of this size. Publications listed in Appendix II describe packaging in more detail, but entrepreneurs should contact local packaging manufacturers or their agents to find the types that are available in their area. The following is a

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Type of equipment	Spares/maintenance required	Cleaning
Airlocks	n/a*	With detergent and clean water, followed by sterilisation in dilute bleach
Blanchers	n/a	After use with detergent and clean water
Boiling pans/ Pasteurising kettles	n/a	After use with detergent and clean water
Bottle coolers	n/a	Weekly with detergent and clean water
Bottle washers	n/a	Weekly with detergent and clean water
Corers	Replacement blade	
Periodic blade sharpening	After use with detergent and clean water	
Corkers	n/a	Weekly with detergent and clean water
Crown cappers	n/a	Weekly with detergent and clean water
Cutting boards	n/a	After use with detergent and clean water
Deep fat fryers	Electric heating element	
Check thermostat setting	Periodic (monthly) removal of oil and cleaning with detergent and clean water	
Dicers	Replacement blade	
Periodic blade sharpening	After use with detergent and clean water	
Distillation equipment	n/a	After use with detergent and clean water
Dryers	Plastic uv-resistant covers	
Replace polythene cover each year or polyester cover every 3–5 years	Cleaning trays after use with detergent and clean water	
Fermentation tanks	n/a	After use with detergent and clean water, followed by sterilisation with dilute bleach
Fillers	n/a	After use with detergent and clean water
Filters	Filter cloths or pads	After use with detergent and clean water, followed by sterilisation using dilute bleach or boiled for 10-15 mins and dried.

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Fruit crushers	Motor drive belt	
Monthly check belt tension, condition of bearings	After use with detergent and clean water	
Fruit presses	Periodic check for wear on screw and bearing	After use with detergent and clean water
Heat sealers	Heating element	Remove any burned-on plastic immediately
Hydrometers	n/a	After use with detergent and clean water
Jam thermometer	n/a	Carefully wipe with a clean cloth
Liquidisers	Monthly, check bearing	
Periodic blade sharpening	After use with detergent and clean water	
Peelers	Replacement blade	After use with detergent and clean water
pH meters	Buffer solutions, probe	
Monthly standardisation	Wipe probe carefully with damp cloth after use	
Pot sealers	Heating element	Weekly wipe with damp cloth
Pulper finishers	Motor drive belt	
Monthly check belt tension and bearings	After use with detergent and clean water, with particular attention to cleaning the screen	
Reamers	n/a	After use with detergent and clean water
Refractometer	n/a	Wipe carefully with tissue paper and rinse with distilled water
Scales	Monthly standardisation with known weights	After use wipe with damp cloth
Slicers	Spare blade	After use with detergent and clean water
Sulphuring cabinet	n/a	Clean trays after each batch with detergent and clean water

* n/a = not applicable

Table 3.1 Summary of spares and maintenance/cleaning requirements for fruit and vegetable processing equipment

brief description of some of the more important points concerning the most widely available packaging materials and the equipment needed to fill and seal them in ACP countries. Additional information that relates to specific products is given in Sections 4.1– 4.12, and marketing aspects are described in Chapter 2, Section 2.3.

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More traditional types of packaging such as jute, hessian, wood and pottery are not usually able to convey an image of 'modern' or hygienic products and, except for some niche export or tourist markets, are not widely used.

Plastic pots and bottles are suitable for chutneys, jams, juices, pastes, pickles, sauces and syrups, and they are becoming increasingly common as their production and distribution costs are lower than those of glass. They are not widely used for vinegar, wines or spirits because of a perceived lower quality, and glass bottles remain the preferred option for marketing these products.

Glass jars and bottles are available in countries that have a glassworks, or an established import system. Because of their heavy weight, high bulk and fragility, glass containers are expensive to transport over long distances. Where they are available, they are usually re-used but great care is needed to ensure that they are properly cleaned. Both new and re-used containers should always be sealed with new caps, lids or corks in order to obtain an adequate seal. Cans are not widely used in small-scale processing for the reasons described in Section 4.2.

Small laminated plastic/foil/cardboard cartons for juices are appearing in many ACP countries, but these are usually imported under licence to large-scale juice manufacturers and are not available to small-scale processors. Other cardboard and paper packaging for dried foods is often widely available and can usually be printed by local print companies.

The most common types of plastic film in ACP countries are polythene and polypropylene, although increasingly import agents can supply more sophisticated (and expensive) laminated films. These can be used for pickles, dried fruits and vegetables, sauces and other liquid products.

Filling

Semi-solid products, such as pickles and chutneys are usually filled by hand using scoops or ladles into jars, plastic pots or bags. This is a time-consuming operation, which may require a large staff input. However, in most small-scale operations, this is the only realistic option because mechanical fillers for these types of product are prohibitively expensive and usually operate at too high a throughput.

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Case study 3.7 Packaging problems and some solutions

The following entrepreneur encountered typical problems in ACP countries: Mr L said: "Good-quality packaging for foods is a challenge in West Africa, particularly in Benin. There is no industry producing printed polythene packaging for foodstuffs and no glass bottles. These materials are bought in Nigeria or Ghana. The same thing could be said for packaging equipment. The problem we have is the quality of old bottles, which can break easily during pasteurisation."

And two processors have found some solutions:
"The packaging materials used by our company include 300-ml glass bottles with crown caps, glass jars with push-on lids, and 4.5- and 20-litre plastic 'gallons' with roll-on capping. The glass bottles and jars with lids are imported from Austria and the plastic gallons are bought from a local manufacturer. Bottles are sterilised using chemical sterilising tablets and then heated to 70°C. For ease of transport and to reduce breakages, the 300-ml bottles are packed in wooden crates and the plastic gallons in cartons." The company has made a substantial investment in bottles and jars and has a good network for their collection and reuse. They have also taught transporters how to minimise breakages.

The company uses 300-ml or 500-ml plastic bottles for retail sales and large plastic containers for bulk delivery. These packaging materials are manufactured in Ghana and Mr K buys them in bulk from the factory in Accra. The University Printing Press in Kumasi produces labels and cartons are bought from a paper company in Accra. The company has overcome quality problems with packaging materials by buying them from a single source to the extent possible.

Although liquid products can also be filled by hand using jugs or ladles, a number of small liquid fillers that are affordable to many small-scale producers are available. They can be made locally by fitting a tap to a stainless steel or food-grade plastic tank.

Domestic taps should not be used because they are difficult to clean, and the 'gate valve' type should be used. Three or four taps can be fitted to a large tank to allow several workers to fill containers at the same time. 'Dispensers' are fillers that contain a piston that measures out the same amount of liquid into each container. Small versions may be available at pharmacies in capital cities, but larger volumes require imported equipment.

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Sealing

The most common jar lids are now the twist-on, twist-off (TOTO) type, although the 'Omnia' type is still found in many countries. Bottles may be sealed using roll-on-pilfer-proof (ROPP) caps, or with crown caps or corks. At most scales of production found in ACP countries, TOTO caps are fitted by hand. Small machines are available to seal ROPP caps onto bottles. Hand-operated crown cappers consist of a die that is placed over a metal cap on a bottle. The cap is sealed in place either by striking the capper with a hammer (Figure 3.17) or by lowering two handles that force the cap onto the bottle. A corking machine has a mechanism that compresses the cork when the lever is lowered and then inserts it into a wine bottle (Figure 3.18).



Fig. 3.17 Crown capper (Photo: Peter Fellows)



Fig. 3.18 Corking machine (Photo: Peter Fellows)

A capsule sealer (Figure 3.19) has a thermostatically controlled heater that shrinks plastic capsules to form a tamper-evident seal on wine bottles. A good-quality electric hair dryer will also shrink capsules.

Pots can be either heat-sealed with a foil lid or sealed with a snap-on plastic lid that is usually fitted by hand (Figure 3.20).

Bag sealers heat and press the two edges of a plastic bag to melt and weld the two layers together, thus sealing the bag. All types of plastic film, with the exception of un-coated cellulose, can be sealed using a heat sealer. It should have a thermostat to adjust the sealing temperature, and an adjustable timer to control the time of heating. A wide seal (3–5 mm) is needed for dried

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Fig. 3.19 Capsule sealer
(Photo: Peter Fellows)

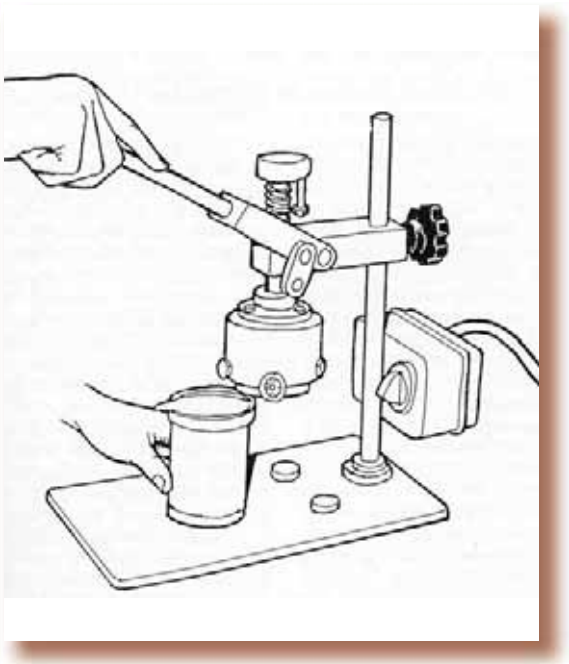


Fig. 3.20 Heat sealer for pots

and liquid foods, and sealers that have a heated bar are preferable to those that have a heated wire. It is important that there is no product on the inside of the bag where the seal is to be made, as this will prevent a proper seal from forming.

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Summary of the chapter

- ✔ Choose a location that is close to the supply of crops and appropriate for food processing
- ✔ Make sure that the size of the factory is appropriate for your intended scale of production
- ✔ Ensure walls, floors, drainage and insect proofing are up to standard
- ✔ Make sure that there is an adequate electricity supply and that the water supply is reliable and provides potable water
- ✔ Leave enough space around equipment for easy access and cleaning
- ✔ Take time to select equipment that is the correct size and type for the intended production
- ✔ Do not forget to order spare parts
- ✔ Details of fruit-processing equipment are included in the chapter
- ✔ Find out what types of packaging are available and select ones that have a low cost but are attractive to the intended customers
- ✔ If only plastic bottles are available, hot-filling is not possible and the use of preservatives may be required.

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Entrepreneur's checklist

❑ Is the location of the factory close to crop suppliers and does it have adequate access roads and services?

❑ Is the factory large enough for the planned production? Is it too big?

❑ Does the factory have walls and floors with no cracks? Is drainage adequate?

❑ Where does wastewater go? Do you have adequate waste treatment?

❑ Have you visited local engineering companies, might they be able to make equipment for you?

❑ Have you investigated alternative sources of equipment? Where can you find information about equipment suppliers?

❑ Do you have access to a computer to find out the prices of imported equipment via the Internet?

❑ What are the alternative types of packaging that are suitable for your product(s)?

❑ Where can you get information about the types of packaging materials that are available?

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Readers' notes

Please use the space below to write your own notes on this chapter

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Processing 4

4.1 Introduction

To stay ahead of competitors, processors should continuously experiment with new and different types of fruit and vegetable products. In the following case studies there are examples of enterprises in ACP countries that have done this successfully. In this chapter the basic principles related to the processing and preservation of different types of fruit and vegetable products are described, together with examples of production methods.

Seasonality of crops

It is important to understand the impact of harvest seasons on production. A complex product such as pepper sauce or mixed fruit drink may contain several ingredients that are harvested at different times of the year (see Table 4.1).

The ingredients required are not available together in any month of the year. The only solution is to have a system of intermediate

Tips for success

- ✔ Be innovative and create new products
- ✔ Collect interesting recipe ideas and try them out
- ✔ Understand the principles related to the preservation of your products
- ✔ Obtain copies of local and international standards for your products
- ✔ Always wash and sterilise bottles outside the processing room to avoid any chance of broken glass in the product
- ✔ Never use ordinary mercury thermometers – use electronic types that do not break
- ✔ Have a diversified product range to make meaningful returns
- ✔ Make sure all workers understand exactly what they are doing, and why
- ✔ Make sure you have the correct equipment for the job
- ✔ Be careful to process products in exactly the same way every time
- ✔ Lay bottles of fruit drinks on their sides to cool and allow a vacuum to form
- ✔ Invest in measuring equipment such as thermometers, pH meters, timers
- ✔ Do not produce distilled spirits unless you are registered
- ✔ Read Sections 2.1–2.5 and 3.2 in *Opportunities in Food Processing, Volume 1*

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preservation for the ingredients thus making year-round production possible. The options are preservation by:

- brine or syrup
- sulphur dioxide or other chemicals
- drying
- freezing.

Ingredient	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bell pepper			x	x	x							
Onion	x	x	x	x	x							
Garlic			x	x								
Papaya						x	x	x				
Mango							x	x	x			

Table 4.1 Seasonality of ingredients for hot pepper sauce

Case study 4.1 Developing new products

One of the owner's strengths is the diversity of her products and the fact that her baobab drink is a new product. She keeps the formulation and preparation method secret, thus limiting imitation, but there has been much investigation by other enterprises to copy the formulation by corrupting her workers.

"We are constantly developing new products and have plans to export to other West African countries. Entry into the Nigerian market has not been that easy, but the company has been able to do this with hard work and high levels of quality assurance".

"We have developed our own recipes over time and continue to improve them to remain competitive. We have also funded universities for product-development work".

She started in a kitchen, moved to a backyard factory and is now in an industrial unit. To enhance her business knowledge of food processing she went on short overseas courses in food processing and business management in addition to on-the-job-training in Ghana. She has worked very hard for the last 15 years and has developed a sizeable market. She has diversified and now produces over ten different products, each with a good market.

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In the Table 4.1 example the trimmed peppers and peeled onions could be stored submerged in brine, the prepared mango and papaya could be preserved in a 1000 mg per kg (ppm) sulphur dioxide solution, and the garlic (after peeling) could either be dried or held in brine containing 20% salt. In general, freezing is too expensive for most small-scale operations.

Planning intermediate preservation requires the entrepreneur to calculate:
- the amount of each ingredient required for the whole year's production
- the financial impact on cashflow of buying many months in advance (Chapter 7, Section 7.1).

Other implications of crop seasonality and methods to ensure the quality of raw materials are described in Chapter 5, Section 5.3 and Chapter 6, Section 6.3.

Other ingredients

Salt

Salt (sodium chloride) should be pure white crystals. Sea salt is more likely to contain impurities and the more-consistent quality rock salt is preferable. Salt easily absorbs moisture from the air and should be stored in a dry place off the floor. In regions of high humidity it should be stored in moisture-proof containers.

Sugar

White granulated sugar is suitable for most uses, but pure sugar is sometimes difficult to obtain in ACP countries due to impurities (traces of molasses giving a pale brown colour) or contaminants. In many ACP countries sugar often contains tiny black specks and these may give rise to customer complaints of ants in the product. Contaminants can be removed by dissolving the sugar in a little warm water and filtering it through a fine cloth or mesh.

Flavourings and colourings

Flavourings can be grouped into extracts, essential oils and essences. Extracts are derived from natural materials using alcohol as a solvent. They give the most natural flavours and are often the most expensive. Vanilla is obtained from vanilla pods and the essence is a 10% solution in alcohol. Synthetic vanilla is also widely available. Essential oils are made by steam distillation of spices, roots, leaves, peels, nuts or flowers. Common types include the oils of: lemon, orange, lemon grass, citronella and peppermint. Essences can be artificial flavourings that resemble natural materials such as lemon,

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orange, chocolate or vanilla, but are not derived from natural materials. They are cheaper than extracts and essential oils, but do not withstand high temperatures. Common ones include pineapple, pear and apple. Natural lemon essence contains 5% lemon oil diluted in alcohol and peppermint essence contains 3% oil. Essences and extracts may also be supplied as blends, and as a general rule their quality is directly reflected in the cost. Spices such as anise, cloves, coriander, cassia, cinnamon, caraway, ginger, mace and nutmeg are available in two main forms – spice oils and ground powders, although ginger is also preserved in syrup. Colourings can be obtained as either liquids or powders. Both types have intense colour and should be carefully diluted before use. Do not use colours that are not certified for foods.

4.2 Bottled fruits

Fruits for bottling must be firm and fresh. Bottling involves placing the peeled fruit, either whole or in large pieces, up to the neck of the jars. Hot syrup, produced by dissolving sugar in water at 60°C, is then added to cover the fruit. This should done slowly to allow the syrup to fill all the spaces between the fruit. Two grades of syrup are commonly used: light syrup containing 200 g sugar per litre, or medium syrup containing 400–600 g per litre. The jars are then sealed and pasteurised in hot water baths. This process inactivates enzymes that might cause colour changes and destroys micro-organisms that could cause spoilage. The sealed container preserves the food by preventing re-contamination and excluding air and sometimes light. Preservation depends on an adequate heat treatment and an airtight (or 'hermetic') seal.

Jars used for bottling must be thoroughly cleaned before use and have new caps. If they are available, caps that have a 'pop-up' vacuum indicator should be used because they give confidence to consumers that the product has been processed properly. After capping the jars are fully submerged in a water bath at about 40°C. The bath is then heated for 20–30 minutes until the temperature reaches 88–90°C. The jars then are held in the simmering bath for a pre-determined time, which depends on the type of fruit, the size of the pieces and the size of pack. The bottles are then removed using tongs and allowed to cool. Samples should be checked to make sure that there is a partial vacuum in the headspace above the product.

Although bottling of fruits appears simple, considerable attention is needed to standardise the processing conditions. In particular, the heat treatment

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should ensure that each piece of fruit receives the same amount of heat to adequately pasteurise it without overcooking or excessively softening the fruit. The calculations required to achieve this are complex and beyond the scope of this book.

The time and temperature of heating vegetables are critically important and must be carefully controlled. The establishment of correct heating conditions depends on the type of food, the size and shape of the container and the initial level of contamination of the food. This requires the skills of a qualified food technologist or microbiologist.

Caution: Vegetables should not be bottled unless they have been acidified with citric acid or vinegar.

If non-acidic foods are under-processed, there is a risk of serious food poisoning.

Inexperienced and untrained processors should not attempt canning or bottling of vegetables.

A note on canning

Canning is not suitable for small-scale processors for the following reasons:

1. Even if cans are available in a particular ACP country, they are usually more expensive than other forms of packaging.
2. Different types of product require a particular internal lacquer to prevent the metal from corroding when it is in contact with the fruits or vegetables and such lacquers may not be available.
3. A 'seamer' is needed to seal the lid onto the can and regular checks and maintenance are necessary to ensure that the seam is properly formed. This requires a skilled technician. Failures in seams are one of the main causes of spoiled canned foods or food poisoning.
4. When vegetables are heated in sealed cans during the canning process, the temperature must rise above 100°C to ensure that micro-organisms are killed. The pressure outside the can must equal that inside to prevent the cans from exploding. This is achieved using high-pressure steam and a strong vessel named a 'retort'. Additionally, compressed air is needed to maintain the pressure while cans are being cooled, which together with the necessary controllers, adds to the capital cost of equipment. The combined costs of a steam boiler, retort and compressor are likely to be beyond the means of small-scale processors.

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4.3 Candied and crystallised fruits

Candied fruits are high-value products that are used as ingredients by other food manufacturers (such as bakeries), or as confectionery. The most common candied fruits are made from citrus, mangoes, apricots, apples, grapes, cherries and pineapple. The method can also be used to remove up to half of the water in fruit and is therefore a cheap way of increasing the production rate of a dryer, or for part-processing fruits for intermediate storage so that production can be extended throughout the year. The process produces a partially dried food that has good retention of colour and a sweeter, blander taste. However, acids are removed from fruits during the process and the lower acidity may allow mould growth if the food is not properly dried and packaged.

Fruits should be washed and larger pieces pricked with a stainless steel fork to allow better penetration of the sugar syrup. The simplest process involves covering the prepared fruit in hot sugar syrup, the concentration of which is increased each day or two. For each 450 g of fruit add 300 ml of liquid and 175 g of sugar, or 50 g sugar and 125 g of glucose syrup. If it is available, glucose syrup is recommended as it gives a 'clearer' surface appearance. The syrup is brought to the boil and poured over the fruit. The next day 50 g of sugar are added and the process is repeated for 5–10 days, after which the syrup has a thick consistency like honey. Water slowly diffuses from the fruit to be replaced by sugar. After candying the fruit can be air-dried to form a surface layer of sugar crystals and the product is then known as crystallised fruit.

In a more complex method, fruit is first boiled in 20% syrup in which it is left to soak overnight. The fruit is then strained from the syrup and transferred each day to 40% and 60% syrups in turn, with optional boiling for 10 minutes at each transfer. After soaking, the syrup is diluted to approximately half of the original concentration. Each day the most dilute syrup (10%) is used for other products and new 60% syrup is made up. The advantages of this method include re-use of sugar syrups and a softer texture in the final product. Some producers have even more stages in the process and may transfer fruit into increasing sugar concentrations each day for up to 14 days. This produces a succulent, soft texture in the final product. Candied and crystallised fruits should be packed in cartons, either lined with waxed paper or plastic film, and with film or waxed paper between layers of fruit to avoid them sticking together.

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Candied peel or citrus peels for marmalade (Section 4.11) are made from orange, lemon, grapefruit or lime peel (Figure 4.1). After washing, the fruit is divided into quarters and peeled. It is important to discard the white pith, which has a bitter flavour. After weighing the peel is simmered in boiling water until it is tender. For every 450 g of peel a syrup is prepared using 300 ml of the cooking water and 225 g of sugar. The syrup should be concentrated by boiling until the temperature reaches 104°C, measured using a thermometer. The peel is then added and allowed to stand for one or two days. The next step is to strengthen the syrup by adding 100 g of sugar. This stronger syrup is poured over the peel. After one day the syrup and peel are placed in a pan and boiled for about 30 minutes. By now the peel should be almost transparent. After straining, the peel is allowed to air dry. All syrups should be retained for future use if sugar is a significant cost. Peels for marmalade production can be stored in syrup for longer periods, up to 6 months, using a preservative such as 1.8% sodium benzoate. The possibility of using the 'spent' syrups in preserves or fermented products should be considered to reduce the costs of buying sugar and disposing of sugar solutions.



Fig. 4.1 Crystallised peels (Photo: Peter Fellows)

4.4 Dried products

Drying removes most of the water from fruits and vegetables to prevent the growth of spoilage organisms and to increase their convenience, value and their shelf life (from days for the fresh fruit to months for the dried fruit). The reduction in weight and bulk also makes transport cheaper and easier, although many dried foods are fragile and require packing in boxes to prevent

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them from being crushed. Some products are hygroscopic (able to pick up moisture from the air) and these require packaging that provides a barrier to moisture. All dried foods are able to pick up odours (e.g. from other strong-smelling foods, diesel etc.) and they should be protected by proper storage and for some, an odour-proof package.

Dried fruits and vegetables have two markets:
- in bulk to other manufacturers, such as bakeries or dry soup producers
- in small retail packs as snack foods or for home use.

This second category offers better opportunities for profitable production by small-scale processors.

Case study 4.2 *Gari* processing

In Ghana a *gari* processing group has developed different types of products for different markets: for example, they produce traditional *gari* for local and export markets, but in particular soy-fortified *gari* for the export market. The soy-*gari* costs twice as much as the traditional *gari* but they cannot meet the demand for it. Their main competitors are *gari* producers in Kumasi, Accra and the Volta Region, but the group has a comparative advantage over them because the cost of raw materials, which form 50% of the cost of production costs, is several times cheaper in their area when purchased at farm gate prices. Also the competitors in Accra package their soy *gari* in small packages whereas the group bulk sells theirs in 50-kg sacks, thus saving on packaging costs.

Pre-treatments

All fruits and vegetables require some form of treatment before drying. In some cases this simply involves selection, washing, peeling and cutting into chips or slices, but in many cases more complex pre-processing treatments such as blanching, sulphuring, sulphiting or chemical treatment are required.

Blanching

Fruits and vegetables contain enzymes that can cause colour and flavour changes (e.g. polyphenoloxidase causes darkening of apples, bananas and potatoes when they are cut). The temperatures used in drying are not high

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enough to destroy these enzymes and they must be inactivated by either plunging the food contained in a wire basket into boiling water, or treating it with steam for a short time. Typical blanching times are shown in Table 4.2. It should be noted that these times are indicative and the exact time depends on the size of the pieces, the type, variety and maturity of the food. Chemical treatments can also help preserve the colour and texture of the food. The addition of a small amount (e.g. 2%) of sodium bicarbonate to the blancher water helps to retain a green colour in foods such as green beans and calcium chloride (2–4%) helps to retain firmness.

Material	Blanching time (min)
Potatoes	10
Carrots	10
Spinach	5
Celery	3
Mushrooms	2

Source: data from Fellows, 1997

Table 4.2 Typical blanching times of selected vegetables

Sulphuring

Sulphur dioxide inhibits the action of some enzymes and is particularly useful to retain the colour of some fruits such as apricots and raisins (NB: sulphur dioxide bleaches red-coloured fruits). It also inhibits the growth of yeasts and moulds. Sulphur dioxide is obtained directly by sulphuring or by sulphiting.

Sulphuring fruits involves burning a small piece of sulphur (3–4 g per kg of fruit) for 1–3 hours in a sealed container or cabinet (Chapter 3, Section 3.4). At larger scale sulphur dioxide gas is fed from cylinders into a sulphuring room.

Caution: Sulphur dioxide gas is very harmful to the lungs.

Workers should be trained in its safe use and work in a well-ventilated environment.

Sulphiting

Sulphiting is a more controllable process than sulphuring and involves immersing the food into a bath of sodium metabisulphite dissolved in water.

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Levels of sulphur dioxide are expressed in mg per kg (ppm). A 1000 ppm solution contains 16 g of sodium metabisulphite in each 10 litres of water. When sulphuring or sulphiting it is important to standardise the amount of sulphur dioxide and the exposure time as, in most countries, residual sulphur dioxide levels are controlled by food regulations (Chapter 5, Section 5.8).

Pre-treatment with sugar

Fruits may be soaked in sugar syrup before drying (see Candied and crystallised fruits Section 4.3). If hot syrup is used any surface microbiological contamination will be greatly reduced. The increased sugar content of the dried fruit also results in a sweeter flavour in the final product

Salting

Some vegetables and a few fruits such as limes may be salted before drying. The high salt concentration preserves the food by both drawing out water and the anti microbial properties of the salt. Salt-tolerant micro-organisms begin to grow while the product is being dried and these produce acids and characteristic flavours. High salt concentrations also inhibit some enzymes, which would reduce the quality of the dried food during storage.

Drying

Fruits, root crops and vegetables must be carefully selected before drying. If fruits are over-ripe they are easily damaged and may be difficult to dry. If they are under-ripe, they have poorer flavour and colour. Attention to hygiene is essential because any bacteria, yeasts or moulds that contaminate fruits and vegetables before drying are likely to survive on the dried food. The temperature of drying is not high enough to kill them and when the food is re-hydrated, they can grow again.

A number of options are available when drying crops and it is important to understand that the selection of a drying system depends on local climatic conditions. In a dry area with low relative humidity, sun drying and solar drying is possible, whereas in a humid climate additional heating is required. Sun drying is the cheapest and simplest technology and is widely used to dry apricots, raisins, dates and starchy root crops such as cassava, sweet potato, cocoyams and yams. The foods can be spread out on a concrete drying floor,

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but to produce higher-quality products, the use of mesh drying trays, inclined at an angle to the sun is recommended. Placing the product to be dried on trays also allows the trays to be moved under cover in the event of rain. The main problems with sun drying are:

- contamination by dust and smoke, theft, or damage by birds, rats or insects
- slow or intermittent drying and no protection from rain or dew that wets the product and encourages mould growth
- low and variable quality products resulting from over- or under-drying
- large areas of land are needed to accommodate the shallow layers of food
- high labour input because the crop must be turned, moved under cover if it rains, and protected from animals
- direct exposure to sunlight reduces the quality (colour and vitamin content) of some fruits and green vegetables.



Fig. 4.2 Sun drying apricots (Photo: Sue Azam Ali)

Case study 4.3 Drying

Mrs F created a micro enterprise drying root crops as a response to unemployment and devaluation of the CFA in 1994. She got the idea that many local roots and tubers can be processed into chips as she has seen in different parts of the world and has since set up a successful business that supports her family.

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Details of solar dryers and mechanical dryers that have electric or fuel-fired heaters are given in Chapter 3, Section 3.4 and in books listed in Appendix I. In *gari* processing, the cassava is first grated and then dried and roasted in large shallow pans over a fire.

Fruit leathers

Fruit pulps can be spread in thin layers on polythene to dry in the sun, or alternatively dried on trays in a dryer. The thin sheet of dried fruit is known as a fruit 'leather' and can be used as a snack food. Different-coloured layers of leather can also be pressed together to make a multi-coloured and healthier alternative to confectionery products.

Shelf life and packaging

The shelf life of dried foods depends on the 'equilibrium relative humidity' of the product in a particular package under normal storage conditions. This depends partly on the moisture content of the food, but because the relationship between moisture content and humidity varies with different foods, it is necessary to do trials to find the highest moisture content at which the food will not spoil. This involves taking samples of food that are dried for different times, packaging them and checking for spoilage after storage for the expected shelf life. The moisture content of those samples that have not gone mouldy is measured and this becomes the target level for subsequent production. Measurement of moisture content is described in Chapter 5, Section 5.5 and methods for calculating the yield of dried fruits are given in Chapter 6, Section 6.3.

The type of packaging used for dried fruits and vegetables depends on:

1. The local climatic conditions and particularly the humidity. In a dry climate it may not even be necessary to package the food because it will not pick up moisture from the air. In a humid area greater protection is needed as the food will absorb moisture and quickly go mouldy.
2. The nature of the food. Foods can be broadly divided into those that quickly absorb moisture (hygroscopic) and those that do not absorb moisture (non-hygroscopic). Due to their high sugar content, fruits are hygroscopic and need packaging that provides a high degree of protection. Dried vegetables are non-hygroscopic and so need less protection.

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3. Any chemical reactions within the product caused by air or sunlight during storage.
4. The required shelf life.
5. Marketing considerations (Chapter 2, Section 2.3).
6. Cost and availability of different packaging materials.

Dried fruits and vegetables are normally packed in plastic bags that are heat-sealed. The selection of the correct material is complex and should take into account the local climate, the type of food, expected shelf life, cost, and in many ACP countries the availability of films. Polythene bags are cheap and widely available but they provide little protection in humid areas. Polypropylene provides a better moisture barrier but it is more expensive. Aluminium foil laminates are expensive and often difficult to source, but they provide very good protection. Dried fruits and vegetables may also be packed in plastic jars or paper bags. Most also need a cardboard carton to prevent crushing and to exclude light which can cause loss of colour and development of off-flavours during storage.

4.5 Fermented products – wines and spirits

Wines are produced by fermentation of sugars in fruit juice (plus added sugar) into alcohol and carbon dioxide by varieties of the 'wine yeast' *Saccharomyces cerevisiae*. Producers need to select one variety that works well in their process and continue to use it to produce a consistent product. Wine yeast is commercially available as a freeze-dried powder. Their alcohol content (9–13%) and natural acidity preserve wines. 'Fortified' wines, such as sherry, ginger wine etc., have an alcohol content of 15–20%. Almost any fruit and many types of vegetable can be used to make wine, but the most popular in many ACP countries are pineapple, papaya, grape, passion fruit, banana, melon and strawberry (or strawberry-flavoured) wines. Typical recipes for banana, carrot, ginger and rice wines are shown in Table 4.3.

In some ACP countries a special licence is needed to sell any alcoholic products, whereas in others it is only distilled spirits that need a licence. Be sure to check whether a special licence is needed to make wines or spirits.

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Ingredient	Banana wine	Carrot wine	Ginger wine	Rice wine
Ripe bananas	1.8 kg			
Chopped raisins	115 g		450 g	450 g
Chopped sultanas		225 g		
Carrots		2 kg		
Root ginger			75 g	
Crushed rice				1.35 kg
Juice from orange	1 fruit	2 fruits		
Juice from lemon	1 fruit	2 fruits	3 fruits	2 fruits
Cayenne pepper			1.25 g	
Sugar	1.35 kg	1.0 kg	1.35 kg	1.35 kg
Citric acid	14 g			
Water	5.7 litres	4.5 litres	4 litres	4.5 litres

Source: Joseph Hounhouigan.

Table 4.3 Recipes for various wines

The principle factors related to the production of good quality wine are:

- use of good-quality wine yeast that is added in sufficient amounts (e.g. 1–2%) to rapidly start a vigorous fermentation
- strict attention to cleanliness and hygiene. All equipment should be sterilised and fermentation vessels should be cleaned with sodium metabisulphite solution before use
- exclusion of air to prevent the development of micro-organisms that convert the alcohol to vinegar. This is best done by using an airlock (Chapter 3, Section 3.4)
- efficient sedimentation and clearing agents that produce a crystal-clear wine.

The time taken to fully ferment the sugars in the 'must' to form alcohol depends mainly on the initial amount of yeast that is added and the temperature of fermentation. Wines are normally fermented at ambient temperature, but ideally it should be 20–25°C.

The following amounts of filter agents are used to filter 5 litres of wine: 10 g of bentonite is first sprinkled on the surface of the wine and left for 10–15 minutes. Then a cupful of wine is mixed with 20 g of perlite and mixed back into the wine. Finally, 10 g of isinglass is sprinkled over the surface of the wine and stirred gently to mix the agents without disturbing the sediment. The

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wine should be left for 30–60 minutes while it is clearing. If a haze remains in the wine, this is due to pectin and it may be necessary to use a pectic enzyme to remove it. It is likely that pectic enzymes (often named 'Wine enzyme' or 'Wine-clearing enzyme') will have to be imported.

Wines should be stored in airtight containers while they are clearing to prevent contamination by acid-producing bacteria that can convert the alcohol to vinegar. They should be bottled as soon as they have cleared and sealed with a cork or plastic cap.

Case study 4.4 Novel fermentation vessels

A manufacturer in Tanzania reported that she has found the large drinking water bottles used in local offices make ideal fermentation vessels. They are clear, helping to check on sedimentation, they can be fitted with an airlock and they have a 20-litre capacity. She reported: "I use a wine yeast, a clearing agent and a wine filter to produce a brilliantly clear product."

Spirits are produced by the distillation of wines or other alcoholic ferments. Alcohol boils at a lower temperature than water and so distillation (vaporising the alcohol) is used to separate and concentrate the alcohol. This is carried out in a still (Chapter 3, Section 3.4). Wine or other alcoholic liquor is placed inside a drum and heated. The alcohol vapour is then passed in a pipe through cooled air or cool water and the distillate condenses and is collected. Despite the fact that many unofficial stills operate, the process cannot be recommended unless the company is legally registered and the owner and staff have been fully trained in safe production.

Knowledge of the safe operation of a still is necessary because during the fermentation process to produce wine other alcohols are produced in small quantities. For example, methanol (methyl alcohol) has a boiling point below that of alcohol (ethanol). There have been many cases of poorly produced spirits containing methanol at levels that can cause blindness or death. Other alcohols, such as amyl alcohol, acetyl alcohol etc. can also be present. These not only have unpleasant flavours but can also cause serious damage to health. The key factors for the safe production of spirits are:

- reject the methanol
- collect the pure ethanol fraction
- reject the higher-boiling alcohols.

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This requires the use of an accurate thermometer and considerable knowledge and experience of distillation.

4.6 Fried products

Fried fruits and vegetables, such as potato, cassava, jackfruit, banana and plantain are popular snack foods in many ACP countries. They are relatively simple to produce using basic equipment, and due to their low moisture content they have a low risk of deterioration when properly packaged. Banana or plantain chips are normally made from semi-ripe firm fruits. Cassava chips should be made from sweet varieties because bitter cassava varieties contain higher levels of toxic cyanide components. It is strongly recommended that manufacturers seek expert advice on suitable varieties of cassava.

When making fried chips it is important that they are sliced to a uniform thickness. Slicing with a knife cannot produce uniform slices and some will be too thick and undercooked whereas others will be too thin and overcooked. Uniform slices can be obtained using an adjustable hand slicer, or at larger scale, an electric food processor or a rotating slicer of the type used to cut ham or bacon.



Fig. 4.3 Fried plantain chips (Photo: Joseph Hounhouigan)

After slicing, fruit or vegetable slices should be rapidly submerged in water containing either 500 ppm of sulphur dioxide (made by dissolving 0.75 g of sodium metabisulphite per litre of water), or adding 5 g of citric acid per litre of water. If these chemicals are not available, it is possible to use citrus juice, but this is less effective and flavours the chips. These soaking treatments reduce browning which is caused by naturally occurring enzymes in the fruit or vegetable.

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Case study 4.5 Fried snackfood businesses

Mrs A is a schoolteacher but also produces the finest plantain and wheat-flour crisps (chips) as snacks for schoolchildren, retail shops and occasional parties. She first got the idea for making crisps during one of her home science classes as a student. Four years later, on completion of her education, she decided to make plantain crisps to sell at her school canteen, both as an income-generation activity and to process excess plantains from her husband's backyard garden. Little did she know this could grow into a big money-spinning venture, generating a high demand from other schools and neighbours. She has now been in this business for eight years and has had to employ her children and another part-time person to meet the demand.

In Benin, Mrs O decided to set up a small business making fried snacks from cassava, yams and potatoes. Her start-up capital was less than US$100, which she used to buy an imported mechanical slicer in order to produce chips of even thickness. These are then fried on a gas stove. She now employs nine people and states that one of her biggest problems is finding suitable equipment. She is now in contact with suppliers in China. The chips are packed in heat-sealed polythene bags that are available in the local market. She now processes 65 kg of root crops into chips each week.

In Uganda, Mr K produces plantain chips for sale as snacks for children and local shops. Over eight years his business has grown beyond his original expectations. He says his equipment is simple and most items were made locally. He uses only one variety of plantain to ensure a standard product and fries the slices in oil over a charcoal stove. Chips for shops are packed in heat-sealed polythene bags with labels. Those sold to children are not packaged but sold on the day of manufacture. In this way he has reduced packaging costs to 10% of his production costs.

After draining, the slices are fried in food-grade cooking oil. The main purpose of frying is to remove water and develop characteristic colours, flavours and aromas in the fried foods. It is possible to train operators to watch each batch of food to ensure that is fried to the same colour each time. However, it is more efficient to standardise the frying time and temperature using a timer and thermometer for each particular type of food. In this way a standard product is produced. The main factors that control the changes to colour and flavour are:

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- type of oil used for frying
- age of the oil
- temperature and time of frying
- size of pieces, moisture content and surface characteristics of the food.

The type of oil is important: it should be stable against breakdown and rancidity and have a reasonable cost. Prolonged heating of oils at the high temperatures used in frying, in the presence of moisture released from foods, causes unpleasant flavours and darkening of the oil. Heating also thickens the oil, which increases the amount lost with the fried food. The same changes occur if the oil is over-heated and the temperature should be controlled within 180–200°C and checked using a thermometer. The use of degraded cooking oil has been shown to cause cancer and it should not be used. In particular, the purchase of used oil from larger food service chains should not be considered even if it is low cost.

In many fried foods, oil can account for up to 45% of the product. Where fried foods form a large part of the diet, excess fat consumption can be an important source of ill health, and is a key contributor to obesity, coronary heart disease and perhaps some types of cancer. These risks and consumer trends towards lower-fat products are creating pressure on processors to alter processing conditions to reduce the amount of oil absorbed in their products. The correct management of frying oil is also important because it represents a major cost. The oil should be filtered each day to remove any small food fragments that would accelerate the development of rancidity. Most types of vegetable oils are suitable for frying, but those that have a higher smoke point, including maize, sunflower and groundnut oils are preferred. In West Africa, palm oil is widely used. A saucepan can be used for small-scale frying but on a larger scale, a thermostatically controlled electric deep-fat fryer is preferred (Chapter 3, Section 3.4) Well-designed fryers prolong the life of the oil because their layout allows small food particles to sink to the cooler zone below the heating elements.

Caution: deep fat frying can be dangerous.

If the temperature of the oil rises above its smoke point an oil fire can injure workers and cause great damage.

It is recommended that a suitable (i.e. non-water) fire extinguisher and a fire-proof blanket should be available and workers trained in their use.

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After frying and shaking off excess oil, some producers dust the chips with a spice/salt mix: chilli pepper is particularly popular in some ACP countries. The chips should be packaged when cool in airtight, lightproof and moisture-proof containers. Many producers use polythene because it is cheap and widely available. However, for a shelf life of more than a few days, it is necessary to use a plastic film that has better protection against air (which causes rancidity) and moisture absorption during storage. The preferred choices are polypropylene or polyester films where these are available. Cellophane is not heat-sealable and therefore not widely used, and aluminium foil/plastic laminated bags are usually very expensive although they provide a far greater degree of protection. In addition, crisps have very sharp edges that quickly penetrate polythene but the other films are more resistant. Bags are usually packed into cardboard boxes to protect the product from light and heat (which also increases rancidity) during storage.

Labelling fried products can be a problem because oil seepage into paper labels makes a package look very unattractive. The options are to have plastic bags pre-printed if this is affordable, or alternatively double-pack the chips in two bags, with the label between the two. Another option is to seal the product into the bag, place the label above the seal and then form the final seal above the label, so keeping it separate from the product.

4.7 Fruit juices, cordials, squashes and nectars

The fruit beverage market is very large and, despite strong competition from large manufacturers, still provides opportunities for smaller companies. In this section the principles of fruit drinks manufacture are described. Carbonated drinks, which are made from flavourings and do not contain fruit juice are not included. All products described in this section contain pulped fruit or fruit juice from either a single or a mixture of fruits. Fruit drinks may be divided into two groups:

- those that are opened and consumed as a single drink. These do not need to contain any form of preservative
- those, such as a squash, that are opened and part-used. These should contain a preservative such as sodium benzoate or sulphur dioxide.

Details of the fruit content in different products and permitted preservatives are given in Chapter 5, Section 5.8.

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The preservation of fruit juices depends upon pasteurisation to about 80°C and having a pH of 3.5–4.0. With a few exceptions (e.g. watermelon and prickly pear), fruit juices are acidic and this means that food-poisoning micro-organisms cannot grow in them. In less- acidic products the acidity is increased by the addition of citric acid. Unopened bottles of both types of product should have a shelf life of 3–9 months, depending on the storage conditions.



Fig. 4.4 Juices, cordials and squashes (Photo: Peter Fellows)

Case study 4.6 Successful juice processing

The company has the potential to develop many products and capture a larger market in West Africa. Mr K is open to new ideas and also seeks professional advice and funds for research projects. The company has developed 'pine–orange' drink (a blend of pineapple and orange juices), which is only produced when pineapple is in season, and he has also developed 'orange–mango' juice, but this is yet to be produced on a commercial basis. The company has also funded research into commercial production of essential oil from waste orange peels.

Extraction of fruit juice or pulp

After selecting fruits, rejecting any that show damage or rot, and washing in clean (potable) water, juice is extracted or fruit pulp is prepared. Soft fruits such as papaya, soursop or passion fruit can be pulped by hand on a small scale, but this is laborious and time-consuming. The only fruit that is pulped in this way on a significant scale of production is banana. In East Africa, clear banana juice is prepared by mixing the fruit with sharp grasses and pulping with the feet. The grass cuts through the cells to release the juice, whereas mechanical pulpers produce a paste and not a clear juice. Research is in progress at the Department of Food Science and Technology, Makerere University in Uganda (Appendix I) to improve the traditional processing technology.

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At larger production rates, soft fruits and harder, more-fibrous fruits such as mango or pineapple, need mechanical pulping. Hand-driven mechanical pulpers are available but at higher production rates powered machines called pulper-finishers are required (Chapter 3, Section 3.4).

Because most fruits are seasonal, producers usually purchase them during the low-price glut season, extract the juice or pulp and store it with 1000–2000 ppm sodium metabisulphite. (NB: red berry fruits such as raspberries, strawberries etc. cannot be stored in this way because metabisulphite bleaches their colour). An alternative method from the Caribbean is described in Case study 4.7.

Case study 4.7 Preserving fruit pulp

"In our plant we produce exotic fruit nectars for rich tourists. One concern was that they should be free of any chemical preservatives. For this reason we decided, despite the higher cost, to store the fruit pulp in 20-kg plastic bags in the freezer of a local ice-cream factory that had unused capacity. In this way we avoided the need to add any form of preservative. This proved to be a great marketing plus – No added preservatives!"

Batch preparation

In most cases the fruit juice or pulp needs to be strained through a large fine-mesh sieve to remove fibre and seeds. Producers should use a standard recipe and carefully measure all ingredients. Where sugar is used as an ingredient, it should not be added directly to the juice but made into syrup and passed through a fine filter. Batches are mixed in a tank or similar container before packaging.

Case study 4.8 Juice processing equipment

At the start of the business, the company manually squeezed orange juice and had one mechanised juice extractor. Now it operates two extractors, a pasteuriser, storage tanks and a complete packaging unit for filling and capping over 1,500 litres of orange juice per day, all year round. The complete set of extraction, pasteurising and packaging machines was imported from India.

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Pasteurisation

Fruit juices must be pasteurised if they require a shelf-life of more than one or two days. This involves heating the product using one of the following methods:

- heating the batch and hot-filling into clean, sterilised bottles
- cold-filling, sealing and heating the bottles in large pans of simmering water. The water level should be at the shoulder of the bottle.

Only stainless steel containers should be used for pasteurisation. On a small scale this can be a stainless steel pan heated by gas. On a larger scale a double-jacketed, steam-heated tilting kettle is required (Chapter 3, Section 3.4). The time and temperature required for in-bottle pasteurisation depend on the type of product and the bottle size, but is typically 10–20 minutes at a fixed temperature in the range of 70 to 90°C. Because the pasteurisation temperature does not exceed 100°C, there is little risk of the bottles bursting. However, as with all glass containers, there is a risk that immersing cold bottles into hot water can cause the bottles to break. This can be overcome by preheating bottles by immersing them in water at an intermediate temperature.

Case study 4.9 Product diversification

The enterprise produces about 265 litres of pineapple juice daily but the quantity of nectars they produce depends on the amount of raw material available. Annual production of pineapple juice has increased from 4,158 litres in 2000, to 12,316 litres In 2002 the owner diversified her products and now produces guava nectar (426 litres), corossol nectar (372 litres) and ginger juice (174 litres).

Cooling

After hot filling or in-bottle pasteurisation, the bottles are immediately sealed, laid on their side and allowed to cool. Alternatively, a counter-current cold-water cooler can be constructed to speed up the cooling time (Chapter 3, Section 3.4).

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Case study 4.10 Solving the problem of mouldy juices

A processor in a Caribbean island reported: "We had serious problems with mould growth on our fruit drinks. One day, by chance, we laid them on their sides to cool rather than upright and saw that bubbles of air were entering the pack. This air, of course, was not sterile. We then tried laying all the bottles on their sides to cool. This meant that the air had to pass through the hot juice and so would be sterilised. This simple change resulted in dramatic fall in the number of rejected packs. A food technologist explained that glass and metal caps have different rates of expansion and that until a proper seal formed the bottles were able to suck in air, which contaminated the juice".

4.8 Papain and pectin

Papain is a high-value enzyme that is used as a meat tenderiser and as clearing agent in beer manufacture. Although synthetic equivalents have been used for many years, natural papain is gaining in popularity because of a move in industrialised countries away from synthetic additives in foods. Natural papain is made by collecting the white latex that flows from incisions made in green papaya fruits whilst they are still on the tree. After drying the crude papain is packed into airtight, moisture-proof containers and sent for refining. It is difficult for small-scale producers to satisfactorily refine papain.

Caution: Papain attacks flesh

All workers should wear protective rubber gloves

Pectin is a component of nearly all fruits and vegetables and can be extracted and used in food processing to form the characteristic gel in jams and marmalade (Section 4.11). The richest sources of pectin are the peels of citrus fruits or apple 'pomace' that is left after juice has been extracted. There is also a report (Gunasena, 2002) that describes pectin production from tamarind seeds. When using citrus peels, they are cut into thin slices (e.g. 1cm wide) and water is added at approximately 8 times the weight of fruit. It is heated gently to simmering and held at that temperature for 20–30 minutes. Longer heating times concentrate the pectin so that it can be stored for a few days, but over-long heating degrades the pectin and it loses some of its gelling power. The pectin concentrate can be stored using 500 ppm sodium metabisulphite. The

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quality and strength of homemade pectin is often very variable and small-scale pectin manufacture is time consuming. It is not economically viable to make pectin powder at a small scale, mostly because propanol (a type of alcohol) has to be used to precipitate the pectin and efficient recovery of the alcohol by distillation is essential if the process is to be economic.

4.9 Pastes, purees and fruit cheeses

Pastes and purees can be made from almost all fruits and vegetables but the most common types are tomato, chilli, ginger and garlic. The first step is to prepare a pulp using a pulper (Chapter 3, Section 3.4), which is then heated over a low heat to boil off water. If a jacketed pan is not used the paste requires constant stirring to prevent it burning onto the pan. Boiling is continued until the solids content of the puree is higher than 36%, measured by refractometer (Chapter 3, Section 3.4). When making vegetable pastes, it is recommended that a small amount of vinegar be added to lower the pH below 4 to prevent the growth of food-poisoning micro-organisms. A little oil may be added to garlic and ginger pastes, and in some preparations, sugar and/or salt are added to assist in preservation and improve the flavour.

One of the most popular types of fruit cheese in many ACP countries is guava cheese although cheeses can be made from any type of fruit. These products are made by concentrating fruit pulp with added sugar until the solids content is 75–85%. Typically one part fruit pulp is mixed with one part sugar. The mixture is then boiled, with constant stirring for about an hour. It is then poured into moulds and allowed to cool. The final product should not be spreadable like a jam but should have the consistency of a soft cheese.

4.10 Pickles, chutneys and salted vegetables

A wide range of pickles and chutneys are produced from both fruits and vegetables. These include raw vegetable pickles and cooked pickles and chutneys. The preservation of these products depends on:

- high acidity, in the form of lactic acid in fermented pickles or acetic acid (vinegar) in non-fermented pickles and chutneys
- relatively low water content and low water activity (A_w), to prevent microbial growth (see *Opportunities in Food Processing, Volume 1*, Chapter 2)
- a relatively high level of salt in some products.

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These conditions prevent food-poisoning micro-organisms from growing. Yeasts and moulds that have a high tolerance to acid and/or salt may cause spoilage of pickles and chutneys. This is seen as a white growth on the surface of vegetables that protrude from the surrounding liquor. Micro-organisms that are capable of causing spoilage tend to adapt to conditions in a processing plant but are unlikely to be found in the home. For this reason many pickled products are pasteurised to destroy salt- or acid-tolerant micro-organisms and later contamination in the home after opening the jar is very unlikely. Because acid-tolerant yeasts and moulds tend to develop in a factory that is producing pickles and chutneys, manufacturers should make sure that good hygiene is a priority at all times. All surfaces, floors, machines and utensils should be washed at the end of the day with hot water and chlorine-based sterilants (further details are given in *Opportunities in Food Processing, Volume 1*, Chapter 5.2).

It is only by maintaining good hygiene that a serious outbreak of product spoilage can be avoided.

Types of product

Vegetables such as cucumbers (gherkins), cabbage, olives and onions are fermented by lactic acid bacteria that can grow in low concentrations of salt. The bacteria ferment sugars in the food to form lactic acid, which then prevents the growth of spoilage micro-organisms. The amount of added salt controls the type and rate of the fermentation: 2–5% salt encourages a natural sequence of different bacteria that produce the lactic acid. Higher concentrations of salt (up to 16%) produce a different product named 'salt stock' pickle, which is preserved by the salt and not by fermentation. In some processes, sugar is added to increase the rate of fermentation or to make the product sweeter. In others, vegetables are submerged in vinegar, salt and sometimes sugar to produce a variety of uncooked pickles, which are usually pasteurised. Sweet pickles are made from single fruits or mixtures of fruits and vegetables that are preserved by the combined action of lactic or acetic acid, sugar and added spices.

In most commercial pickle production plants the acetic acid content of ordinary vinegars (Section 4.13) is too low to ensure a Preservation Index (PI) that is high enough to preserve the product (see below). For this reason

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Fig. 4.5 Pickles (Photo: Peter Fellows)



Fig. 4.6 Chutneys (Photo: Peter Fellows)

many manufacturers prefer to use food- grade 'glacial' acetic acid. It must be stressed that this pure acetic acid must be **guaranteed** as food-grade because other commercial types may contain high levels of lead. In most ACP countries vinegar is imported and although food-grade glacial acetic acid is more expensive, because of freight costs the actual price is lower than vinegar because 95% of vinegar is water. Incoming bottles of acetic acid should be diluted to 10% acetic acid for storage and use.

Pure glacial acetic acid is dangerous.

It must be handled with care and any worker using this product should be trained and provided with protective clothes (gloves, eye and nose protection).

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Chutneys are thick, jam-like products made from a range of sour fruits and vegetables (e.g. lime, mango) with sugar, spices and sometimes vinegar – the sourness of the fruit complements the sweet taste from the sugar. Most products are boiled both to pasteurise them, and to caramelise the sugar, producing a richer flavour and the required colour and thickness. Other chutneys are allowed to ferment naturally and are preserved by the acids produced in the fermentation. In many ACP countries mango chutney, often called *achar*, and tomato chutney are very popular. A typical mango chutney recipe is shown in Table 4.4.

Ingredient	Quantity
Prepared mango flesh	1.35 kg
Salt	75 g
Water	2 litres
Sugar	450 g
Vinegar	600 ml
Ginger	75 g
Garlic	75 g
Chilli powder	75 g
Cinnamon	75 g
Raisins	125 g

Table 4.4 Recipe for mango chutney

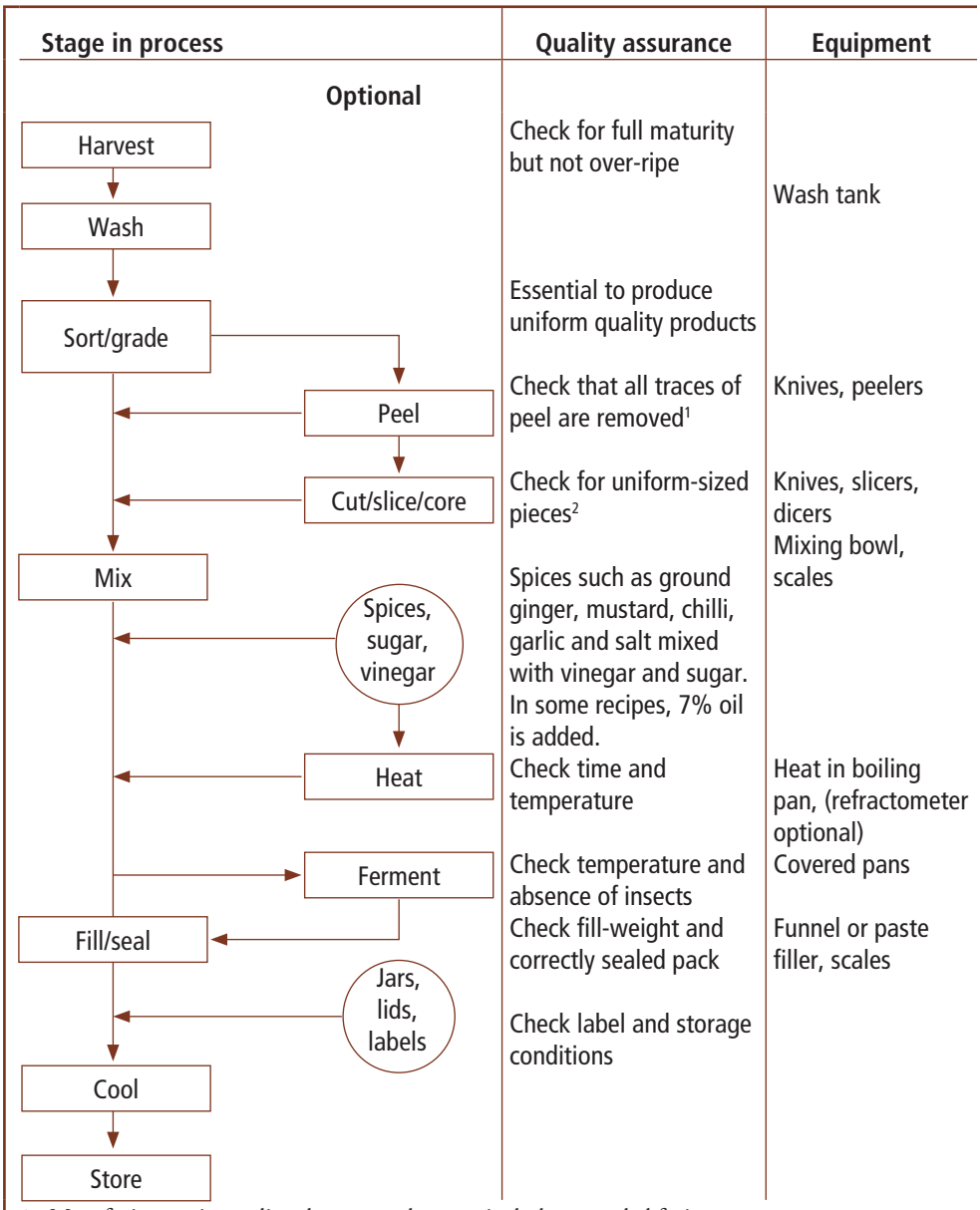
The mixture is boiled until it reaches a thick consistency and is then filled into clean jars, sealed, inverted for a short time to sterilise the lid and allowed to cool (Figure 4.7).

Intermediate storage

Many pickles, chutneys and sauces are made from fruits and vegetables that each has a different harvest season. Producers buy in season when prices are low and hold semi-preserved ingredients in sufficient quantities to allow production throughout the year. It also results in hardening of the vegetables. The most common storage method is to cover vegetables with brine. Traditionally this was carried out in wooden casks now largely replaced by food-grade plastic drums. The ideal temperatures for brining vegetables are 18–25°C and typical brine strengths are 15–20% salt. A small amount of lactic acid (0.5%) may be added to the brine to reduce the pH to below 4. When brining vegetables it is important that:

- containers are rolled from time to time to mix the contents
- vegetables remain submerged in brine, because any pieces exposed to the air will spoil
- containers are topped up with 15–20% brine as required to maintain the correct strength.

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1. Most fruits require peeling, but some chutneys include un-peeled fruits
2. It is important to have similar sizes to obtain uniform mixtures

Fig. 4.7 Process for making pickles and chutneys

Brine strength can be measured with a salometer (Chapter 5, Section 5.5).

The **Preservation Index (PI)** is used to predict the level of acetic acid required to preserve products. This formula takes into account the amounts of solids

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Fig. 4.8 Intermediate storage of fruits for chutney manufacture (Photo: Peter Fellows)

(including vegetable solids, salt and sugar) in the product and is calculated as follows:

$$\frac{\text{Total acidity x 100}}{\text{(100 – total solids)}} = \text{higher than 3.6}$$

Conversely the equation can be used to calculate the acidity required to avoid spoilage:

$$\text{Acidity} = \frac{\text{3.6 x (100 – total solids)}}{\text{100}}$$

Methods for measuring total solids and acidity are described in Chapter 5, Section 5.5. If the preservation index is less than 3.6 the product formulation should be modified to avoid spoilage, as described in Case study 4.11.

Salted vegetables are made by alternating layers of chopped or shredded vegetable (e.g., cabbage to make sauerkraut), with layers of salt in a sealed drum. The salt draws out water from the vegetables to form concentrated brine that also has a direct anti-microbial action.

4.11 Preserves: jams, jellies and marmalades

Jams, jellies and marmalades are collectively known as preserves and are semi-solid gels each made using the same process. Jams are made from fruit pulp or juice from a single fruit or from a combination of fruits. A recipe for mango

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Case study 4.11 Development of a sweet pepper pickle

The following recipe was used: 764 g green peppers, 656 g red peppers, 200 g prepared onion, 424 g brown sugar, 21 g salt, 40 ml pure food-grade acetic acid. The vegetables were chopped and boiled for 2 minutes and the sugar and salt stirred in. After cooling for 10 minutes the acetic acid was mixed in. The acidity was measured as 2.3% and total solids as 32%. This resulted in a preservation index (PI) of 3.4, which is too low to ensure that no spoilage can occur. Taste panel tests indicated that the pickle tasted too acidic. Increasing the PI by the addition of more acetic acid was thus not an option; indeed the acid level needed to be reduced. It was therefore decided to increase the solids content by using 25 g of salt (up from 21g) and 450 g of sugar (up from 424 g). This re-formulation resulted in a pickle with a PI above 3.6 that would not spoil after opening, but with a lower acidity and a sweeter taste.

jam is shown in Chapter 6, Section 6.3. Tomato and jackfruit jams have also been made in some ACP countries and a processor in Uganda is successfully selling sweet potato jam. Jellies are crystal-clear jams that are produced using filtered juice instead of fruit pulp. Marmalades are produced mainly from clear citrus juices and have fine shreds of peel suspended in the gel. Ginger may also be used alone or in combination with the citrus fruits. The composition of preserves is controlled by law in some ACP countries (Chapter 5, Section 5.8).



Fig. 4.9 A stock of jam awaiting labelling (Photo: Peter Fellows)

The preservation and quality of jams, jellies and marmalades depends upon:

- rapid boiling to destroy contaminating micro-organisms and quickly remove water to concentrate the mixture before it darkens and loses its ability to form a gel

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- a sugar content that is high enough to prevent the growth of micro-organisms once the pack is opened
- a level of acidity that allows the pectin to form a strong gel and also contributes to preventing spoilage micro-organisms from growing after the pack is opened
- sufficient pectin to provide a firmly set gel.

Case study 4.12 A small-scale fruit processor

Mrs L's products include jams and juices (from pineapple and ginger), syrups, nectars and juices (from mango, guava, corossol and papaya). The strengths of her enterprise lie in the quality of its products, the low production cost compared to competitive products, and the technical assistance from her husband who is a specialist in food processing. Her weaknesses lie in the existence of many other similar enterprises and similar products, hesitation by consumers to buy new products (ginger, guava, corossol), problems with packaging, and the distance from the production site to customers.

Sugar content

Micro-organisms require a minimum water content to be able to grow. In the case of preserves the majority of the water in the fruits is removed by boiling until the sugar content rises above 68%, which will prevent mould growth after the pack is opened. However, if the sugar level rises above 72% there is a risk that sugar crystals will develop as the product cools, giving a grainy sensation in the mouth. The sugar level is thus critical, lying between 68–72%. Methods for measuring sugar content are described in Chapter 5, Section 5.5.

Pectin and acids

Pectin is needed to form the characteristic gel in preserves. Not all fruits (e.g. melon, papaya, pineapple, peach and strawberry) contain sufficient pectin to form a gel and commercially available pectin is therefore used to increase the amount in the mixture. Other fruits including guava and apricot are higher in pectin and apples and citrus are high in pectin. Suggested requirements are shown in Table 4.5.

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Pectin is available as either a powder or a liquid concentrate, and if it is stored in cool, dry place it will lose only about 2% of its gelling power per year. There are many different types of commercial pectin, but in most ACP countries the ones that are likely to be available are 'slow-set' pectin, used for jams and 'rapid-set' pectin, used to ensure that the peels in marmalade do not float to the surface before the gel has set. Powdered pectin is added to fruit pulp at 3–6 g per kg of product, but it should be mixed with about five times its weight of sugar to prevent lumps forming when it is added to the pulp or juice.

Fruit pectin content	30% fruit	40% fruit	59% fruit	60% fruit
Low	360–450	260–330	180–230	110–160
Medium	270–330	190–250	120–170	70–110
High	180–240	100–170	60–110	30–70

Source: Food Ingredient Technology Ltd. www.fit-ltd.co.uk

Table 4.5 Recommended amount of pectin (g) per 100 kg of finished preserve

To form a gel, it is important that the pH of the fruit pulp or juice is within the range 3.0–3.3. Many fruits are naturally within this range and can be used without adding acid. However, some fruits are less acidic and these require the addition of either citrus juice or citric acid. Limes have a pH of about 2 and their acidity must be reduced by the addition of sodium bicarbonate when making lime marmalade.

Type of preserve	pH range	Solids range (%)	Filling temperature (°C)
Rapid set	3.2–3.6	58–66	85
Medium set	3.2–3.6	62–68	70
Slow set	3.2–3.6	63–70	60

Source: Food Ingredient Technology Ltd. www.fit-ltd.co.uk

Table 4.6 Types of pectin

Processing

Fruit pulp is either used directly or filtered through coarse muslin cloth to obtain juice. Fine cloth or special juice filters are needed to obtain crystal-clear juices for jellies or marmalades. For marmalade, thinly sliced citrus peels are

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boiled in 60% sugar syrup to prevent them floating in the mixture (Section 4.2 and Case study 4.13). Approximately equal weights of sugar and pulp are usually mixed but preserves can be made with 30–60% fruit depending on requirements. In many ACP countries the composition of preserves is governed by food regulations (see Chapter 5, Section 5.8).

Case study 4.13 Overcoming a marmalade problem

Mrs A in southern Africa said: "I had a severe problem with the peel floating to the surface of the jars of marmalade. I overcame this by holding peel shreds in strong sugar syrup for several weeks. The peel absorbed sugar and became more dense. This sugared peel, which had more or less the same density as the marmalade, did not float".

The mixture is boiled quickly in a stainless steel pan, with constant stirring to prevent burning, until the correct sugar content is reached, or at higher production rates in a steam- jacketed pan (Chapter 3, Section 3.4). If whole fruit is used, there are two heating stages: first the fruit is heated slowly to soften the flesh and to extract the pectin; then it is boiled rapidly to obtain the required solids content. This change in heat output requires a sufficiently large and easily controllable heat source. It is essential to stop boiling when the solids content reaches 68–72%. This can be checked using a refractometer, a jam thermometer (noting when the temperature reaches 108°C), or by placing a few drops of the product onto a cold plate to see if it sets (see also Chapter 5, Section 5.5).

Preserves are filled into jars or other containers while still hot (around 80–85°C) and sealed so that a partial vacuum forms in the space above the product as it cools. It is important that the preserves are not hotter than this because steam condenses on the underside of the lid and the water drops onto the surface of the preserve, reducing the sugar concentration and allowing mould to growth once the jar is opened (Case study 4.14). If the filling temperature is too low, the preserve thickens and is difficult to fill into containers. Manual filling is possible in small-scale operations, but for higher production rates, small hand-operated or semi-automatic piston fillers are available (Chapter 3, Section 3.4). Containers should be filled to approximately nine tenths full to assist in forming the 'headspace' vacuum, checked using a 'headspace gauge' (Chapter 5, Section 5.6). They are kept upright until the

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gel has formed during cooling. The jars can be cooled using a bottle/jar cooler (Chapter 3, Section 3.4).

Although making preserves can appear to be simple, there are many things that can go wrong. Table 4.7 lists some common problems.

Case study 4.14 Get help to solve problems

Another jam producer in Kenya stated that she had problems with mould growth on the surface of her jam despite filling and sealing it while hot. A specialist was consulted who said that the jam temperature when filling was too hot and steam condensed on the cool metal lid. This then dripped back onto the surface of the jam, diluting the surface layer and lowering its sugar content. This then allowed mould to grow in the surface layer. The solution was simple: fill the jam at a slightly lower temperature so that steam does not condense. Lesson – Do not be afraid to ask for help.

Problem	Suggested cause	Solution
Preserve does not set to a firm gel	• Too little pectin or wrong grade of pectin • Pectin not fully dissolved when added to batch • Boiling time too long resulting in pectin breaking down • Pectin is old • Holding too long at high temperatures	• Try another grade of pectin, or use more per batch • Mix with sugar before dissolving and use a high-speed blender • Make smaller batches • Replace • Reduce cooking time in smaller batches and consider force cooling the jars
Gel too firm	• Too much pectin • Solids too high	• Reduce amount • Reduce boiling time, add water
Jam starts setting before filling	• Filling temperature too low • Solids too high or pH too low	• Increase filling temperature • Check that solids are between 68 and 72% and pH 3.0–3.5
Fruit or peel floats	• Filling temperature too high • Low solids or pH too high • Wrong type of pectin	• Lower filling temperature • Check and adjust • Try a rapid-set pectin • Acclimatise peel in sugar syrup
Gel cracks and liquid oozes out (syneresis)	• Filling temperature too low • Moisture content of fruit too high allowing moisture to 'leak' into the preserve	• Increase • Pre-mix fruit in strong syrup and stand for 24 hours

Source: Food Ingredient Technology Ltd. www.fit-ltd.co.uk

Table 4.7 Common problems encountered when making preserves

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The manufacturing steps involved in making jams, jellies and marmalades are shown in Figure 4.10.

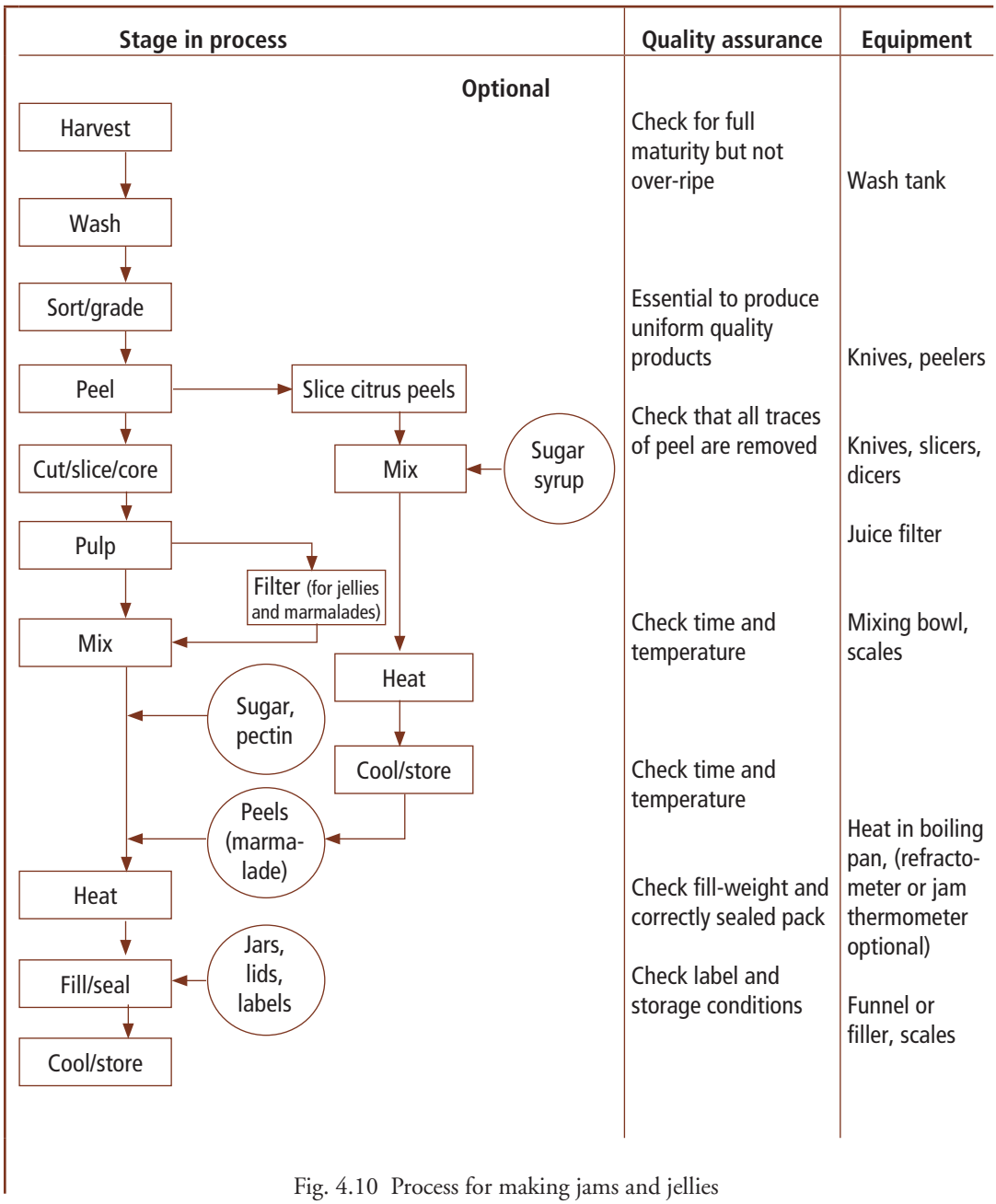


Fig. 4.10 Process for making jams and jellies

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4.12 Sauces

Sauces are similar to chutneys except that the ingredients are ground to a paste and sometimes sieved. Sauces can be made from a wide range of fruits and vegetables, the most popular in ACP countries being chilli pepper and tomato sauces. A typical recipe for tomato sauce is shown in Table 4.8.

Ingredient	Quantity
Tomato pulp	197 kg
Sugar	87 kg
Vinegar (5.6% acetic acid)	75 litres
Water	80 litres
Onions	7.7 kg
Salt	6.8 kg
Ground nutmeg	450 g
Ground cardamom	113 g
Ground cinnamon	113 g
Ground cloves	113 g
Ground coriander	113 g

Source: Binstead, Devey and Dakin (1971).

Table 4.8 Recipe for tomato sauce

Sauce preservation depends on a correct balance of vinegar and solids – i.e. having the correct preservation index (PI). The stages in sauce manufacture are:

- selection, washing and preparation of the raw materials
- batch preparation by adding vinegar, water, salt and spices
- grinding to form a paste using either a liquidiser or a high-speed blender
- sieving
- pasteurisation/cooking in a pan or a double-jacketed kettle (Chapter 3, Section 3.4)
- hot-filling into jars or bottles.



Fig. 4.11 Sauces (Photo: Peter Fellows)

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Case study 4.15 Sauce manufacture

The Limited Company was started by Mrs A making *Shito*, a spicy pepper sauce and peanut butter at home for her children. Her children's friends always loved the *Shito* and she soon realised she could make money out of it. So she started to produce it on a micro-scale for sale to her children's friends. In the mid-1990s she quit her job as an anaesthetist to produce *Shito* and peanut butter for school children and for the armed forces. The enterprise has grown to a medium-scale operation, employing over 50 people and producing different types of *Shito* to be eaten with beef: plain, mild, hot, and pepper-free.

4.13 Vinegars

Vinegar is the key ingredient in pickle, chutney and sauce manufacture and can also be made for retail sales. The following vinegars are commonly used:

- brown 'malt vinegar' is the most widely available and cheapest. It is made from the fermentation of malted barley and has a minimum acetic acid content of 5%
- colourless 'distilled vinegar' is produced by the distillation of malt vinegar and also has an acetic acid content of 5%
- 'wine vinegar' is produced by the acidification of wines with *Acetobacter* sp. but owing to its higher cost it is used for cooking in some hotels and restaurants and is rarely used in pickle manufacture
- 'pickling malt' and 'pickling distilled' vinegars have a slightly higher acetic acid content (6%).

Vinegar is produced by a two-stage fermentation of sugars found in grains, fruits or vegetables, often with added sugar. In the first stage yeasts ferment the sugars to alcohol, and the second fermentation by acetic acid bacteria (*Acetobacter* species) converts the alcohol to acetic acid. Unlike the yeasts used in wine fermentation, acetic acid bacteria require the presence of air. Traditionally this is provided by allowing the wine or other alcoholic ferment to trickle over wood shavings, twigs or corncobs in a 'generator'. The wood becomes covered in the bacteria and the acetic acid level rises to 6–10%, which preserves the product for many months provided that it is sealed in an airtight container to prevent the acetic acid from evaporating.

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Case study 4.16 Application for a loan to start tomato sauce production

The following is the introduction to a loan application made to a Ugandan bank:

In Kampala there is a need to start a tomato sauce manufacturing industry because so many hotels, restaurants and food take-away places are now used by middle-class people, whose eating habits have changed, and whose use of tomato sauce has increased considerably. When this business is set up, it will be the first of its kind in the country. Until now tomato ketchup has always been imported from neighbouring countries, which makes it very expensive for ordinary customers. The objectives are to create employment within the community and have an added income to my family. My customers will be hotels, restaurants, food take-away places and individuals in Kampala and the outskirts of the city. The competitors are the four traders and importers in the city that I know of. Their success has been mainly due to non-existence of a local industry. They depend on external production to satisfy the demand and also they have to rely on foreign exchange to bring in tomato sauce. My product will be locally manufactured using local high-quality raw materials, which will be available throughout the year. The product will be cheaper than my competitors'. I plan to make direct sales to customers from the business premises, to nearby retail shops using a bicycle, and hotels and restaurants will pick up bulk packs from the business premises. I shall sell each 250-ml bottle of sauce at USh 600 (competitors sell at USh 800). Advertisements will be placed in the local newspapers, and I will use posters at the retail shops and in various eating places. Free samples of sauce will be given to hotels, food take-aways and restaurants. An invitation to housewives in the neighbourhood to tasting panels will also be used to promote the sauce. In the first year, I need to buy an electric cooker and a gas cooker as backup for when the electricity is not available. Also I plan to purchase saucepans, a juice extractor, sieves, chopping boards, kitchen scales, knives, buckets and worktables. I shall contribute 50% of the total capital (USh 45,000) and this proposal is for a loan for the remainder of the money. I plan to repay the loan in 12 months.

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'Spiced vinegars' are used in the pickling industry. Traditionally they are made by either steeping spices and herbs in gently boiling vinegar for a few minutes, or steeping them in cold vinegar for several weeks. After steeping, the vinegar is filtered through muslin cloth and stored for use as an ingredient. Although the production appears to be simple, spiced vinegars require a considerable degree of expertise to develop the balance of flavours and prevent any one spice dominating. A typical recipe is shown in Table 4.9

Ingredient	Quantity (kg)
Chillies	12.70
Cloves	6.35
Pimiento	9.50
Ginger	4.50
Coriander	9.00
Mustard seed	4.50
Black pepper	6.35

Source: Binstead, Devey and Dakin (1971).

Table 4.9 Ingredients for spiced vinegar

The spice mix is covered with 320 litres of hot vinegar and then allowed to stand for a week. After straining this spiced vinegar concentrate is sufficient to flavour 18,000 litres of natural vinegar.

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Summary of the chapter

✔ The chapter describes the production of the following products:

- Bottled fruits
- Candied and crystallised fruits
- Dried products
- Fermented products – wine and spirits
- Fried products
- Fruit juices, cordials, squashes and nectars
- Papain and pectin
- Pastes, purees and fruit cheeses
- Pickles, chutneys and salted vegetables
- Preserves – jams, jellies and marmalades
- Sauces
- Vinegars

✔ Be innovative and develop new products to stay ahead of the competition

✔ Make careful measurements of ingredients and processing conditions when developing new products so that they can be repeated when correct

✔ Evaluate your products objectively before putting them on the market

✔ Be careful when processing vegetables to ensure good hygiene and prevent the risk of food poisoning

✔ Do not process spirits unless the business is registered and operators are trained in safe production

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Entrepreneur's checklist

- ❑ Do you know where to get information on product recipes and ideas for new products?
- ❑ Do you know how to make a new product by producing test batches?
- ❑ Do you have standard recipes and production systems?
- ❑ Has the local authority approved the production unit and do you have any permits required for food manufacturing?
- ❑ Do you need further training to be able to make a satisfactory product? Who can train you?
- ❑ Do you know how to objectively assess your products?
- ❑ Do you have a good relationship with local authorities such as public health and local support institutions?

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Readers' notes

Please use the space below to write your own notes on this chapter

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Quality assurance and legislation 5

5.1 Introduction

Product quality is one component of the marketing mix (Chapter 2, Section 2.3) and has two aspects: products must of course be safe to eat, but they must also meet consumers' ideas of good quality and value for money. Producers should find out what their customers think by conducting market surveys (Chapter 2, Section 2.2). There are also other aspects of quality to consider: regulatory quality concerns the laws that relate to the quality of foods in general, and there are specific laws for individual products. General food laws are described in *Opportunities in Food Processing, Volume 1*, Section 6.3, and an overview of specific laws for fruit and vegetable products are described in Section 5.8.

Tips for success

- ✔ Quality can only be achieved and maintained through hard work and commitment
- ✔ Maintain your standards of quality because once customers are lost, they cannot be recovered
- ✔ Understand how to control the process to make consistent products. Know the control points in your process
- ✔ Know about local food laws and take advice
- ✔ Personal hygiene should not be compromised
- ✔ Ask yourself, is this product good enough; is it presentable
- ✔ Teach staff to do simple checks on the quality of ingredients and products
- ✔ Provide clean uniforms, toilets and washing facilities
- ✔ Have contracts with suppliers to help guarantee the quality of fruits and vegetables[9]
- ✔ Know the potential risks to your products
- ✔ Properly clean equipment and the processing room each day
- ✔ Do not penalise staff who are sick, move them to another job
- ✔ Consistency is the key to good product quality
- ✔ Do not compromise on the quality of raw materials or ingredients
- ✔ Do not forget quality assurance in the storerooms and during distribution
- ✔ Read Sections 4.1–4.3, 6.1–6.6 and 10.2 in *Opportunities in Food Processing, Volume 1*

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Both the consumers' view of quality and the legal aspects of quality require that products be safe and made to a consistent standard in every batch.

People expect the quality of their processed food to be the same time after time.

To achieve this it is necessary to have a Quality Assurance (QA) system. Many small-scale processors do not have such a system in place; instead problems are simply resolved as they arise. This approach does not ensure consistent product quality and any failures in processing may pass un-noticed and lead to faults in the product.

It is much better to identify where problems may occur and have a plan to prevent them before they arise, rather than trying to correct them afterwards.

Not only will this ensure that products are of uniform quality, but the producer also saves money and the image and reputation of the company is protected.

This chapter describes the steps needed to set up a QA programme in a fruit or vegetable processing unit. A QA programme should include:

- the condition of the building
- ingredient and raw material inspection
- the correct operation of equipment
- process control
- operator training
- product quality and fill weights
- correct sealing of packs
- routine cleaning programmes
- control over distribution.

Each of these areas is summarised in Table 5.1 and described in more detail below.

Producers who wish to export their products must have in place quality assurance systems that meet international standards. These are described in detail by the *Codex Alimentarius* Commission and may be available from the local government's export promotion or export development ministry.

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Stage	Activity by processor	QA control points[1]
Crop production	Advice to farmers during cultivation in contract farming[2]	Types, amounts and timing in the use of agricultural chemicals
Harvest and on-farm storage	Advice to farmers on timing of harvest and post-harvest storage conditions in contract farming[2]	Maturity at harvest, type and condition of storage structures, measures to prevent insect/rodent attack or mould growth
Reception and storage at the processing unit	Weighing incoming crops, inspection and quality checks, supervision of storage	Weight of contaminants, condition of storeroom, prevention of insect/ rodent attack, routine cleaning schedules
Crop preparation	Checking operation of fruit/ vegetable washers, slicers etc.	Efficiency of cleaning, minimising re-contamination
Processing	Checking that correct weights of ingredients and processing conditions are used	Processing times/temperatures, machine settings Correct formulation used
Packing	Checking correct packing into containers	Correct fill weights, correct labels, adequate pack sealing
Product storage and distribution	Supervision of storage and distribution	Condition of storeroom, prevention of insect/rodent attack, routine cleaning schedules and condition of distribution vehicles and retail storage/displays

1. Details of control points are given in *Opportunities in Food Processing, Volume 1*, Section 10.2
2. Contract farming is described in Chapter 6, Section 6.3

Table 5.1 Quality Assurance (QA) control points for fruit and vegetable processing

5.2 Safety of products

In most ACP countries, the law requires food processors to produce safe foods in a hygienic way, and there are serious penalties for those who contravene hygiene and food safety legislation (*Opportunities in Food Processing, Volume 1*, Section 6.3 and Section 5.8 below). The safety of fruit and vegetable products can be ensured by implementation of a management method known as the Hazard Analysis Critical Control Point (HACCP) system. This involves the following stages:

- identify potential hazards
- assess the level of risk
- design and implement procedures for monitoring and controlling hazards
- apply corrective action in a process
- train all staff in the implementation of the procedures
- develop appropriate reporting procedures.

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Case study 5.1 Importance of QA

"Our company works six days a week producing over 1,426 litres of mixed fruit juice per day in two 8-hour shifts. We do not compromise on quality because that is our trademark." Not only are they particular about the quality of the final product, but also about the quality of ingredients, water, packaging materials and the whole manufacturing process. "We have our own laboratory where the sugar content is analysed with a refractometer, the quality of the ingredients and final products are analysed and samples are sent to independent laboratories such as the Department of Food Science at the university." Since the Standards Board also certifies them, they conduct random quality-assurance checks on products.

The company has strict quality assurance, with the section headed by a food biochemist, whose job is to ensure that the ingredients, processes and packaging meet international food standards, particularly those of the EU since that is where they send over 50% of their export products.

In the Pacific region, a person providing training and support to small food processing enterprises stated: "I make every effort to work towards Codex standards in each enterprise. I distribute a blank 'Standard Sanitary Operating Procedures' form to all processors to use as an 'aide memoire' to set up formal clean-down procedures. We have also found that countries such as Australia, New Zealand and the west coast of the USA are very tolerant to new processors even though they are far from meeting full *Codex Alimentarius*/Hazard Analysis Critical Control Point (HACCP) codes."

Many small-scale processors think that HACCP systems are not necessary or not possible because they are too difficult or too expensive for them. However, in many ACP countries HACCP is no longer a choice and is demanded by the local Bureau of Standards or by companies that buy processed fruit and vegetable products. Consumers also have greater awareness of food safety , and they are becoming more quality-sensitive as a result of the imported food products they can buy in supermarkets. HACCP is also necessary for any products that are exported or sold to the larger supermarkets that are becoming more numerous in ACP countries. These developments are likely to result in basic HACCP systems being required for all food processors in most ACP countries. However, to develop a system, most processors need assistance and advice

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from professionals, including staff with experience of the product and the process at a Bureau of Standards or a university. This type of assistance can also be provided by manufacturers' associations.

Identify potential hazards and assess the level of risk

The ways in which contaminants could enter a food are identified for each processing stage, as:

- sources of contamination
- methods of contamination
- effect of the process on levels of contamination
- probability of micro-organisms surviving the process and growing in the product.

Following identification of hazards, the effect of processing conditions on contaminating micro-organisms is then assessed. This should include all parts of the process, from the purchase of raw materials and ingredients to storage and consumption of the final product. Examples of factors that should be examined are ingredients that are likely to be heavily contaminated with micro-organisms, the pH or moisture content of the product and any preservatives that are used. Once the potential hazards are identified, control methods can then be developed to prevent contamination or loss of quality. These are known as Critical Control Points (or CCPs). A Decision Tree (Figure 5.1) can be used to help decide on the CCPs. Target limits and tolerances are then decided for each CCP, together with the actions that are necessary if a target limit is not met. An example of potential hazards and the level of risk in sauce production are shown in Table 5.2.

Train staff to implement procedures

Staff should be trained to operate the QA methods, including an understanding of the tolerances allowed in processing conditions, the required standards of cleanliness and the quality of the product that should be routinely achieved. The more staff understand what they are doing and why, the lower the risk of problems.

Develop reporting procedures

Methods for monitoring the QA system should be developed, together with a plan of what to do if the process tolerances are exceeded. It should be clear who has the authority to make decisions and who is responsible for checking

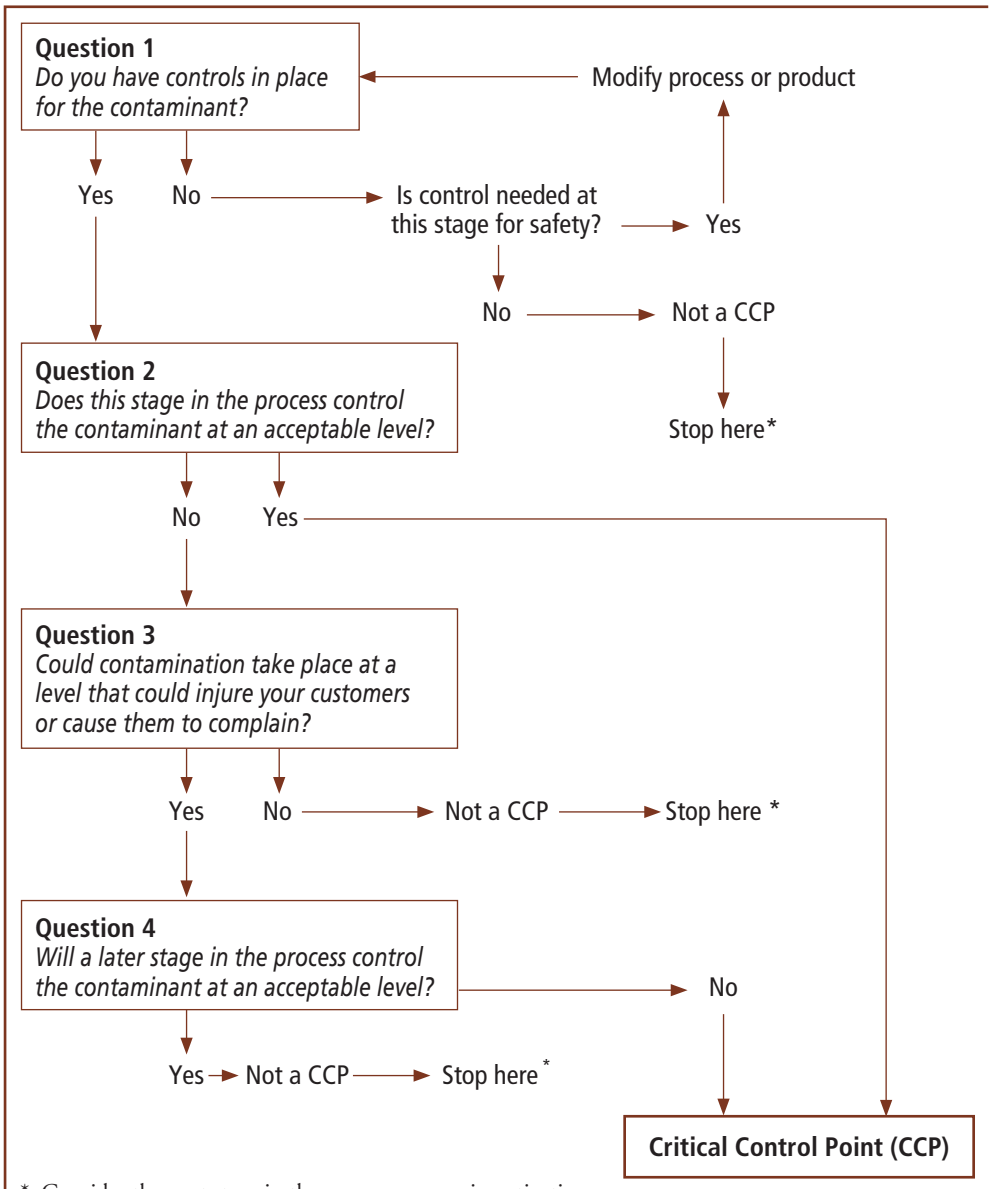
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Stages in process	Potential hazards	Level of risk and measures to address risks	CCPs
Harvest	Herbicides	Talk with farmers	Chemical applications
Wash/sort	Mouldy fruit, contamination with soil, leaves etc.	High risk: mould contamination could affect flavour and shelf life of product Moderate risk: extraneous matter such as insects could contaminate product if not removed during inspection	No mouldy fruit or insect contamination
Peel/pulp	Seeds and skins not removed, fruit pieces remain	Lower risk: cosmetic faults in fruit could be removed later in the process	No peel or seeds in product
Mix	Contamination of spices with dust, moulds, bacteria or foreign bodies Correct pH of mixture	High risk: shelf life depends on correct mixture of acid, salt and sugar – ingredient weight should be checked Moderate risk: contamination of spices – remove mouldy items and other contaminants during inspection and washing High risk: incorrect pH, product depends in part on acidity for preservation – check pH	Correct ingredient weights +/–5%, correct pH +/–0.2 units, no mouldy or contaminated spices
Heat	Insufficient heating resulting in incorrect product consistency and flavour	Lower risk: product quality affected, not safety	Heating at 100°C for 20 minutes +/–5 minutes
Fill/seal	Faults in glass Inadequate seal	High risk: faults in glass could injure consumers – check by 100% inspection of bottles High risk: faulty seal on cap could allow re-contamination – Check caps are correctly sealed	No glass faults No faulty cap seals
Pasteurise	Insufficient heating resulting in survival of contaminating enzymes and micro-organisms	High risk: adequate heating needed to destroy enzymes and contaminating micro-organisms – results in spoilage during storage. Check time and temperature of heating	Pasteurise at 88°C +/–2°C for 20 minutes +/–1 minute
Cool	No hazards		
Label/store	No hazards		

Source: Adapted from: Fellows (1997).

Table 5.2 Potential hazards in sauce production

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* Consider the next stage in the process you are investigating
Source: Adapted from Dillon and Griffith (1995)

Fig. 5.1 'Decision Tree' for assessing Critical Control Points

that correct actions were properly done. This is not just the responsibility of the owner or manager and QA should be developed with the process workers so that everyone is clear about each other's part in the system. In the absence of the owner one staff member should have the authority to stop production in the case of a serious problem. The QA system should be reviewed every year.

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5.3 Quality of raw materials

This section describes the quality checks that should be made on crops. Preventing contamination is an important aspect of QA and the main contaminants found in fruits and vegetables include:

- foreign material (soil, weeds, seeds, stones, string, leaves etc.)
- infestation by insects, excreta, hair from rodents or feathers from birds
- mould growth
- chemical residues (e.g., insecticides, fertilisers)
- oil or grease from vehicles or machinery.

A well-designed QA programme prevents these contaminants from entering the factory or discovers and removes them before they can be incorporated into the product. The processor should also check that the fruits or vegetables are fit for processing and reject those that are not suitable. This normally includes a check on the following characteristics in addition to checking for the above contaminants:

- maturity (over-ripe or under-ripe)
- colour
- size or shape (for some products)
- serious bruising or cuts

A great deal can be done to meet these standards if farmers are familiar with the quality needed and why this is important.

The percentage of rejects should be monitored as this is an important factor in calculating the true cost of useable raw material (see Section 7.1).

Poor-quality raw materials produce poor-quality final products and it is not possible to improve the quality of raw materials by processing them.

Careful inspection by properly trained staff to sort out substandard materials before money is spent on processing them is one of the most cost-effective methods of ensuring a uniformly high quality in the final product.

The more people that examine the raw materials and ingredients, the greater the level of control.

Poor-quality crops are one of the most common problems facing processors. Most small-scale processors buy their crops from farmers or local market

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traders, and therefore have little control over the way in which the crop is grown, harvested, stored or transported. Contract agreements with farmers can improve the amount of control that processors have over their raw materials. Transport operators are paid by the weight or volume of goods moved, and do not suffer financially if the quality or safety of the crop is compromised. Crops are often transported with other non-food goods that may cause contamination by oil, grease, metal fragments or wood splinters. Foods can also easily absorb odours from kerosene or diesel fuel, and care should be taken to ensure that these materials do not come into contact with them. However, the power of traders and middlemen sometimes makes it difficult for processors to introduce changes and a better option is for processors to collect crops directly from the farmers using their own vehicles, or use contracted hauliers' vehicles that have been inspected to ensure that they are clean and well-maintained (Case study 5.2). Control over the quality of crop containers is part of a QA scheme, and it is preferable for processors to supply good-quality sacks for collecting contracted crops, and a member of staff to fill and weigh sacks at the time of collection.

A particular problem facing fruit and vegetable processors in many ACP countries is the large number of different varieties of a particular raw material. Not all varieties are suitable for processing and the processor must either select suitable varieties, or develop a system of blending raw materials. This is not always easy because individual farmers often grow several different varieties of fruits and vegetables in small quantities.

Most crops are loaded into sacks for ease of handling during transport, but the quality of re-used sacks is often not checked and may be a source of contamination. The amount of protection offered by sacks is limited and the first check should ensure that the crops are not damaged (cut, bruised etc.) infected with mould or rot, or seriously contaminated by rats, insects or birds. Crops may also be contaminated by weed seeds, stalks, soil, stones, dead or living insects. The crops should be spread onto an inspection table and any foreign materials, mouldy, damaged or discoloured pieces removed. A periodic QA check is to collect and weigh the contaminants that are separated from the crop. The weight can be expressed as a percentage of the batch weight:

$$\text{Contamination \%} = \frac{\text{weight of contaminants}}{\text{weight of batch}} \times 100$$

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Case study 5.2 Quality of raw materials

The following are examples of processors' experiences of raw material supplies in Africa and the Caribbean:

The company has a 15-acre orange orchard where they grow early and late Valencia varieties, a mango farm and vegetable gardens for ginger and onions. The orchard can supply 70% of its orange requirements during the bumper season and 50% during off-peak. Owning a farm therefore ensures that production is carried out all year round. The company prefers the 'sugar loaf' variety of pineapple because these are very sweet with the right acid content. The company also buys from certified citrus growers who have planted particular varieties of oranges, pineapple, mangoes and watermelons that the company requires. Occasionally they have had problems with transporting raw material from the farm to the factory when the rented vehicles break down. They have overcome this by hiring vehicles from a designated and reputable transport company that has a big fleet of vehicles, and more recently by investing in a brand new 5-tonne truck.

Not all the varieties of fruit, roots or tubers are suitable for chip production because some varieties are badly affected by processing. The best varieties are selected using the manager's experience. It is always difficult for the manager to get these varieties delivered because the suppliers cannot distinguish between the varieties, or are unable to provide them because the current crop production is not well adapted to the needs of industrial processing.

They ensure the quality of *gari* by buying cassava from local farms in specific districts to ensure that they purchase the right variety of high-quality, freshly harvested cassava.

For mango, a specific variety or graft is required. The crops are bought directly at the farm gate from producers without any contract. Sometimes, this leads to a scarcity of some fruits (especially guava and corosol), and the immaturity of other fruits constitutes a real problem.

Mr K has a 100-acre orange orchard and a 45-acre mango plantation. Three main varieties of orange are cultivated: early Valencia (early-maturing), late Valencia (late-maturing) and Obuasi (a year-round variety). The selection of these varieties was based on expert advice from the Ministry of Agriculture and the University of Ghana Research Station. Orange and mango seedlings were purchased from these sources to ensure good planting materials and the correct variety. The company also followed the strict planting and maintenance methods stipulated by experts. The cultivation of these three varieties ensures year-round production, although they sometimes have to buy additional oranges from outgrowers. The purchase of oranges from outgrowers can sometimes be a problem because some of them are not sweet enough or of lower quality.

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The weight and type of contaminants in crops supplied by different traders or farmers can be recorded over a period of time to see whether some suppliers' produce is of consistently lower quality than others. The evidence from these checks can be used to negotiate with each supplier, either to reduce the price or to improve the quality of future deliveries. Where there is a choice of suppliers, the processor may want to use this evidence as a reason for changing to a new supplier. If suppliers know that such checks are being made, it may encourage them to improve their handling and storage procedures, particularly if the processor is willing to offer a premium price for higher-quality crops.

If crops are bought on the open market from traders or farmers, processors have little control over quality. Contract arrangements with farmers allow greater control by processors over the quality of their raw material.

In contract growing of crops (Chapter 6, Section 6.3), QA checks (in addition to the ones described above) can be used to ensure:

- correct application of chemicals during cultivation
- harvest at the correct stage of maturity
- adequate post-harvest storage
- proper handling, packing and transport of crops.

Improper use of pesticides or chemical fertilisers can lead to sub-standard quality crops or potential safety hazards. This is most likely where farmers have inadequate knowledge of, or training in, the correct quantities and timing of chemical applications. If processors provide support to farmers as part of contract agreements, they can prevent such problems by supervising chemical use and conducting checks to ensure that chemical applications are in line with manufacturers' recommendations. The laws in some ACP countries control the use of agricultural chemicals and the presence of residual chemicals in crops. Processors should check with the Ministry of Agriculture and the Bureau of Standards for details of the specific laws in their country.

The proper training and involvement of staff is particularly important in fruit processing. All fruits and vegetables should be processed as soon as possible after harvest to reduce the risk of spoilage before processing. This is particularly important for vegetables to reduce the risk of growth by food-poisoning bacteria.

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Many fruits and vegetables must be harvested when they are fully mature to give the best flavour and colour in products. Some farmers harvest their crops too early because they need to generate an income as soon as possible, or they fear theft from the fields. However, immature crops produce substandard products, but many mature crops are soft and therefore more easily damaged. This allows moulds and yeasts to grow on fruits or rotting bacteria to grow on vegetables. Additionally, damage to a few fruits or vegetables can quickly lead to the infection and loss of a whole batch. Crops should therefore be harvested carefully by cutting them from the tree or plant. With fruits, it is important to leave the stem in place to reduce the risk of infection by moulds and yeasts through an open stem hole. Bad practices at harvest cause many problems for the processor later on, but farmers often do not understand the processors' requirements. If possible, the processor should work with farmers to improve the quality of raw materials by:

- ensuring crop handlers cut their fingernails to prevent them puncturing fruits
- cooling fruits and vegetables in tropical climates after harvest to remove some of the 'field heat' and store them in a cool place or covered with wet sacks
- removing any damaged pieces from the bulk to prevent spoilage of surrounding foods
- filling fruits and vegetables into crates that are small enough to be carried and not dragged along the ground (crops should not be thrown into piles)
- not over-filling crates as this crushes the crops if they are stacked. Ideally, foods should be packed into stackable crates that prevent crushing.

As part of a contract arrangement, a processor can specify and/or supervise harvesting at the correct stage of maturity, and also control on-farm processing to reduce the level of contamination.

5.4 Process control

After initial inspection, fruits and vegetables are washed in potable water, which is chlorinated if necessary (*Opportunities in Food Processing, Volume 1*, Section 5.2). It is important that the processing staff are trained to remove any rotten pieces as these would contaminate the wash-water and infect good-quality crops. They should also remove all leaves, insects and other materials that could contaminate the final product. The next stages of peeling, slicing,

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Case study 5.3 Stock management

To ensure that ingredients of the specified quality are supplied, the processors go to outgrowers to buy them and randomly taste the oranges. They have a stock control system and the company has sought the assistance of the local university's Department of Mathematics to develop a programme for managing stock and controlling production. To ensure quality, the company routinely tests both raw materials and products, and also takes samples to the university Biochemistry Department for analysis.

pulping or filtering require quality checks to ensure that all peel is removed, that slicing produces uniform-sized pieces (for banana chips or shreds for marmalade), and that pulps are prepared without large pieces of fruit and filtered to a clear juice for squashes, jellies or juices.

The correct formulation of a batch of ingredients is critical to both the quality of the final product and the financial viability of the business. QA at this stage enables uniform products to be made in every batch and avoids wastage of expensive ingredients.

Any mistakes that are made at this stage cannot be easily corrected later and may result in having to throw away a whole batch. The correct formulation of a batch of ingredients is therefore critical to both the quality of the final product and the financial viability of the operation.

The staff responsible for batch formulation should therefore be given thorough training and a management system should be put in place that records batch numbers and amounts and types of ingredients used (see also Chapter 6, Section 6.6). Equipment required for batch formulations includes good-quality scales or calibrated cups, spoons or jugs to measure out ingredients accurately to ensure that the same amount is added in every batch. Processing of each batch should be defined in terms of the conditions (mainly temperature and time). Staff should be trained to be aware of the need for these controls, the procedures that allow correct conditions to be used, and to record the process data for each batch. They should in particular understand the HACCP system to ensure that any deviations are identified and corrected.

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Case study 5.4 Raw material and process control

Producing high-quality plantain and wheat flour chips is the hallmark of Mrs E. She does this by ensuring she uses high-quality raw materials and her attention to detail during processing. For example, she makes sure that the oil temperature is correct to avoid soggy chips. Chips take up lots of oil if the temperature of the oil and the texture and thickness of the pieces are not right. Timely After frying the chips it is essential to rapidly drain off the oil.

Over-heating of sauces, preserves, drinks and bottled fruits lowers quality by loss of texture, colour or flavours, whereas under-heating allows enzymes and micro-organisms to spoil a product during storage. It is therefore essential that operators be trained to use the correct heating temperature and time for every batch of product. Internal (people within the business) and external taste panels are a very valuable and inexpensive way of making sure a consistently high-quality product is made.

5.5 Methods of analysis

The following tests are suitable for small-scale processors because they:
- are relatively simple to use
- are sufficiently accurate for quality control purposes
- do not require sophisticated or expensive equipment
- do not require a high level of skill
- are relatively inexpensive.

Yeast

Yeast for wine making is supplied as dried powder or granules. It has a shelf life of one to two years, provided it is stored in an airtight container and kept in a cool, dry place. It is essential that the yeast is active (alive), and a test for yeast activity is to dissolve a little yeast in a dilute sugar solution (3 g or one teaspoonful per 100 ml water) and allow it to stand in a warm place. If there are no signs of fermentation (bubbles in the liquid or froth on the surface) after one hour, the yeast has probably died.

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Water

Good-quality water is required as an ingredient in some products and to wash equipment. If mains water is not chlorinated, it should be treated on-site. Details of checks for correct water treatment are given in *Opportunities in Food Processing, Volume 1*, Section 5.2.

Other ingredients

Pectin is usually supplied as a powder in ACP countries (occasionally as a liquid concentrate) and colours are supplied either as liquid concentrates or as powders. Preservative chemicals, such as sodium metabisulphite are sold in either plastic bags or glass jars. Powdered ingredients quickly absorb moisture from the air and should therefore be stored in airtight containers such as lidded tins or screw-capped, coloured glass jars. Essences are supplied in small glass bottles and should be stored in a cool place away from sunlight. Quality tests are not normally required on these ingredients.

Salt and sugar

Generally these ingredients require little testing, but they may contain dust and dirt. Their purity can be checked by dissolving a small amount in hot water and allowing any dirt to settle out. If salt has a pink tinge it should not be used, as this is an indication of bacterial contamination, which occurs in sea salt originating from lagoons.

Salt concentration (e.g., in pickling brines) can be measured using a special hydrometer (or salometer, Figure 3.13), placed into a sample of brine at 20°C in a glass or plastic cylinder. Fully saturated brine contains 26.5% salt and this concentration is taken as 100 degrees on the salometer scale. Pure water is measured as 0 degrees. So each salometer degree is equal to 0.265% salt. The reading is converted to % salt using a conversion table supplied with the hydrometer.

The sugar concentration in jams, sauces, syrups etc. can be checked using a refractometer, a hydrometer, or a special jam thermometer that reads up to 150°C (Chapter 3, Section 3.4). Refractometer readings are in 'degrees °Brix', which corresponds to % sugar. The concentration of sugar in syrups

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can be measured more cheaply using a hydrometer having a scale reading % sucrose. Syrups should be tested at 20°C, which is the reference temperature for the hydrometer. Jams have the correct sugar content when the boiling temperature reaches 108°C at sea level. In mountainous regions producers should first check the boiling point of water and make the necessary corrections. With experience, it is also possible to estimate whether preserves have been sufficiently boiled/concentrated by cooling a sample of the boiling mixture on a cold plate to see if a firm gel forms.

Acidity

Some preserves (e.g. chutneys and pickles) rely on the correct balance of acids, salt and sugar because they are not often pasteurised (Chapter 4, Section 4.10). To check their pH (see *Opportunities in Food Processing, Volume 1*, Section 2.3), pH paper can be dipped into a sample of food and the colour change compared with a reference chart. For greater accuracy a pH meter should be used (*Opportunities in Food Processing, Volume 1*, Section 2.3). However, pH measurement does not reveal the amount of acid present, which is important in pickling. To measure the amount of citric acid or acetic acid:

- mix a 10-g sample of food with 90 ml of distilled water and a few drops of phenolphthalein indicator solution
- titrate with 0.1M sodium hydroxide until the pink colour does not change.



Fig. 5.2 Equipment for measuring acidity (Photo: Peter Fellows)

The amount of acid is calculated using the formula:

% acid = number of ml of sodium hydroxide x one of the following conversion factors:
Acetic acid (vinegar) = 0.060,
citric acid = 0.070,
tartaric acid = 0.075,
lactic acid = 0.090.

(It is necessary to know which type of acid is in the food before selecting the conversion factor).

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Moisture content

Measurement of the moisture content of fruits and vegetables is useful when calculating the end point for drying and the yield of dried food (Chapter 6, Section 6.3), and the PI of pickles and sauces. It is measured by drying a known weight of finely chopped food until it does not lose any more weight. The test requires accurate scales, a thermostatically controlled oven and a laboratory desiccator. The method is as follows:

1. Accurately weigh (to +/– 0.001 g) triplicate 2-g samples into small dishes and place them in an oven at 104–105°C for one hour
2. Remove, put into a desiccator to cool and re-weigh
3. Replace the dishes in the oven for 30 minutes and repeat the process until their weight does not change
4. Calculate the moisture content using the following formula:

$$\% \text{ moisture} = \frac{\text{initial weight} - \text{final weight}}{\text{initial weight}} \times 100$$

It is important that measuring equipment is handled carefully and checked regularly for accuracy to ensure consistent test results. The results of tests should be recorded on logsheets and reported to the manager. Operators should be given training to enable them to conduct the tests properly, and should be supervised to ensure that accurate information is recorded.

5.6 Packaging, storage and distribution

For many processed fruits and vegetables, long-term preservation depends on the type of package that is used and the temperature and humidity of storage. Value is added to raw materials at each stage of processing and a product has gained most of its final value by the time it is packaged. Any losses of packaged product cause the greatest financial loss to the processor. Great care should therefore be taken in handling packaged foods and they should be stored in boxes on pallets or shelves to keep them off the floor. The storeroom should be cool and dark with a good ventilation to maintain a flow of air and with protection against insects and rodents. Storerooms for ingredients and packaging materials should have similar protection. It is therefore important that packaging, distribution and storage are each included in a QA schedule.

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Glass bottles and jars may contain splinters, cracks, bubbles in the glass or strings of glass across the interior. They should therefore be checked more carefully than other types of packaging to prevent these defects causing serious harm to consumers. Staff who check bottles or jars should be fully trained to look for faults and they should only work at inspection for 30–60 minutes at a time to maintain their concentration. The dimensions of glass jars and bottles are also more variable than other types of packaging and it is important to check that containers have the correct capacity and that the neck is properly formed to allow the lid to fit. It is also necessary to find the heaviest empty container to use in check-weighing (the check-weight is the weight of the heaviest container plus the net weight of product). If jars or bottles are re-used, they should be thoroughly washed and inspected by smelling them to ensure that they do not contain any residues.

In most ACP countries it is an offence to sell an under-weight product, and over-filling means that a producer is giving product away. A simple gauge for checking that a product has been filled to the correct level in a jar can be made locally (Figure 5.3). It is placed on the rim of the jar and the level of product can be read where it touches one of the prongs. A random sample of packages should be checked to ensure that the fill weight is the same as the net weight described on the label using a check-weighing scale (*Opportunities in Food Processing, Volume 1*, Section 6.6). At the same time the label should be checked to ensure that it matches the product inside, and that the sell-by date and batch code numbers are correct. The capacity of a jar or bottle can be checked by weighing a dried container, filling it with distilled water and re-weighing it. The difference in weight is equivalent to the capacity in millilitres.

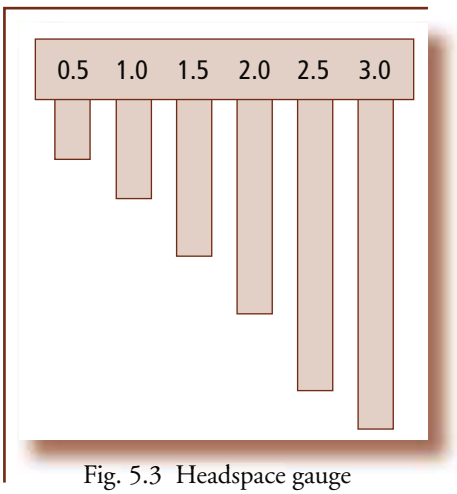


Fig. 5.3 Headspace gauge

Typical faults in plastic bags and films include: incorrect printing, odour from solvents used in their manufacture, layers of film sticking together, curling (in which a film curls up rather than laying flat) and incorrect thickness. Thickness can be measured by cutting 10 squares of film, each 10 cm by 10 cm and carefully weighing them.

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The result (in grams per square metre) is then checked against the suppliers' specification. Apart from visual examination, the procedures and equipment for testing plastic films are likely to be too expensive for most small-scale processors and for the majority of faults the only remedy is to return the film to the supplier. Further information can be found in packaging textbooks described in the bibliography in Appendix I.

QA systems should also be developed to monitor the types and amounts of products, ingredients and packaging materials that are in storage, and the time that they remain in storage. (Records that should be kept by storekeepers are described in Chapter 6, Section 6.6.) Stores should be cool, dry, regularly cleaned and protected against insects and rodents. Mobile racks or steel shelving with adjustable supports are easy to inspect and assist stock rotation. Slotted high-density polyethylene or polypropylene trays are easily cleaned and stacked, and they can store a variety of different products together. Similarly, mobile plastic or stainless steel ingredient storage bins keep materials clean, restrict contamination by insects and rodents and can be wheeled to the point of use. Correct stock rotation is needed to prevent unnecessary wastage and to maximise profits. Weekly checks should be made on products and raw materials. Stock rotation of products is easier to operate using date coding, and most products legally require a sell-by date (see Section 5.8). Producers can use a date stamp on packages to identify the date of production. Similarly, control of product quality does not finish when the product leaves the processing unit and manufacturers should monitor and control the distribution methods to retailers and discuss with them the best ways of storing and displaying the products.

Case study 5.5 Quality checking

"We do check the quality of all raw materials when they come in, such as check-weighing on receipt and occasionally taking samples for analysis. Processing has critical points that we take care over, and storage is supervised. We use batch codes and date codes and occasionally take samples to check out the shelf life."

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5.7 Hygiene and sanitation

Strict hygiene in the processing room and by operators is needed to reduce the risk of both food spoilage and food poisoning. This must include proper cleaning of knives, drying equipment and processing rooms, washing hands, and removal of waste foods as they are produced. Together, a manager and processing staff should develop a cleaning plan and personal hygiene rules that ensure safe food preparation. The manager should make sure that all staff are trained and know their own responsibilities.

Legislation often includes actions required by the manufacturer for testing and monitoring operators' health. It is important not to penalise staff for having an infection, otherwise they will hide a problem in order to be paid. If staff report a stomach illness or skin infection, they should be transferred to other jobs that do not put them in direct contact with the product. The processor should provide cleaning materials and equipment, and allow sufficient time for staff to clean machinery and processing areas after production has finished. Cleaning schedules should be drawn up when specific hazards have been identified. Workers should know their cleaning responsibilities within a cleaning plan and the manager should take overall responsibility to ensure that cleaning is done to the correct standard.

Cleaning should not be regarded as something done as quickly as possible at the end of the day. It should a planned activity.

All wastes should be placed in bins and not piled on the floor. Processors should have a management system in place to remove wastes from the building as they are produced, rather than letting them accumulate during the day. Wastes should never be left in a processing room overnight.



Fig. 5.4 Hygienic processing (Photo: Ann Hasson, courtesy of Practical Action)

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Case study 5.6 Hygiene and sanitation

The system developed by the owner for assuring quality consists of workers' hygiene and the cleanliness of the plant and equipment; the workers wear uniforms and cover their hair.

Based on her training, the manager has adopted good hygienic practices (GHP), covering personnel, materials, equipment, processing and the factory environment, to ensure the quality of her products. Periodic samples of products are analysed at the National Quality Control Agency. But the enterprise is facing difficulties due to the fact that the personnel are changing all the time and she has to keep training new staff in QA.

The manager has been trained in quality management (GHP, GMP, HACCP) and she is aware that these systems can help to produce good-quality products. However, at the enterprise level, these systems are more difficult to apply: they require financial resources for implementation, training of personnel and acquisition of adapted materials.

It is essential that the building is correctly constructed (*Opportunities in Food Processing, Volume 1*, Section 5.1 and Chapter 3, Section 3.2), and that routine monthly inspections are made to ensure that floors and walls have not developed cracks, and that windows and ceiling panels are intact and in place. This should be part of the job description for a member of staff, who should tick off each check against a written checklist. A supervisor or owner/manager should ensure that the checks are done properly. If animal or insect infestation is found it should be treated immediately using traps or poisons, but the best approach is to prevent infestation from occurring by proper cleaning. Care should be taken to ensure that recesses behind machines, ledges and windowsills are also properly cleaned. Using brightly coloured brooms, brushes and cleaning cloths ensures that bristles or cloth fragments can be seen and removed easily, thereby preventing contamination of the product.

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5.8 Summary of legislation

Establishing an enterprise and factory

In most ACP countries there are laws governing the setting up, registration and operation of fruit and vegetable processing businesses. Failure to follow the law may lead to punishment by the authorities or forced closure of the business. However, legal requirements vary in different countries, and the following details are given for guidance only. Processors should check their local laws with the relevant authorities, such as the Bureau of Standards or Ministry of Trade. Processors should also contact either the Health Ministry or Food Commission for details of laws relating to public health, food safety and hygiene and sanitation on their premises. A summary of the requirements for registration of a food-processing businesses is given in *Opportunities in Food Processing, Volume 1*, Section 6.1 that also contains details of the general regulations concerning labelling, presentation and advertisements, weights and measures and hygiene practices during processing and handling.

Legislation covering exports and international trade can be obtained from the United Nations Committee on Trade and Development (UNCTAD) (see Appendix II). The *Codex Alimentarius* Commission (see Appendix I) sets the standards for many raw materials, processed and semi-processed foods. Each member country has a focal point where information on the Codex can be obtained.

Product specifications

The following fruit and vegetable products often have compositional standards:

Fruit juices and nectars

Juice should be pure juice with nothing added except vitamin C, specified acids used to adjust the pH and maximum residual levels of sulphur dioxide if this has been used. Typically nectars should contain a minimum percentage of juice (between 25% and 40%) depending on the type of fruit and a maximum of 20% added sugar. There are also minimum limits for the acid content of nectars.

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Soft drinks

Squashes, crushes and cordials are each defined in law and have minimum fruit contents specified for different types of fruit. These are typically 1.5–5% minimum fruit content for drinks that are not diluted, and 7–25% minimum fruit content for those drinks that require dilution with four parts water to one part drink. They each have maximum permitted levels of sugar or artificial sweeteners and can contain specified food acids or synthetic colours.

Jams and other preserves

Jams should contain a minimum amount of fruit pulp, which varies with the type of fruit used, but for many is around 200 g pulp per kg product. Similarly the amount of fruit juice in jelly and marmalade is specified. Normally jams should have minimum of 60% soluble solids and there are limits on residual sulphur dioxide in all products. There are detailed regulations covering definitions of the names: *jams, jellies, marmalades, conserves, preserves, extra jam or jelly and reduced sugar jam, jelly* or *marmalade*. Table 5.3 summarises some legislation from the *Codex Alimentarius* Commission.

Aspect	Regulation
Fruit	Fresh, sound fruit free from deterioration
Fruit pulp	Edible part of whole fruit, with or without peel, skin or pips, that has been sliced or crushed but not made into a puree
Single fruit preserve	Made from as single type of fruit and declared on the label
Mixed fruit preserves	Made from two or more fruits which must be declared in descending order of weight of each used
Fruit content	Declared as 'X g of fruit per 100 g of product'
Jam	Shall contain not less than of 250 g of fruit per 1000 g for most fruits Exceptions exist, e.g. 150 g per kg for ginger
Extra jam	Generally must contain not less than 350 g fruit per kg
Marmalade	The quantity of citrus fruit shall not be less than 200 g kg of which not less than 75 g will derive from peel
Preservatives	Sodium benzoate, sorbic acid maximum of 1 g per kg singly or in combination
Sulphur dioxide	100 mg per kg of the final product
Permitted food colours	Max 200 mg per kg

Source: *Codex Alimentarius* Commission Standards for Jams and Jellies. Codex Stan 79-1981 DATE?.

Table 5.3 Examples of Jam Regulations

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Tomato ketchup

This should have a minimum of 6% tomato solids and not contain seeds. There is a maximum limit on contamination with copper and no other fruits or vegetables can be used except onions, garlic or spices for flavouring.

Additives and contaminants

In most ACP countries the Bureau of Standards or its equivalent produces lists of permitted food colours, emulsifies, stabilisers, preservatives and other additives that can be added to foods. Any chemical that is not on these lists cannot be used. There are also maximum levels set for each additive in specific foods and lists of foods that are able to contain specified preservatives. Typical permitted levels of sulphur dioxide are shown in Table 5.4.

Food	Sulphur dioxide (µg per kg or ppm)
Apricots	2000
Bananas	1000
Coconut	50
Dry potato granules	400
Figs	2000
Ginger	150
Grapes	2000
Mushrooms	100
Onion	300

Source: UK Food Regulations (1995).
NB: Some EU countries have stricter limits on sulphur dioxide content and exporters should check with each country's regulations. Some importing companies also have lower limits than national regulations

Table 5.4 Permitted residual levels of sulphur dioxide in fruits and vegetables

Contaminants, including herbicides, pesticides, hormones, other agri-chemicals and poisonous metals such as arsenic and lead, have maximum permitted levels in specified foods.

Food labelling

When prosecutions of food companies are analysed, a large percentage often relate to 'technical' breaches of the law because a label is incorrectly designed. It is therefore in the processors' interest to involve the local Bureau of Standards or other appropriate body at an early stage of label design to avoid problems with prosecution and expensive re-design after labels have been printed. There are general labelling requirements that describe the information that must be included on a label (*Opportunities in Food*

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Processing, Volume 1, Section 6.4), but in many countries there are also very detailed laws concerning some or all of the following aspects:

- specify names that must be given to different types of ingredients
- the use of such words as 'best before' and 'sell by'
- the declaration of alcohol content on spirit drinks
- positioning of the name of the food, the sell-by date and the net weight (they must all be in the same field of vision when a customer looks at the label)
- visibility of information and the ability of customers to understand it (including the relative print sizes of different information)
- claims and misleading descriptions, especially about health-giving or tonic properties, nutritional advantages, diabetic or other medicinal claims
- specifications of the way in which certain words such as 'flavour', 'fresh', 'vitamin' etc. can be used.

This is also a complex area and professional advice should be sought from graphic designers who are experienced in label design, or from a Bureau of Standards or other appropriate organisation.

Hygiene and sanitation

Laws relating to food production premises and the staff who handle foods are among the most widely enforced in most ACP countries. Guidelines on the design and construction of premises and hygiene of operators should be consulted before submitting a new processing facility for inspection and certification. These guidelines should be rigorously enforced to ensure that safe, high-quality products are produced. In summary, the laws are concerned with the following aspects of health, hygiene and sanitation:

- processing that is carried out in unsanitary conditions or where food is exposed to the risk of contamination
- equipment (which must be able to be cleaned and kept clean)
- persons handling food and their responsibilities to protect it from contamination
- building design and construction including water supplies, drainage, toilet facilities, wash-hand basins, provision of first aid facilities, places to store clothing, facilities for washing food and equipment, lighting, ventilation, protection against infestation by rats and insects and removal of wastes.

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Weights and measures

This legislation aims to protect customers from being cheated by unscrupulous manufacturers (e.g., being sold underweight packs of food) and the laws require the amount of food that is declared on the label as the net weight (the weight of product in a pack) to be the same as the weight of food that is actually in the pack. However, it is recognised that not every pack can be filled with **exactly** the specified weight because both machine filling and hand filling of containers is subject to some variability. In some countries, there are specified weights that must be used when selling dried fruits and vegetables and jams or marmalades (but not other processed fruit and vegetable products).

Other information required on labels

Nutrition information on a label may also include a full list of vitamins and minerals, especially the salt content. A label can be used to make claims about the health benefits of a food, but such claims are illegal if there is a risk that they could give false or misleading information. Claims that are not allowed include those that say a food is 'wholesome', 'healthy', or can 'cure disease'.

Packaged goods should indicate on the label the name and address of the producer, the type of product and a complete list of ingredients, starting with the largest amount and ending with the smallest amount. It is not necessary to indicate the actual amounts of ingredients used. Water should be included as an ingredient if it is above 5%. Any additive that is used only as a processing aid and has no function in the final product need not be included. Essences do not need to be individually identified, but simply described on the label as 'flavourings'.

If a producer wishes to use the European system of 'E-numbers' to identify additives, the code numbers can be obtained from offices of the European Union or Centre for the Development of Enterprise (CDE) in capital cities, or by contacting UNCTAD (see Appendix II). The ingredient list must show a category name such as 'preservative', 'colour' or 'emulsifier' before the E- additive or number (e.g. 'acidity regulator – sodium citrate').

A date mark is required for products that have a shelf life of less than 12 months.

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Summary of the chapter

- ✔ To obtain high quality raw materials and ingredients, consider contracting farmers or making formal agreements with suppliers
- ✔ Assess all raw materials to ensure they have the required quality
- ✔ Identify control points in your process to assure product quality. Do not forget storage and distribution
- ✔ Develop routine cleaning programmes and ensure they are properly implemented
- ✔ Develop routine methods to assess product quality
- ✔ Know the laws that affect your products
- ✔ Ensure that production methods are suitable for making products that are legal
- ✔ Make sure your labelling meets legal requirements
- ✔ Seek advice from the Bureau of Standards or other appropriate organisation if you are not sure.

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Entrepreneur's checklist

- ❑ Do you know what the control points are for each of your products?
- ❑ Do you routinely check the quality of your raw materials or ingredients?
- ❑ Do you use this information to improve supplies?
- ❑ Do you have contracts with suppliers? If not, have you assessed the benefits of agreeing contracts?
- ❑ Do you have routine cleaning schedules? Are they satisfactory?
- ❑ Do you routinely check the quality and the fill weights of your products?
- ❑ Does your labelling comply with the law?
- ❑ Do you know where to get advice on the law relating to your products?
- ❑ Do you have the necessary approval and certificates?

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Planning and managing production 6

6.1 Roles and responsibilities within the business

Managing a fruit and vegetable processing enterprise means having full control over what is happening in the business. It involves aspects such as planning, purchasing, production, marketing, finances and managing the staff that work in the business. At the smallest scale of operation, where the business owner works on site and supervises a few workers, there is often little differentiation in the roles that each person has in the production process, and each worker can do all the different jobs. Owners or managers decide which production tasks workers will do throughout the day, and do all the other work themselves (e.g. accounts, sales etc.). However, once the size of the business increases, it is better to give specific roles and responsibilities to different people. This not only increases the efficiency of the operation, but also enables people to specialise and develop their skills in a particular area. As the business grows, there may be further differentiation of jobs.

Tips for success

- ✔ Be ready to delegate duties to others and play a supervisory role
- ✔ Make workers feel part of a team, they will be more responsible
- ✔ Proper record-keeping is vital. Keep records of everything and take time to analyse them
- ✔ Using good quality raw materials
- ✔ Motivate your staff and invest in them through salaries and allowances or training
- ✔ Build good relationships with your staff
- ✔ Start small, get the experience and capital and then expand
- ✔ Employing skilled workers or train your staff to bring them up to standard
- ✔ Having timely and correct maintenance done by qualified personnel
- ✔ Correctly schedule ingredients for particular products
- ✔ Mix ingredients in the correct amounts
- ✔ Having the correct machine for the intended production
- ✔ Be honest and dependable – give people what they ask for
- ✔ Pay your workers well
- ✔ Read Sections 4.1–4.7, 8.1–8.2, 6.1–6.6 and 10.1–10.4 in *Opportunities in Food Processing, Volume 1*

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Case study 6.1 Work organisation

The *gari* processors, under the leadership of Madam M, consist of five women who have come together to process roasted cassava grits and soybean-fortified *gari*. Because the women work as a group they are able to improve their technical capabilities through regular training. This has increased the economy of scale in their production and has enabled them to fix their prices and supply large quantities to exporters and institutions. Of the women, only the youngest has a Junior Secondary School education, so they rely heavily on the expertise of their youngest partner.

The company employs a technician to operate the cassava graters and extra temporary labour to assist with sieving the roasted *gari*. Preference is given to family members or neighbours.

Planning is essential, not only when a business is being set up (Chapter 2, Section 2.1), but also for daily operation. Good production planning makes the best use of people, materials and equipment, and also helps the entrepreneur to:

- think ahead about the business to prevent problems arising during operation
- avoid 'bottlenecks' in the process, or running out of an essential ingredient
- know if the business is going to make profits in the future
- predict the growth of the business and decide what actions are needed to achieve it.

Small-scale processors often fail to perform adequate production planning and production may cease due to a lack of spare parts for machinery, or the business runs out of labels, or an important ingredient such as a preservative. In the authors' experience, these failures in production planning are the most important reason for a business to operate below its expected capacity.
The following sequence of events can take place:

1. Production stoppages and low production rates mean that the fixed costs (see Chapter 7, Section 7.1) become a relatively large proportion of total costs.
2. The business simply does not make enough products (and hence does not receive sufficient income) to make a profit or even to pay the bills.
3. The products then become over-priced and uncompetitive.
4. In extreme circumstances the producer reaches credit limits with suppliers, who eventually refuse to provide inputs, and the business fails.

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The questions below illustrate some of the routine planning decisions that need to be taken in a fruit or vegetable processing business:

- What are the expected sales for next week?
- What are the stocks and what production will be needed to meet the expected deliveries?
- Are enough raw materials, ingredients and utilities available for next week's production and are they of the correct quality?
- Is the equipment ready for the expected production levels?
- Are there enough packaging materials available?
- Are trained workers going to be available, or should extra workers be hired for the week?

6.2 Expected sales

The manager should ensure that sales and marketing staff discuss with production staff the amounts of products required each week. There are two reasons for this: firstly to plan the production levels for the near future, and secondly, to monitor long-term trends. Salespeople gather orders from customers, and production staff then draw up a production plan showing how much of each product should be made during the next few days or weeks. The production manager can then arrange for the necessary amounts of ingredients, packaging and labour to be available to meet the orders (Figure 6.1). Clearly, the more notice that can be given of anticipated sales, the easier it is to plan production.

Sales staff should discuss the popularity of each product with retailers and customers, and find out whether demand is increasing or decreasing. By doing this, they can get an idea of future sales trends. This type of information allows the owner or manager to draw up long-term plans to cope with expected changes in demand (Case study 6.2). Sales staff can also report on any new developments by competitors.

6.3 Production planning

Fruit and vegetable processing are highly competitive types of business, and good production planning and management are needed to control expenditure and reduce product costs, in order to maintain or increase a company's profitability (Chapter 7, Section 7.4). The main considerations are:

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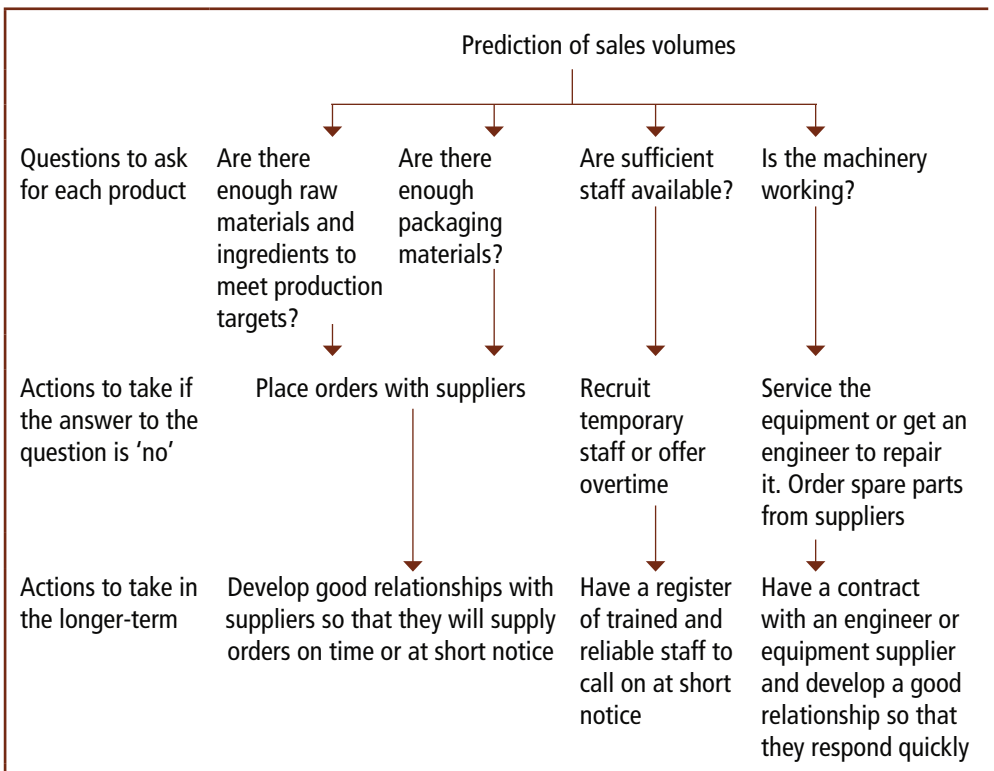


Fig. 6.1 Planning production based on sales predictions

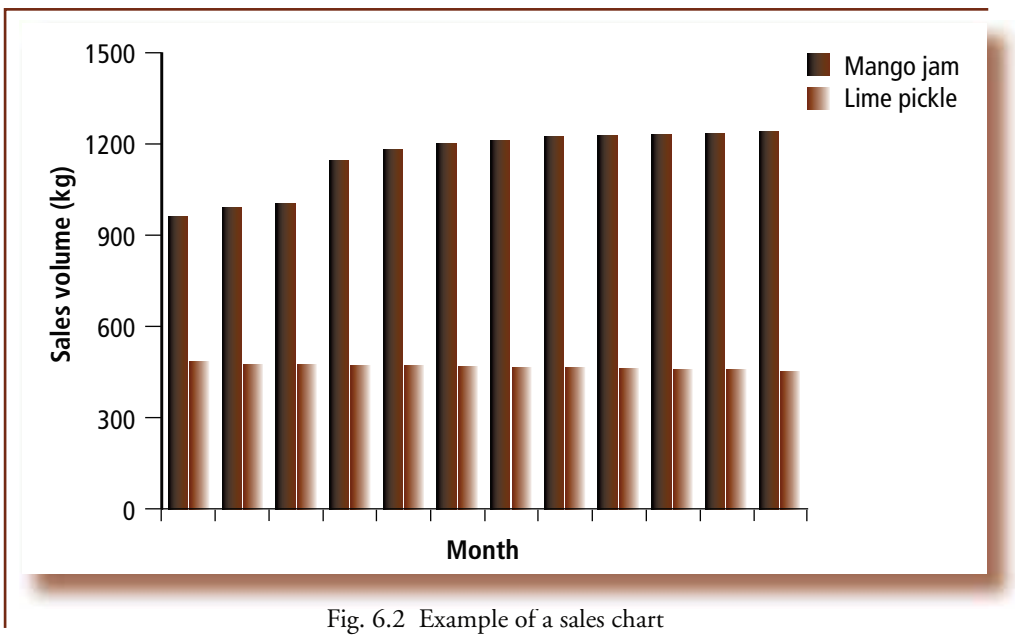


Fig. 6.2 Example of a sales chart

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- locating sufficient amounts of raw materials and ingredients that have an acceptable quality and price
- proper staff recruitment and training to ensure a uniformly high product quality
- maintenance of equipment to prevent breakdowns and ensure uninterrupted production
- record keeping
- business productivity improvement.

Each of these is described in more detail below.

Case study 6.2 Business planning

With his accounting background, Mr K has developed a business plan for forecasting marketing and production plans. He has also prepared a financial plan to analyse the likely income and costs that the business could generate when he increases production or introduces a new product. With these he is able to predict the viability of his business and expands only when he is convinced about the market, availability of raw materials and likely increase in profit.

Inputs of raw materials, ingredients and packaging

The need to secure a supply of raw materials, often for a full year's production, is a major constraint and may require careful negotiations with farmers or other suppliers. Ideally, there should be strong, trusting relationships between farmers and processors, which bring a number of benefits:

- there is reduced uncertainty in both costs to the processor and income for the farmers
- an assured supply of high quality raw materials
- reduced buying costs
- better production planning and cashflow management because of guaranteed raw material supplies
- better understanding by farmers of processors' quality requirements
- increased incomes to farmers from guaranteed sales of crops.

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The most important component of any agreement with farmers is the price offered by the processor. A number of arrangements are possible to determine the prices that are paid for crops. For example in contract growing schemes, the processor sets a fixed price and the farmers have a guaranteed income, but farmers do not benefit if the market price rises. They are more likely to renege on the agreement under this type of contract and sell their crop to the highest bidder. In contract processing schemes, the processor buys a proportion of the crop at a fixed price and the remainder belongs to the farmer. This places the risk with the farmers, but also gives them the opportunity to get the full market price for part of their crop. For any type of agreement to be effective, both parties must keep their side of the arrangement, and this requires a high level of trust and understanding (see also Case study 5.2).

When a processor has decided on the amount of production needed each week to meet the expected demand, the weights of ingredients can then be calculated using the recipe for each product (Table 6.1). All other production inputs can then be scheduled, and orders placed with suppliers to maintain the required stock levels.

Pickle ingredients (g)	Calculation	Amount (kg) needed to make 5.5 kg
Limes 170.0	(170/433.5) x 5.5	2.160
Sugar 90.0	(90/433.5) x 5.5	1.140
Vinegar 80.0	(80/433.5) x 5.5	1.010
Salt 81.5	(81.5/433.5) x 5.5	1.030
Spices 12.0	(12/433.5) x 5.5	0.155
Total 433.5		5.500

Table 6.1 Sample calculations of the weights of ingredients from a pickle recipe

In many ACP countries there are difficulties in securing reliable supplies of ingredients and packaging materials. To overcome this some processors keep large amounts of stock to protect themselves against production stoppages. These large expenditures may cause cashflow difficulties because cash is tied up while stock that has already been paid for is waiting to be used. Holding stocks of materials for a long time may also result in spoilage or theft; and it increases the cost of production and decreases the competitiveness of the business. Smaller enterprises may buy materials in smaller quantities more regularly to overcome cashflow problems. However, this is a more expensive

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way of buying than bulk buying and there is a constant risk of production stoppages because stocks of an essential ingredient cannot be quickly replaced. The problem of how much stock to hold can be partly addressed by adequate initial financing that is available in phases over several months to meet the planned shortfalls in cashflow, and by periodically buying materials in bulk.

Production planning

The data from market surveys (Chapter 2, Section 2.2) is used to decide the scale of production required and hence:

- weights of raw materials and ingredients required each day
- number of workers and their different jobs
- time required for production, given the size of the equipment and the need to build up of stocks for peak demand (e.g., the operation of more shifts) When planning the process, it is necessary to calculate the size of equipment needed to achieve the planned production
- number of packages required each day.

Calculation of production rate

In the example in Figure 6.2, mango jam sales are 1,240 kg per month which requires a minimum production rate of 62 kg per day (or 7.75 kg per hour), assuming that production takes place for 8 hours each day for 20 days per month. This figure for the production rate is important in all subsequent planning. Every effort should be made to ensure that it is as accurate as possible by checking all assumptions carefully. In particular, the number of assumed working days may fall below 20 if there are regular power failures or other production stoppages. Using mango jam as an example, Table 6.2 shows the recipe and Table 6.3 shows losses during each stage of the process. Using these calculations, the amount of mangoes that need to be bought to produce the required weight for each day's production can then be calculated (assuming that each batch of jam is made in a 60-litre pan) as shown in Case study 6.3 and Table 6.3.

Ingredient	Weight per batch (kg)
Mango pulp	27.0
Sugar	27.0
Pectin	1.5
Total	55.5

Table 6.2 Ingredients for mango jam

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Case study 6.3 Calculation of boiling losses

The solids content (data from Table 6.2) in the mix of ingredients before boiling is:

Ingredient	Weight (kg)	Solids content (%)	Weight of solids (kg)
Mangoes	27	15	4.05
Sugar	27	100	27
Pectin	1.5	99	1.485
Total	**54**		**32.54**

Percentage solids in batch before boiling = (32.54/55.5) x 100 = 58.6%

So 32.54 kg of solids give the batch a solids content of 58.6% before boiling. After boiling there is no loss of solids (only water is removed) but the solids content has been increased to 72%.

Therefore the 32.54 kg solids represent 72% of the total weight of jam. Therefore the total weight of the batch after boiling = (100/72) x 32.54 = 45.2 kg.

Processing stage	Losses (%)	Weight of mangoes (kg)	Batch size (kg)	Processing time (min)	Number of workers	Equipment used
Mangoes						
Wash/sort	0	60		30		
Peel/	5	60		120	2	Work tables and knives
de-stone				90	2	
Cut	45	57		30	1	
Weigh/mix	10	31.35				
		28.2				
	4	2	27 kg mango + 27 kg sugar for batch of 54 kg			
Boil	18.51		45.2	30		Boiling pan for 60-kg batches
Fill/seal	10		40.7	180	1	
Cool/label	0		40.7	60	2	Two fillers
Store	0		40.7		1	
Weight of product						

1. Evaporation losses during boiling (See Case study 6.3)

Table 6.3 Calculation of throughput at each stage of mango jam production

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In the example in Table 6.3 each batch produces approximately 47 kg jam and takes a total of 540 minutes (9 person hours). With two production staff, two batches of jam can be produced in a working day. Clearly the production rate could be increased if more staff were employed.

A note on losses

Nearly all fruit or vegetable processing results in losses of material. Different types of fruit and vegetables have different levels of wastage and examples are given in Table 6.4. These may arise from many sources, including substandard fruits and vegetables that are thrown away during sorting, peeling losses, spillage during filling into jars or from food that sticks to equipment and is lost during washing. Different varieties of the same fruits such as mangoes can have large stones and hence higher wastage.

Case study 6.4 Buying fruit

A Caribbean producer of soursop and mango nectar found it was much more economic to buy the largest fruits she could. "A small soursop is all skin and seeds," she said "and I get a much higher yield from big fruits. The same with mangoes, some of the very big types cost a bit more but have far more useable flesh."

Typical losses from other sources in a well-managed production process are shown in Table 6.5. However, it is necessary for an entrepreneur to do trials to calculate the actual amount of wastage experienced with any particular variety of fruit or vegetable and with each particular process that is being used. These losses should be monitored and the entire process managed to ensure that they are as low as possible, since losses have a direct effect on the cost of raw materials and a significant effect on the total cost of production.

Calculation of water lost during drying fruits and vegetables and the yield of product

The amount of water in fresh fruits and vegetables can be found from textbooks or from staff at university food science departments. Some examples are given in Table 6.6.

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Fruit or vegetable	Typical losses during preparation (%)	Notes
Apple	23	Peeled and cored
Apricot halves	12	De-stoned
Banana	41	Peeled
Cabbage	30	
Carrot (without leaves)	4	
Cauliflower	38	
Currant	3	Seeds and skins removed
Fig	2	
Grape	19	Skins and pips removed
Guava	22	
Lemon	40	Peel and seeds removed
Mango	45	Peeled and de-stoned
Melon	42	Peel and seeds removed
Okra	12	
Onion	3	
Orange	25	Peel and seeds removed
Passion fruit	58	Peel and seeds removed
Papaya	38	Peel and seeds removed
Pea	50	Bought in pods
Pepper – chilli	15	Seeds and stalk removed
Pepper – green	14	Seeds and stalk removed
Pineapple	48	Peeled and cored
Plantain	39	Peeled
Tomato	4	Seeds and skin removed

Source: Paul and Southgate (1991) and field data collected by the editors.

Table 6.4 Typical losses during the preparation of selected fruits and vegetables

Stages in a process	Typical losses
Washing fruits/vegetables	0–10
Sorting	5–50
Peeling	5–60
Slicing/dicing	5–10
Batch preparation/weighing	2–5
Boiling[1]	5–10
Drying[1]	10–20
Packaging	5–10
Machine washing	5–20
Accidental spillage	5–10
Rejected packs	2–5

Source: Fellows (1997).

1. Does not include water lost through evaporation

Table 6.5 Typical losses incurred during fruit and vegetable processing

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Fruit/vegetable	Moisture content (%)
Banana	71
Cabbage	91
Cassava	65
Mushroom	91
Onion	88
Potato	76
Red pepper	85

Source: Paul and Southgate (1991).

Table 6.6 Moisture contents of various fruits and vegetables

Generally, fruits and vegetables should be dried to below 10% moisture in order to ensure that they do not go mouldy during storage. The method for measuring moisture content is shown in Chapter 5, Section 5.5. The method for calculating the yield of a fruit or vegetable after drying is shown in Table 6.7 (the same calculation is used to calculate yield of preserves after boiling).

It is in the interests of the processor to reduce losses as much as possible. The main ways in which this can be done include:

- contracts with reliable suppliers to ensure lower levels of poor-quality raw materials
- well-managed production by trained staff
- QA procedures, to reduce wastage, especially during later stages of processing when the product has higher added value (Chapter 5, Section 5.3).

Processors should use data from production trials to calculate the amounts of raw materials and ingredients that are needed to produce the required weight of product using the procedure shown in Table 6.3 and Case study 6.3. This will also enable the true cost of raw materials to be calculated for use in

Fruit before drying	Weight (kg)	Moisture content (%)	Solids content (100 – moisture content) (%)	Weight of solids (kg)
Pineapple	50	84	16	8 (16% of 50 kg)
After drying there is no loss of solids (only water is removed) and the moisture content has been reduced to 9%. Therefore the solids content has increased to (100 – 9) = 91% and thus is still 8 kg. The weight of product after drying (the yield) = (100/91) x 8 = 8.8 kg				
Fruit after drying	8.8	9	91	8

Table 6.7 Calculating the yield of fruit or vegetable after drying

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financial planning. The data in Table 6.3 indicate that only 45% of incoming raw materials were actually used in the product (27 kg of the 60 kg bought). This is know as the 'yield' of crop. If mangoes were bought for US$0.2 per kg, the true cost of the fruit is calculated as US$0.44 using the following formula:

$$\text{True raw material cost} = \frac{\text{Supplier cost}}{\text{\% Yield}} \times 100$$
$$= (0.2/45) \times 100$$
$$= \text{US\$ } 0.44 \text{ per kg}$$

Feedback from small-scale fruit and vegetable processors revealed that raw material and ingredient costs represent a significant proportion of total production costs (between 20–50%). Raw material costs therefore have a significant effect on the profitability of the business, and it is important to ensure that materials are correctly ordered and checked upon delivery. (Details of QA checks are given in Chapter 5, Section 5.3.)

6.4 Staff recruitment and training

Planning human resources (manpower) means making decisions on the present and future staffing needs of the enterprise. Larger companies have a systematic approach to recruiting and training employees, which has substantial benefits. Such an approach is also likely to benefit small companies, but requires the owner or manager to develop company policies and terms of employment, as described in *Opportunities in Food Processing, Volume 1*, Section 10.3. Opinion is divided among small-scale processors as to whether it is a good idea to employ friends and relatives (Case study 6.5). Although friends and relatives can usually be trusted, they may not have the best skills for the job.

There is a widespread and serious problem in many ACP countries to identify and retain skilled and reliable staff for food-processing businesses at all scales of operation. Although many ACP universities and other institutions now offer training in food science, and hygiene courses are available in many government and privately run institutions, qualified people tend to seek employment in larger companies where the benefits and salaries are better. Small-scale processors therefore continue to find it more difficult to find suitable staff and to retain their employment (Case study 6.5).

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Case study 6.5 Retaining staff and employing friends and relatives

Generally, the workers are young people (18 to 35 years old), male and female, not necessary family members, with a basic education level, although sometimes higher. The problem is that generally, most of them – particularly the men – do not stay for more than two years.

Mr K carefully employs his staff. He has 15 permanent workers on the farm and 10 in the factory and he employs casual labourers during harvesting and peak production seasons. Of the workers 20% are family members, while the rest are employed from the surrounding villages to reduce commuting time and to create employment for the villages. The workers' ages range from 20 to 58 with an average of 36 years. This ensures commitment to work and experience in whatever they are engaged in. 30% of the workforce is women, mostly working in the factory whereas the farm employs more men. The level of education of workers ranges from illiteracy to Masters level, but in total over 80% of them are educated. Five workers, two of which are graduates, have a tertiary education.

The company does not have many problems keeping staff except when they have to go back to school to continue their education. This is mainly the case with senior school leavers who want to continue their education after a short break, or when they have made the grades. These students are engaged when on vacation. The main problem with staff is lateness and absenteeism, which is often a problem with family members.

"The company has so far been lucky in keeping its junior workforce, but we have had problems keeping senior managers when they become experienced, and we have had to renegotiate their salaries to retain them. Most workers seem very happy with their conditions of service. Incentives and bonuses are given as rewards for hard work and maintaining high quality standards."

Previously the enterprise had no formal recruitment procedures. The owners employed family members and friends who may or may not have had the expertise. This has now changed and recruitment is done by advertising the position, conducting interviews and offering the job to the most suitable applicant. As a result, the company now boasts a qualified food processing technologist, a materials engineer, business and marketing consultants, a chartered accountant, technicians, a project manager and an experienced workforce. The company only employs literate staff and the basic requirement for all workers is a Junior Secondary School Leavers' Certificate. Both men and women are given equal opportunity but the company has a policy of affirmative action for women to take up challenges and aspire to top positions, and to take maternity leave. All employees are entitled to annual, sick and maternity leave.

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In fruit and vegetable processing, each day's work will initially involve preparation of the raw materials and then move through processing to packaging. It is possible to have all workers doing the same type of activity throughout the day, but it is often more efficient to allocate different jobs to each worker as the day progresses. A convenient way of planning this is to draw an 'Activity Chart' (*Opportunities in Food Processing, Volume 1*, Section 10.1). This shows the type of work that is to be done each hour during the day, the number of people involved with each activity and the sequence of work that individuals will do during the day. This type of chart is useful for assessing the time required to complete each stage of the process and for thinking through the problems that are likely to occur. When production begins, it can be used as a basis for training in each job and it should be constantly reviewed to optimise production efficiency.

Depending on the particular ACP country, labour costs can be a relatively high proportion of total production costs. Processors reported labour costs to be between 15% and 50%. The high costs of staff and staff training mean that it is important to retain experienced staff. However, many owners of small businesses refuse to train their staff because they are worried that the staff will ask for higher pay or will move to a competitor. Both attitudes are short-sighted and could eventually cause the business to fail.

As in other aspects of running a business, the owner or manager should have a wider view of where the business is heading and what is needed to get it there.

Staff development is an important aspect of forward planning, and the business should be willing to invest in its employees.

There are different types of training, but all should build up in a systematic way, developing skills, knowledge and attitudes that are relevant to the job. 'On the job' training either involves the new employee working immediately in his or her normal job under the supervision of more experienced workers, or the employee can do different jobs to gain experience of the whole operation. If staff are trained to do different jobs, the business will have greater flexibility to deal with absenteeism, holidays etc. Selected institutions that offer training in processing are listed in Appendix II. Case studies 6.6 and 6.7 illustrate some experiences with staff training and motivation.

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Case study 6.6 Staff development

The women's *gari* processors group were micro-producers processing around 50 kg per day, until the Ministry of Agriculture programme to promote food crops, enabled them to access skills in group formation and capacity building, innovation, marketing and product development, together with aquiring information on packaging and provision of credit. As a result, the women have grown their business dramatically in the last two years from micro- to small- and then medium-scale. They now have a turnover of several thousand US$ per week.

"Staff in our accounts section are being trained to computerise the accounts and to keep good records. Those on the farm are occasionally sent for short refresher courses at the university or the Ministry of Food and Agriculture. One of my daughters is pursuing a degree course in Agri-business at university and hopes to work in the business. Staff also attend seminars and workshops when possible.

"Our workers are trained in the factory in good manufacturing practice and good hygienic practice under the supervision of experts from support agencies. But, since most of them don't stay for more than a few years, this training must be renewed. Skilled workers are generally scarce and expensive and the market for staff is so fluid that the manager cannot develop a long-term strategy to train her personnel."

A successful business of any size has workers who feel rewarded and are willing to work for the company because they have a future in it.

Motivation is an important part of staff development and encourages employees to achieve their highest level of performance

Staff gain satisfaction from their jobs if they receive reasonable pay and have good working conditions, together with management methods that motivate them so that they enjoy their work. Well-motivated staff have limitless potential in their individual jobs, and improve the overall productivity of the enterprise. Managers should therefore devise ways of motivating staff and improving job performance. Examples of staff benefits identified during interviews with processors and processors include:

- competitive salaries and regular review of salaries, prompt pay and extra rewards when the business does well

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- paid overtime
- paid leave and holidays
- interest-free and flexible loan facilities for school fees, during bereavement, with rent and other family needs
- free meals, lunch allowance or food allowance
- staff discounts for products
- sick pay and sick leave, hospital and health care benefits, paying medical bills, medical examinations or a proportion of salary held for medical support costs (In many ACP countries, staff are required to undergo a medical examination to obtain a health certificate for working with foods)
- uniforms, aprons, head scarves and work clothes
- toilets and washing facilities with hot water
- transportation to work or transport allowance
- representation or attendance at staff meetings
- small gestures such as a birthday card that help to improve staff morale.

Even the lowest-paid worker needs a sense of security, recognition and belonging. The terms and conditions of employment vary widely in ACP countries but, as a minimum, managers should give workers contracts of employment and encourage a sense of status and pride at all levels to help employees identify themselves with the enterprise.

Health and safety

Every entrepreneur has a responsibility to provide a safe and healthy working environment. Many, but not all, ACP countries have laws concerning the health and safety of workers and the safety of equipment, but even if legislation does not exist, the consequences of accidents and illness arising from poor working conditions are far greater than any difficulty in ensuring safety.

It is important to have a regular maintenance programme for equipment that would be dangerous if a failure occurred, and all staff should be properly trained to carry out potentially hazardous operations.

Unsafe working conditions can also arise due to poorly designed workplaces (e.g., lack of adequate lighting, ventilation, slippery floors or steps) and unsafe actions (such as interfering with safety guards or working double shifts without rest periods). These are all the responsibility of the manager or owner.

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Case study 6.7 Staff motivation and rewards

"We occasionally motivate our workers by giving them bonuses when targets have been met. We also have staff meetings to present the company's targets to the managers as well as the workers. They all make suggestions on how best to achieve their targets and are committed to them. Some workers belong to the Association of Food Processors by virtue of the company being a member of the Association of Ghana Industries. The advantage to the employees of belonging to an association is that they can negotiate their conditions of service knowing the minimum national levels. In fact, our workers have very good conditions of service compared to other similar businesses."

"The workers enjoy benefits including sick and annual leave, paid holidays, health care benefits when needed, food allowances and a good welfare scheme."

The business has no formal employee benefit scheme such as social security, transport or food allowance. However, they are generous when it comes to paying part of hospital expenses or contributing to funeral expenses.

Mrs E employs an elderly woman part-time to help with production and distribution, and engages the whole family in the business in the evenings and at weekends. They are paid a daily wage and are allowed to bring their children to work. They also have lunch allowances and their hospital bills are supplemented when necessary.

The company does not discriminate on age or gender, but women make up 70% of the workforce and the top management is mainly male. "This is a reflection of what pertains nationwide," said Mrs A, "but also because women are more qualified as food processors and maintain higher quality standards." The company is also very particular about the health of the workers and they undergo periodic health checks. Other benefits include health care, social security, transport, clothing and meal allowances. They do not have childcare facilities but this is not surprising since the majority of the workers are over 35 years old.

Simple safety precautions reduce the chance of accidents, and enhance the good name of the company. This increases the confidence of customers in its products, and improves the working conditions and productivity of the staff.

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Fewer accidents also reduce production losses, repair costs, extra costs of training new staff and medical bills. Simple precautions are listed in Table 6.8. Temporary installations are one of the most frequent causes of accidents and include:

- use of cables without insulation
- lack of protective covers on switch gears, fuse-boxes etc.
- use of un-earthed equipment
- unauthorised additions to circuits resulting in overloading and fire risk
- bridging over fuses
- improper adjustment and maintenance of equipment

Safety tips for fruit and vegetable processing

1. Do not allow customers, children, visitors or animals into the building. Ensure that only trained staff enter the premises and operate the machines.
2. Prevent staff wearing any loose clothing (e.g. ties, un-buttoned or long-sleeved shirts) that could become caught in running machines. Provide them with overalls.
3. Do not allow staff to start a machine unless they know how to stop it. Only one person should operate a machine at any one time.
4. Make the layout of machinery logical, and leave sufficient space around it so that there are few chances for operators to get in each other's way.
5. Do not try to attract operators' attention by touching or calling them from behind if they are using a machine. Always speak to them from the front, or wait until they have finished what they are doing.
6. Train staff to be familiar with potential hazards (e.g. potentially dangerous machines or hot surfaces), and make sure they know what to do in the event of an accident. Use charts hung on the wall near each machine to show safety precautions.
7. Ensure that guards are fitted and in place over all moving parts of a machine and alert staff to machines that appear to be standing still when running at high speed.
8. Never allow staff to clean, adjust or lean over moving machinery and do not allow them to leave a running machine unattended.
9. Encourage operators to report any loose parts on a machine.
10. Do not allow staff to work with equipment that is defective. Put a note on any machine that is under repair saying 'DO NOT TOUCH'.
11. Do not allow anyone to touch inside electric equipment while it is connected.
12. Regularly check the cords of electrical appliances to ensure that outside covers are not broken and wires are not exposed.
13. Prevent staff from running inside a building. Immediately clean up any water, oil or grease on the floor using sawdust, sand, husks etc.
14. Clean the building each day.
15. Have a first aid box containing sterilised dressings, cotton wool, adhesive plasters and bandages. In many ACP countries, the law requires every factory to have one.

Table 6.8 Safety tips for fruit and vegetable processing

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- poorly aligned drive belts to machinery
- poor maintenance or use of incorrect spare parts
- failing to use the correct tools for the machine.

Powered equipment should always have guards in place over drive belts, and staff should be trained in safe operating procedures. The manager should also prevent operators from wearing clothes or jewellery that could become entangled in moving equipment. In the event of an electrical fire, the electricity should be turned off at the main switch and the fire either smothered with a damp cloth or put out using sand.

Water should never be used to extinguish an electrical fire.

6.5 Maintenance of equipment

Machine breakdowns reduce productivity and increase production costs. Lack of maintenance is one of the most common reasons why small-scale processors lose money. In addition to posing a potential hazard to operators, poorly maintained machines produce substandard products and can contaminate products with metal fragments. Proper maintenance ensures that machinery operates correctly and safely and prolongs its life, thus reducing capital and operating expenditure. Most small-scale processors do not have a programme of planned maintenance, preferring instead to rely on the maxim 'if it is not broken, don't fix it'. Some engineers agree with this and regard planned maintenance as unnecessary. They believe that it is cheaper to allow equipment to break down and then repair it. Others consider that it is cheaper to stop production on a regular basis and replace parts before they wear out. On balance, it is probable that the costs and benefits of planned maintenance depend on the speed at which repairs can be done and the value of the spares that have to be held in stock.

As a minimum, managers should monitor the state of equipment and facilities that are likely to wear out. As experience of the rate of failure accumulates over the years, they should buy spare parts or send the machine for servicing when the next replacement is anticipated.

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The following actions are needed to put preventative maintenance into practice:

- identify priority machinery where components wear out more frequently
- write a clear description of the procedures and standards for the work of machine operators and maintenance workers (such as lubricating, tightening bolts, making adjustments etc.) in daily, weekly and monthly routine maintenance plans
- organise a schedule and train staff to implement maintenance plans
- prepare a maintenance budget
- record inspection results, analyse the records and evaluate the success of maintenance
- update procedures and standards on a continuous basis.

Maintenance records

Maintenance and spares records (Tables 6.9 and 6.10) should be used to provide information on the performance of equipment. Records help to ensure that maintenance costs are included in the cost of running the business, and to plan purchases of spares, making sure they are available when required.

Date	Work carried out	Parts used	Cost

Table 6.9 Sample blank maintenance and repair records

Type of spare:				
Quantity purchased	Cost	Quantity in stock	Quantity used	Date fitted

Table 6.10 Sample blank spares records

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6.6 Record keeping

There are three sets of basic records that should be kept by the owner of a small fruit and vegetable processing unit: financial records, those that relate to the production of the products and sales records. The uses of these records are inter-related and are described in more detail in *Opportunities in Food Processing, Volume 1*, Sections 8.1–8.2. As with all other inputs to a business, keeping records is an investment of time and money and the benefits must outweigh the costs.

There is no point in recording information for its own sake and records must be used if they are to have any value.

This means that the owner or manager must understand why the information is collected and what it can be used for. Similarly, the time and effort spent in keeping records must be related to the scale and profitability of the business. While it is true that some successful entrepreneurs keep all of the information in their head and do not keep records, no-one else can help run the business during times of illness or absence. Some examples of the value and costs of keeping records are shown below:

Case study 6.8 Record keeping

"We have a stock control system and we have installed accounting software which enables the production manager, accountant, marketing consultant and the executive director to assess the state of the business on line."

With their training in book keeping they are able to keep records and make projections. They keep good records of raw materials, production costs and stock and have also engaged the services of an accountant who prepares their quarterly and annual financial reports.

She normally keeps records of production costs and sales to work out her profit. She also keeps records of debtors to enable her to recover outstanding debts. Debt recovery requires several visits to the debtors and most of the time she is able to collect her money without any hassle.

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Value of record keeping:

- detailed knowledge about the operation of the business
- identification of trends
- accurate control over finances and product quality
- identification of individual costs to allow changes to a product or process to optimise profits
- keeping track of money owed to the business
- evidence for tax authorities (may be a legal requirement)
- factual basis for product pricing or salary levels
- knowledge and avoidance of theft.

Costs of record keeping:

- time spent learning how to keep records or training staff
- time spent writing them
- cost of materials such as ledgers and pens
- information is written down and therefore potentially available for competitors or authorities to see
- cost of keeping records private and secure.

Accurate information is essential and this means that staff who are required to collect information should know its value and why it is being collected. This should be part of the induction and training when new staff members learn their job. The entrepreneur should employ people who have the skills and aptitude to do the work, but should also put in place a system of checks to ensure that one person does not have responsibility for a whole area of business activity. For example, the person responsible for keeping records of purchases should be different from the person who records use of materials or levels of stocks. The owner or manager should also ensure that all records are kept up to date and where appropriate, the arithmetic is checked for accuracy. There is no single correct way to keep records and individual owners should devise systems that suit their way of working. Examples are given in *Opportunities in Food Processing, Volume 1*, Sections 8.1–8.2.

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6.7 Business productivity improvement

The companies that assisted in the preparation of this book ranged in size from 2 to 50 employees, with the majority employing 8–15 workers. The businesses varied greatly in their productivity: for example one company with 10 workers was able to produce 2000 litres of juice per day (>10,000 litres per week), whereas another with 6 employees produced 260 litres of juice per day (1,300 litres per week), and another with 9 workers produced 600 litres of juice and 12 kg of fried chips per week. Most produced a range of products, with one or two producing only two products.

The companies provided details of the following types of activities that they have used to improve their productivity:

- improved efficiency (e.g., lowering operating costs, reducing idle machine time and reducing waste)
- better procedures for buying materials
- reducing losses of raw materials
- improved decision-making and communication
- increased output by minimising equipment breakdowns and reducing other causes of lost time
- improved organisation, better staff morale and co-operation.

The layout of a production unit is another factor that can affect efficiency. When deciding where to fix permanent machinery, care should be taken to plan the layout to allow for a flow of product through the process, sufficient space to avoid congestion and to ensure safe operations (see Chapter 3, Section 3.2).

Case study 6.9 Improving productivity

Mr K has seen a big jump in the volume of production in the last five years from less than 50 litres of orange juice per day to over 1,500 litres per day at present. This achievement is the result of technological upgrading, improved quality assurance, good financial management and customer care.

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In order to assess whether improvements to productivity are taking place, it is necessary to measure and record consumption of materials, amount of labour used etc. These figures can then be used to calculate, for example:

- actual usage of raw materials and ingredients per kg product (i.e., not the planned usage in the recipe but what actually happens during production).
- amount of packaging per kg of product
- labour costs per kg product
- energy used per kg product etc.

Productivity can also be improved by changing the design of the product or the layout of the production facilities, changing raw materials suppliers or work organisation. Improving efficiency in a process involves reducing wastage of time, materials and space, or unnecessary movement of foods, staff or equipment.

Reducing the cost of services

The cost of electricity, fuel and water was reported by processors to be 20–30% of total production costs. The main reported problem is interruption to the supply of electricity, which stops processing altogether. If services are likely to be inadequate or unreliable, steps should be taken to find alternatives (e.g., a borehole for water, diesel-powered machines or a backup generator). A number of businesses that were surveyed have taken steps to reduce the cost of services (Case study 6.10).

Case study 6.10 Reducing the cost of services

"I reduced service costs by replacing electric power by gas, which is cheaper than electricity to pasteurise the juices or to fry the chips."

To reduce cost of such services as fuel, power, water and waste disposal, the company has invested in its own generator for use when power from the main grid is interrupted; it has sunk a well to ensure a constant water quality and quantity; it uses its waste by distilling essential oil from orange peel and selling this product to multinationals, confectionary businesses or export agents. These innovations have made it possible for the company to maintain service costs at 20–25% of the cost of production.

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Ideas that can reduce energy consumption and save processors money include:

- switching off lights and electrical equipment when they are not being used
- solar water heating (e.g., for pre-heating process water or washing equipment)
- building in the flexibility to use alternative energy sources when installing new equipment so that they can use the most environmentally suitable and cost-effective fuels
- buying fuel from local briquette makers rather than using fuelwood
- using local suppliers of raw materials that can be delivered by bicycle or head loads, rather than using a vehicle to collect them. similarly, make as few journeys as possible to deliver products to wholesalers or retailers.

Case study 6.11 Reducing energy consumption

With the recent increase in fuel prices, 30% of the production cost is for energy. They use a lot of firewood so they have sought advice to obtain energy-efficient stoves and roasters.

The company spends 25% of its production cost on utilities. Although the cost of electricity for commercial users is more then twice that for domestic use, the company has reduced this cost by over 100% by running its own generator. Not only is this cheaper but also guarantees an uninterrupted supply of power.

She has taken steps to reduce utility costs by using a fuel-efficient stove to improve fuel efficiency by 30% over the traditional charcoal pot.

Avoiding waste

Companies reported different methods of increasing efficiency by reducing wastage (Case study 6.12).

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Case study 6.12 Reducing wastage

The company spends quite a lot of money on transporting factory waste for disposal. The orange and pineapple peels are carted to the farm to produce green manure for farm use or for sale. Pork producers buy pineapple waste for feed production and broken bottles are sold to bead makers. About 50% of the factory waste is recycled or used as raw materials for other businesses. The company adheres to the strict environmental laws of the country and wastewater is channelled to the main sewer system.

Waste disposal is a big problem in *gari* processing industries, particularly the disposal of starchy liquids expressed from cassava dough. The starch ferments and can cause a bad stench when it accumulates for days. Others have tried to recycle the starch for sale, but this is only possible when starch collectors are attached to manual cassava graters. Alternatively a drain can be constructed to take the waste away from the premises, a practice that is not stringently enforced by the district Health, Water and Sanitation Department.

They have dug a pit for the solid orange wastes with the aim of producing fertiliser for the farm or kitchen garden.

She has subscribed to the services of a waste collection organisation because the enterprise generates a lot of waste. The processing water is collected through a filter introduced into the local wastewater system.

Mrs E does not have an income from waste plantain peels but they are collected for animal feed and soap production by her neighbour.

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Summary of the chapter

- ✔ Use sales information to plan daily and weekly production as well as to formulate long-term plans concerning changes to production levels
- ✔ Predict the growth of the business and decide what actions are needed to achieve it
- ✔ Think ahead about the business to prevent problems arising during operation
- ✔ Be active and innovative in managing the business
- ✔ Carefully plan production to ensure: 1. adequate supplies of raw materials and packaging are available, 2. sufficient numbers of trained staff are available and 3. all machinery is serviced and in working order
- ✔ Avoid 'bottlenecks' in the process, or running out of an essential ingredient
- ✔ Consider making agreements with both suppliers and buyers to assist production planning
- ✔ Think carefully before employing friends and relatives
- ✔ Carefully plan work for all staff to maximise their productivity
- ✔ Train staff so that they can work to a high standard without supervision
- ✔ Motivate and reward staff to gain their loyalty and deter them from leaving
- ✔ Ensure that the factory is safe and does not damage workers' health or injure them
- ✔ Ensure that all machinery is safe to operate and that all guards are in place
- ✔ Design and implement a regular maintenance programme for machinery and equipment
- ✔ Invest in ways to save energy and reduce water consumption
- ✔ Develop ways of improving the productivity of both staff and machines.

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Entrepreneur's checklist

- ❑ Are you regularly on site to manage the factory? If not, do you have a trusted manager?
- ❑ Do you know how to plan your production to meet demand for each product by:
  - Securing raw materials/ingredients and packaging material supplies?
  - Having sufficient numbers of trained staff?
  - Ensuring that all equipment works properly?
- ❑ Do you have a formal recruitment policy for staff?
- ❑ Have you recently reviewed the rewards and benefits you offer your staff?
- ❑ Have you made sure that all operations in the factory are safe?
- ❑ Are all guards in place on your equipment and are all safety features operational?
- ❑ Have you taken steps to improve the productivity of:
  - Your staff?
  - Your equipment?
- ❑ Have you investigated ways to save energy or water?

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Planning and managing finances 7

This chapter examines the aspects of financial management that are specifically relevant to businesses involved in fruit and vegetable processing and highlights specific opportunities and problems that may arise.

7.1 Production costs

Start-up costs

One of the first problems facing a small-scale fruit and vegetable processor is finding enough money to start the business. A processor can begin at home using domestic equipment, although it is preferable to start with a separate facility. However, additional start-up costs include:

- conducting a feasibility study and preparing a business plan
- obtaining licences and health certificates
- recruiting and training staff
- buying ingredients and packaging before there is any income from sales.

The initial financing of a processing business should therefore be based on a detailed feasibility study (Chapter 2, Section 2.1) that takes all costs into account. It is likely that funds will be required at

Tips for success

- ✔ Make sure that all products are profitable
- ✔ If you don't have much capital, start small
- ✔ Keep records of all expenditure to reduce your tax bill
- ✔ Book-keeping should be carried out every day
- ✔ Motivated workers will contribute to profits
- ✔ All activities, including quality assurance and cleaning, are a cost
- ✔ Get advice from an accountant who is familiar with local tax legislation
- ✔ Profits belong to the business and not the owner
- ✔ Do not take money for personal use out of the daily takings, have an allowance
- ✔ Cost your products whenever there are changes in raw materials or other areas of production. This will help you decide when you need to raise your prices
- ✔ Have sufficient working capital to buy crops during harvest to process throughout the year
- ✔ Read Sections 7.1–7.5 and 8.1–8.2 in *Opportunities in Food Processing, Volume 1*

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different stages (Table 7.1) and this should be planned for when arranging a loan or discussing the business proposal with potential investors. Many small-scale processors in ACP countries do not wish to deal with banks because of the generally high interest rates, but some positive experiences were reported by businesses during research for this book (Case study 7.1).

Stage	Finance required
Initial idea	Travel to get information for feasibility study and meet potential investors
Planning	Travel to meet equipment suppliers, builders etc.
Establishing the factory	Constructing or modifying a building, installing services, buying equipment, advertising, recruiting and training staff, travel to meet raw material suppliers and retailers
Commissioning	Testing equipment, buying raw materials, ingredients and packaging, establishing production routines, training staff
Starting production	Production costs (see text)
After start-up	Bulk supplies of raw materials or packaging, additional finance to keep a positive cash flow (see Section 7.3)

Table 7.1 Phases requiring funding in a new business

Details of start up costs and finding money to start a business (the 'start-up capital') are given in *Opportunities in Food Processing, Volume 1*, Section 7.2. Additionally, 'working capital' is needed to buy sufficient crops as they come into season, to buy a stock of packaging materials and the other ingredients that are required, product promotion etc. before the business generates income from sales of the products.

Fruit and vegetable processing has relatively high requirements for working capital compared to other types of food processing because of the seasonal nature of crop production and the need to buy several month's supply of crops so that production can continue for a large part of the year. The requirement for working capital also continues as the business develops. The start-up capital and initial working capital are calculated to determine whether the entrepreneur's savings (known as the 'owner's equity') will be sufficient to start the business without a loan. An example of the start-up costs of a small business are shown in Case study 7.2.

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Case study 7.1 Getting finance

With a start-up capital of 50,000 FCFA (US$90), and working with her own kitchen equipment, Mrs A decided to create her enterprise to produce dried chips from roots, tubers and fruits. Today she employs seven workers. She successively got bank credit of 1,950,000 FCFA (US$3500) in 1998 and 1,525,000 FCFA (US$2,750) in 1999 from a micro-finance institution to develop the factory.

In Ghana, the initial problem facing women processors was finance to purchase equipment and raw materials. They were able to overcome this by forming themselves into a group to access group financing from the Agricultural Development Bank. With assistance from an NGO they were able to fulfil the bank selection criteria and with additional financing and good management they have now acquired new machines for grating and pressing the cassava, additional *gari* roasters and a mill for processing soybean into flour. They also now have a large storage area for pressed cassava and a large storeroom with pallets for storing up to 105 bags of *gari* at full capacity.

"One of the eligibility criteria for accessing credit facilities from the bank or micro-finance institution was to develop a business plan with six-monthly or yearly projections depending on the type of business. The high demand for our soy-*gari* product has forced us to have a well-defined production plan to meet customer demands, particularly those for export."

There are presently institutions providing micro-finance, expertise or capacity building that can assist with getting credit, technical assistance from experts or training. Mrs L has experienced benefits from all these institutions.

They have come this far with the financial advice and credit facility from the bank. One of the main problems is the high interest rate that can be as much as 32%, which makes it difficult for them to operate effectively, but they could not have managed financially without them. They have a monthly overdraft facility from the Agricultural Development Bank under a special government financing arrangement. As an incentive to help them grow the business, the government has a policy that provides a tax holiday for five years for new and emerging agro-industries.

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Case study 7.2 An example of start-up costs (US$)

Modification to building	2,500
Equipment	2,030
Registration of business and business licence	125
Hygiene inspection and certificate	30
Initial stock of crops and ingredients, and initial stock of packaging	1,600
Initial product promotion	500
Staff training and salaries	1,100
Total	**7,885**

The owner borrowed US$2,500 from relatives, contributed US$400 as owner's equity and took out a bank loan of US$5,000 to cover the balance of the total start-up costs. A negative cashflow was predicted in the feasibility study during the first year of operation when crops were purchased, so the owner therefore accepted a second partner's equity of US$600 to be used as working capital.

Operating costs

There are two types of operating costs: those that have to be paid even if no production takes place ('fixed costs') and those that vary with the amount of food produced ('variable costs'). They are described in *Opportunities in Food Processing, Volume 1*, Section 7.1 and examples of each are shown in Table 7.2.

Businesses producing complex fruit and vegetable products have additional costs that should be counted in the cost of production. These include:

- use of expensive ingredients (preservatives, seasonings, colours etc.)
- need to buy in specialist services (microbiological testing, insurance, product analysis)
- losses and costs related to product development, unsold stock, returned goods and time spent on customer care
- time and materials used to maintain cleaning schedules which might, for example, require all workers to spend one hour each day on cleaning tasks.

Calculating depreciation in a multi-product facility can also be complex as one item of equipment may be used to make several products. An example of the type of analysis required to apportion depreciation costs (in hours per week) in a complex production unit is shown in Table 7.3.

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Production costs	Costs of tomato sauce production per year ($)
Fixed costs	
Rent	1,500
Labour[1]	3,000
Loan repayment[2]	1,762
Professional fees (accountant)	120
Maintenance of equipment	135
Depreciation of equipment	450
Total fixed costs	**6,967**
Variable costs	
Raw materials and ingredients	11,580
Fuel	2,250
Power	200
Packaging materials for stock	600
Transport/distribution	750
Seasonal labour[1]	450
Advertising	1,450
Total variable costs	**17,280**
Total production costs	**24,247**

1. Labour is a fixed cost if workers are employed full-time, but it is a variable cost if people are employed temporarily – e.g. for seasonal production
2. The loan of US$1762 is repaid within the first year

Table 7.2 Example of operating costs

Case study 7.3 Integrated finance and support

These women, who were considered poor five years ago, have proved that with well integrated government policies, subsistence agriculture can be transformed into viable small-scale food processing enterprises. One of the essential micro-finance policies that has contributed most to the success and sustainability of the enterprise is its 'credit-plus' approach. Under this approach the focus is not only on the provision of adequate and timely credit, but also a continuous effort to integrate credit with other developmental activities such as community organisation and development, skills and entrepreneurship training, financial management, and social mobilisation.

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Equipment	Cost (US$)	Mango chutney	Mango jam	Pepper sauce	Orange juice
Pulper	800	4	2		2
Steam kettle/boiler	3000	2	4	1	2
Blender	500			3	2
Liquid filler	300			4	6
Labelling machine	200	2	2	2	1

Table 7.3 Apportioning time usage (in hours) to equipment in order to calculate depreciation

Calculating costs becomes more complex in an enterprise producing a wide range of products such as chutneys, jams and sauces. Careful and detailed analysis is required, not only to cost individual products but also to decide which are the most profitable. Labour costs need to be timed and divided between different products. One worker may, for example, spend two hours on one product, three hours on another, one hour on a third and one hour on general cleaning in any given day. These times will need to be measured and fed into a calculation of person time per unit of production. Accurate product costing should not be regarded as an academic, paper exercise. It should be used to determine:

- Which products are most profitable
- If the product can match the prices of the competition
- Where, and how, savings can be made in order to reduce costs.

Enterprises that supply lower income markets or supply ingredients to commercial buyers, such as bakeries have little price flexibility as their customers are influenced by value for money. Enterprises selling foods to middle- and upper-class consumers have a greater pricing flexibility as sales are influenced by factors other than price (e.g., presentation and packaging).

7.2 Income and profit

The 'gross profit' is the difference between the income and operating costs. Income is calculated as follows:

Income = Selling price per unit x number of units sold.

Details of pricing products and calculating income and profit are given in *Opportunities in Food Processing, Volume 1*, Sections 7.3 and 9.3.

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NB: Entrepreneurs should not consider the gross profit as their own income

Profits belong to the business and owners should take a salary that is recorded as a business expense. When an owner takes large amounts of cash (e.g., to pay for a wedding or other family occasion) this disrupts the cashflow of the business and is a common cause of business failure. Profits should primarily be used to develop the business by, for example, funding advertising or promotion, developing new products or improving the skills of workers. While it is perfectly reasonable for the owners to increase their salaries if the business is doing well, this should be a carefully considered decision.

Case study 7.4 Income and profit

Mrs E and her family regard the business as profitable and they are able to use the profits to pay their children's school fees, supplement housekeeping and to embark on a building project. She can get a credit facility for the business from her bank but she is not keen on this because the interest rates are too high for a small business such as hers.

This is a really viable and profitable business. Mr K said: "When production is at its peak, with careful production and financial management coupled with good customer care, the company can make a profit of not less than 30%." This is considered very lucrative, especially after this young company has invested in equipment and machinery. He said: "The value of the land continues to appreciate and this has been one of the best business decisions I have made."

He has built the company's assets from his own resources. He has reinvested his profits back into the company and he is free from any bank interest, which is currently between 30–40%. He is often encouraged by banks to take a loan, but he has never been interested. He has good financial analysis tools and is able to determine cash flow, stocks, output, required investment, operating costs etc.

With current production of 20,000 litres of juice, the enterprise has a gross turnover of 12.4 million CFA (US$22,300) this year. After subtracting all costs, the owner obtained a gross profit of 1.86 million CFA (US$3,350).

The price that is charged for the product should therefore allow the producer, the distributors and the retailers to make an adequate profit. The operation of the business should be above the 'breakeven point' (*Opportunities in Food Processing, Volume 1*, Section 7.4), which is the minimum level of production

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that can enable the enterprise to make a profit. Breakeven point can be calculated as follows:

1. Calculate the contribution for variable costs per pack.
2. Subtract the value obtained from the sale price to obtain the 'unit contribution'.
3. Calculate the total fixed costs per year.
4. Divide the fixed costs by the unit contribution to obtain the annual production rate that will allow the business to break even.

Case study 7.5 Breakeven point

In the example of tomato sauce production (Case study 7.3), the contribution for variable costs per pack for production of 75,000 bottles per year = US$17,280/75,000 = US$0.230

Sale price = US$0.850 per bottle.

Unit contribution = sale price –(variable contributions) = 0.85 – 0.23 = 0.62

Total fixed costs per year = US$6967

Breakeven = fixed costs/unit contribution = 6967/0.62 = 11,237 bottles per year

When expressed as a percentage of production capacity (80,000 per year), the breakeven point = (11,237/80,000) x 100 = 14%.

In other words, the processor must operate at above 14% of the available capacity in order to make a profit.

7.3 Financial planning

A 'cashflow forecast' shows whether there is sufficient cash available to operate the business and an example is given in Table 7.4.

The data in Table 7.4 shows expenditure on stocks of crop and packaging materials leading to an accumulated negative cashflow of US$2,000 by April, but the losses were planned for and addressed by using the second loan. This shows both the owner and lenders that the business is under control and that the negative cashflow will cease (after 8 months). The data are also presented as a 'profit and loss statement', to calculate the net monthly profit before tax (*Opportunities in Food Processing, Volume 1*, Section 7.4).

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Month	J	F	M	A	M	J	J	A	S	O	N	D
Income (US$'000)	2.4	2.6	1.5	1.6	1.2+2.0[1]	1.7	3.1	3.2	3.5	3.7	3.7	2.7
Expenses (US$'000)	2.0	2.2	3.4	2.5	3.1	1.8	2.8	2.8	1.4	2.8	2.2	2.4
Cumulative gross profit/ (loss) (US$'000)	0.4	0.8	(1.1)	(2.0)	(1.9)	(2.0)	(1.7)	(1.3)	0.8	1.7	3.2	3.5

1. The second partner's equity of US$2000 was used in May

Table 7.4 Example of cashflow forecast for chutney manufacture

7.4 Managing finances

The three essentials to managing profitability involve:

1. Maintaining, or preferably increasing, income from sales by setting correct prices for products.
2. Controlling, or preferably reducing, costs.
3. Maintaining a positive cashflow so that the business can always meet its costs and obligations. This requires accurate bookkeeping.

Profitability depends on having other aspects of the business operating successfully, such as marketing and sales (Chapter 2, Section 2.3) and production planning (Chapter 6, Section 6.3).

Pricing products

Details of different methods for costing a product to determine its price are described in *Opportunities in Food Processing, Volume 1*, Section 7. Product costing for a small enterprise with a single product, such as banana chips, is relatively straightforward because:

- there are a limited number of raw materials
- only one production method and few items of equipment are used, therefore equipment depreciation costs are easy to calculate
- there is little variation in market prices for products.

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However, there are often limited opportunities for processors to control the price that they charge for products, because of competition from other processors. When a variety of products are produced, accurate costing enables the processor to find out which products are the most profitable and where expanded production would benefit the business. This can also show which products are the most expensive to produce and where costs could be cut. This method of calculating the cost of a product (based on production costs) is straightforward and suitable for most processors. The profit margin that is added to the production costs is determined by the amount of competition, any government price controls, and the demand for the product. If there are fewer competitors and hence more flexibility for pricing, the processor should decide the price that the market will bear.

Case study 7.6 Financial records

The company analyses financial records based on daily receipts and expenditure weekly, monthly, quarterly and annually. They are able to analyse their production costs to determine the selling price with a reasonable margin for profit. They minimise fixed costs as much as possible, assess cash flow, analyse sales, income, and expenditure accounts to prepare financial statements that show the position of the business including assets and liabilities. An annual budget and auditor's report are also prepared at the end of the year for the board of directors and the bank. All these financial reports help the company to monitor their financial plans. They are able to see the factors that the business can control and those it cannot, so that they can adjust effectively to make a profit and to stay in business.

Controlling costs

The main costs for fruit and vegetable processors are raw materials, labour and power charges. Of these, the raw material costs are the most important and these can be controlled in a number of ways:

- bulk purchase of crops during the harvest season when prices are lowest
- buying directly from farmers rather than from traders, preferably using a company-owned vehicle for transport
- fixing prices for crops through contracts with farmers
- price incentives to encourage farmers to supply high-quality crops.

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Details of the required quality of crops and contract farming are given in Chapters 5 and 6. Contracts also provide the opportunity to stabilise prices, which is important when raw material costs vary throughout the year. Other methods of cost control include:

- planning the work of production staff to ensure that they are fully occupied throughout the day, and training them to maximise their output and productivity
- creating or modifying recipes to reduce the amounts of expensive ingredients while maintaining the required quality
- reducing stocks of expensive ingredients, or materials that are likely to deteriorate quickly and result in wastage
- keeping records of inputs and relating these to the amount of products that are sold so as to identify changes in the efficiency of material usage in the overall processing
- monitoring yields by direct measurements to identify actual losses and opportunities for improvement.
- minimising debts and maximising credit.

The profitability of an enterprise also depends on the productivity of the workers and the equipment they use. Motivated workers with a loyalty to the business have the potential to greatly increase productivity. While the terms and conditions of employment and benefits given are important, developing a feeling of 'self-worth and belonging' is vital to encourage high productivity (Chapter 6, Section 6.4).

Some ingredients, such as spices, pectin and preservatives are very expensive and have a limited shelf life in tropical conditions. Good stock control that maintains minimum stocks but ensures continued production is important. It is also important to keep records on process yields (Chapter 6, Section 6.3). Reductions in yield due to careless workers negatively affect profitability. Finally, many fruit and vegetable processing enterprises use a lot of energy for heating. This energy must be used efficiently to minimise costs: boiler pipes should be lagged and a careful watch kept on wasteful use of energy. Power consumption can be controlled by ensuring that equipment is correctly set up and regularly maintained (Chapter 6, Section 6.3) and it is switched off when not in use.

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Case study 7.7 Managing debt and credit

"It is common for me to spend a lot of time and money recovering outstanding debts from distributors. All this is done through negotiation and patience. Delays in payments to suppliers are also common."

"We do not have problems of payment by wholesalers and retailers because we do not supply on credit. We always encourage wholesalers to pay by instalments into our bank account and the products are only supplied after full payment has been made. In the case of retailers they have to pay by cash."

"We have sales representatives in seven of the ten regions of the country. Our main problem is with debtors who do not pay on time. What we have done now is to supply on a cash basis or give two weeks' grace within which debtors should pay their bills. We also give discounts on products that are sold at the fuel stations and selected supermarkets. One of our policies is not to sell on credit if the customer has no credit record with the company."

The company has contracts with suppliers and it has a 90-day credit facility with an Austrian packaging company.

They are able to recover outstanding debts by reminder notes. In one bitter encounter they had to send one of their clients who owed them so much to court. It was such a gruesome battle that they hope never to be involved in such a mess again. To avert this, they no longer give a credit facility of more than two weeks to existing customers, while new customers on the have to pay cash on delivery.

Mr K keeps good records of debtors and creditors with constant monitoring and updating of his records. To avoid high default rates on payment of debts he usually sells on a cash basis, but has some concessions for long-term, faithful customers. For example, some wholesalers are given two or four weeks to pay for goods as a way of maintaining good customer relations. Customer complaints are addressed instantly through personal contact or by withdrawal of batch products if the problem is to do with product quality.

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Book-keeping

Accurate record keeping is needed to successfully price a product, keep control over production costs and cashflow and meet the requirements of local tax authorities. To calculate the profitability of the business, a processor also needs to know the level of assets in the business (e.g., cash, machinery, stocks of materials etc.) and any liabilities (loans, creditors, taxes owed etc.). These figures should be recorded using a 'balance sheet' (*Opportunities in Food Processing, Volume 1*, Section 8.2). Book-keeping should be regarded as an integral part of each working day and not as an 'extra chore'. All enterprises should keep records that allow easy analysis either by the owner or an accountant. Remember: the better the records, the easier the accountant's job and the lower the bill.

Case study 7.8 The importance of financial records

Mrs B produces a range of products including plantain chips. After many years in business she has recently started to keep records. She has received training from an NGO and, as she is illiterate, her daughter now helps her with record keeping. By local standards she is a very good businesswoman and makes good profits. She advises: "A good business person needs to be smart and record how much profit she makes every day."

Mrs Q learned the importance of good record keeping the hard way. She was very busy establishing both the business and a new hotel and failed to keep production records. Only later did she discover that her sauce business had been making a loss. She says records must be kept for each batch to determine whether the cost of production allows a reasonable profit to be made.

Common financial mistakes

In summary, some of the areas where processors tend to go wrong are:

- treating profits as their income, instead of paying themselves a salary (the profits belong to the business and should be used to develop it)
- failing to cost and price products correctly, so they do not make a profit
- poor record keeping, so they do not know if they are operating profitably
- over-spending or having a loan that is not repayable
- having too many debtors or creditors.

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Summary of the chapter

- ✔ Assess start-up costs and ensure that adequate finance is available before you start the business
- ✔ Obtain the necessary information for bank loans, suppliers' credit etc.
- ✔ Do not rely solely on loans; have your own money too
- ✔ Assess all production costs (fixed and variable costs) to calculate prices for your products
- ✔ Manage your finances well and make sure you always have a positive cashflow
- ✔ Keep records so that you know the financial position of your business at any time
- ✔ Examine all costs and find ways to reduce them
- ✔ Do not treat profits as your income, they belong to the business
- ✔ Try hard to get prompt payment from customers
- ✔ Estimate realistic start-up costs and put in place all finance before starting the business and incurring major expenditure
- ✔ Records of start-up costs should be kept as it may be possible to offset them against tax
- ✔ Make sure the enterprise maintains a positive cashflow and is in profit
- ✔ The division of costs in a multi-product enterprise can be complex. Seek advice so that you know which products are most profitable.

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Entrepreneur's checklist

- ❑ If you are starting a business, do you know what all the start-up costs will be?
- ❑ Do you have enough money or agreed loans or investment from backers?
- ❑ If your business is operating, do you know all your production costs?
- ❑ Do you know the profitability of the different products that you produce?
- ❑ Do you record and use financial information to plan the next steps in developing your business and check on profitability?
- ❑ Have you examined different ways to reduce costs?
- ❑ Are the prices for your products competitive and high enough to make a profit?
- ❑ Do you know what your income is going to be this week and whether you will make a profit? If not, why not?
- ❑ Have the business projections of expected income and expenditure over the longer term (quarterly and annually) been achieved?

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Appendix I

Bibliography and further reading

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Wood, B.J.B. (Ed), 1985. *Microbiology of Fermented Foods*. Elsevier, London, UK.

Packaging materials and labelling

Fellows, P.J. and Axtell, B. 2002. *Appropriate Food Packaging*. IT Publications, London, UK.

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Oti-Boateng, P. and Axtell, B. 1996. *Packaging, Food Cycle Technology Sourcebook*. IT Publications, London, UK.

Other books that may be of interest are:

Imani Development (Pvt) Limited in collaboration with Saasa, O., 2000. *Small-scale Food Processing Sector in Mozambique*. Technical Centre for Agricultural and Rural Co-operation (CTA), Wageningen, The Netherlands.

Imani Development (Pvt) Limited in collaboration with Saasa, O., 2000. *Small-scale Food Processing Sector in South Africa*. Technical Centre for Agricultural and Rural Co-operation (CTA), Wageningen, The Netherlands.

Imani Development (Pvt) Limited in collaboration with Saasa, O., 2000. *Small-scale Food Processing Sector in Zambia*. Technical Centre for Agricultural and Rural Co-operation (CTA), Wageningen, The Netherlands.

CTA also distributes the Agrodok series of books, in particular:

de Veld, Ad, 2000. *Marketing for Small-scale Producers*. Agrodok No. 26. Technical Centre for Agricultural and Rural Co-operation (CTA), Wageningen, The Netherlands.

Hygiene and quality assurance

Anon, 1992. *Export Quality: World Directory of Standardisation and Quality Assurance Related Institutions*. International Trade Centre/United Nations Conference on Trade and Development/General Agreement on Tariffs and Trade (ITC/UNCTAD/GATT), Geneva, Switzerland.

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Websites

For producers who can obtain assistance from a small business advisory service or an international development agency with access to the Internet, there are a large number of websites on fruit and vegetable processing. Many are commercial sites that sell equipment or ingredients, but some give recipes and information on how to make products. The following websites have useful information and good links to other sites:

CAB International: www.cabi.org

FAO has a number of links to relevant sites:

Agricultural Research Information System (AGRIS): www.fao.org/agris
Agricultural Network Information Centre. Includes AGRICOLA (AGRICultural On-Line Access): www.agric.org
FAO Catalogue on-line. Some with links to full text: www.4.fao.org/faobib
FAO World Agricultural Information Centre (WAICENT): www.fao.org/waicent

The following provide direct links to pages within the WAICENT site:

FAOSTAT, a wealth of statistical data on many agro-related topics: www.apps.fao.org
Information Network on Post-Harvest Operations (INPHO): www.fao.org/inpho
SCIRUS – for scientific information only: www.scirus.com
AGRALIN, Information sources in agriculture and related fields: www.agralin.nl/desktop
Technical Centre for Agricultural and Rural Cooperation (CTA): www.agricta.org

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Network of European Tropically and Subtropically Oriented Agricultural Universities (NATURA): www.wau.nl/natura/

Global Forum on Agricultural Research (GFAR). Information exchange and communication between national agricultural research systems, advanced research institutes, non-government organisations and international agricultural research organisations: www.egfar.org

Pesticide information site for Africa (in French): www.isysphyt.ci.refer.org

Association of African Universities: www.aau.org

Food Ingredient Technology Ltd: www.fit-ltd.co.uk

IDRC Books: www.idrc.ca/books

International Network for the Availability of Scientific Publications: www.inasp.info

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Appendix II

Institutions offering support to small-scale processors

The following institutions in ACP countries are able to provide advice and assistance dairy processing enterprises. These are in addition to those described in Appendix III of *Opportunities in Food Processing, Volume 1*.

Africa

Angola. Minieteno da industria, Rua Chequered Lukoki No. 25, 7 ander CP 594, Luanda
Tel: +244-233-7294
Fax: +244-233-2400
e-mail: inanorq@metangola.com

Botswana. Botswana Bureau of Standards, Plot 14391, Private Bag B 048, Gaborone
Tel: +267-316-4044
Fax: +267-316-41042
e-mail: infoc@hq.bobstandards.bw
www.bobstandards.bw

Botswana. Botswana Technology Centre, PO Box 0082, Gabarone
e-mail: scitech@botec.be
www.botec.bw

Democratic Republic of Congo. DRC National Programme of Nutrition, Kinshasa
Tel: +243-8-525-7861,
e-mail: fmekob@yahoo.fr

Ghana. Council for Scientific and Industrial Research, PO Box M20, Accra
Tel: +23-321-777-330 / 761-209 / 777-647
e-mail: csir@ghana.com
Web: http://www.csir.org.gh/

Ghana. Department of Food Science and Technology, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi
e-mail: foodtech@knust.edu.gh

Ghana. Export Promotion Council, PO Box M146, Accra
Tel: +233-21-228813 / 228-830
e-mail: gepc@ghana.com
www.gepcghana.com/

Ghana. Ghana Standards Board, PO Box MB245, Accra
Tel: +233-21-500-065 / 500-066
e-mail: gsbdir@ghana.com
http://ghanastandards.org/GSB_intro.htm

Ghana. Technology Consultancy Centre, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi
Tel: +233-51-60296 / 60297
e-mail: ustlib@libr.ug.edu.gh
www.knust.edu.gh/tcc/index.php

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Ghana. Suame Intermediate Technology Transfer Unit (ITTU), College of Engineering, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi
Tel: +233-51-21177
www.knust.edu.gh/tcc/index.php

Kenya. Kenya Bureau of Standards, PO Box 30016, Nairobi
Tel: +254-20-502-211-19 / 722-751-666
Fax: +254 20 609660 / 503293
e-mail: tomc@kebs.org
www.kebs.org/

Lesotho. Lesotho Standards and Quality Assurance Section, PO Box 747, Maseru
Tel: +266-22-317-454 / 320-659
Fax: +266-22-311-075 / 310-326
e-mail: lessqo@leo.co.ls

Malawi. Malawi Bureau of Standards, PO Box 946, Blantyre
Tel: +265-1-670-488
Fax: +265-1-670-756
e-mail: mbs@malawi.net
www.sadc-sqam.org

Malawi. Malawi National Laboratory, Biochemistry Laboratory, Lilongwe
Fax: +265-1-789-431 / 789-536/788-232

Mauritius. Mauritius Standards Bureau, Villa Road, Moka
Tel: +230-433-5051 / 433-5150
Fax: +230-433-3648
e-mail: msb@intret.mu
http://msb.intnet.mu/

Mozambique. National Laboratory for Food and Water Hygiene, Av 25 de Serembno, No 1179, 2 andar, Maputo
Tel: +258-1-325-178
e-mail: parruque@hotmail.com

Namibia. Namibia Standards in Information and Quality Office, Ministry of Trade and Industry, Goethe Street, Private Bag 13340, Windhoek
Tel: +264-612-837-111
Fax: +264-612-20227,
e-mail: ndishishi@mti.gov.na

Republic of Seychelles. Seychelles Bureau of Standards, PO Box 953, Victoria, Mahé
Tel: +248-380-400
Fax: +248-375-151
e-mail: sbsorg@seychelles.net
www.seychelles.net/sbsorg/

South Africa. Council for Scientific and Industrial Research/FOODTEK, PO Box 395, Pretoria 0001,
Tel: +27-12-841-2911 / 2663 / 3661,
Fax: +27-12-841-2185 / 4790 / 3865
e-mail: info@csir.co.za
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South Africa. South Africa Bureau of Standards, Private Bag X 191, Pretoria, 0001
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Glossary and acronyms

ACP	Africa, Caribbean and Pacific
Absorption	The soaking up of one substance into another
Blanching	A heat treatment by hot water or steam in order to inactivate enzyme
Additives	Any small amount in a recipe other than the main ingredients
Blend	To mix ingredients together
Breakeven point	The level of turnover at which all costs are covered
CCP	Critical Control Point
Case hardening	Development of an impervious surface layer on foods during drying that restricts the passage water and so slows drying rates
CDE	Centre for the Development of Enterprise
Conduction	Movement of heat through solid materials
Convection	Movement of heat through liquids or gases
CTA	Technical Centre for Agricultural and Rural Cooperation, The Netherlands
Emulsifying agent	A chemical that stabilises an emulsion and prevents it separating into its component parts
Enzymes	Natural proteins that can cause changes to the colour, flavour and texture of foods
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration of the USA
Ferment	To produce carbon dioxide and alcohol by the action of yeast)
FIFO	'First In First Out' system
Gelatinisation	Changes to starch during heating in water in which the cells burst and a gel is formed
GHP	Good Hygienic Practice
GMP	Good Manufacturing Practice
HACCP	Hazard Analysis Critical Control Point system of quality assurance

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High-acid foods	Foods with a pH < 4.5 that cannot support the growth of food-poisoning micro-organisms
Hygroscopic	Able to absorb moisture
KNUST	Kwame Nkrumah University of Science and Technology, Ghana
Large-scale processing	A business having more than 50 employees, and capital in excess of US$1,000,000
Low-acid foods	Foods with a pH >4.5 that can support the growth of food-poisoning micro-organisms
Medium-scale processing	A business with 16–50 employees, and capital of US$50,000–1,000,000
Micro-scale processing	A business with less than 5 employees and capital of less than US$1,000
Osmosis	A process in which water is removed from a food by immersion in a strong salt or sugar solution
Pectin	A carbohydrate, found in particularly high levels in apples and citrus peels, that forms a semi-solid gel and is used in jam making.
pH	Scale from 1–14 that is used to measure acidity; acidity < 6, neutrality = 7, and alkalinity > 8
ppm	Parts per million equivalent to mg per kg
Preservation Index	A formula, relating acidity and solids content, that allows prediction of the stability of pickles and sauces against spoilage
QA	Quality Assurance
Refractometric solids	Measurement of soluble solids (e.g. sugar) using a refractometer
Relative humidity	A measure of the amount of moisture in air
Small-scale processing	A business with 5–15 employees, and capital of US$1,000–50,000
Smoke point	The temperature of oil when a blue smoke haze forms above its surface
Sodium metabisulphite	A chemical preservative effective in the control of yeasts
Sulphiting	Treatment of a food with sulphur dioxide in the form of sodium metabisulphite
Sulphuring	Treatment of a food with sulphur dioxide gas generated by burning sulphur
UNCTAD	United Nations Committee on Trade and Development

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