Setting up and running a small-scale cooking oil business

Opportunities in food processing

a CTA series

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The Technical Centre for Agricultural and Rural Cooperation (CTA) is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU). Its mission is to advance food and nutritional security, increase prosperity and encourage sound natural resource management in ACP countries. It provides access to information and knowledge, facilitates policy dialogue and strengthens the capacity of agricultural and rural development institutions and communities.
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Preface

This handbook is the result of a collaborative effort by small business owners and advisers of small-scale food processors in ACP countries. The effort was 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 oil processing enterprises and prepared reports that were then edited by Midway Associates. The oil processing specialists John Wegrzyn, Dave Harcourt and Tony Swetman reviewed the draft publication and made valuable contributions to the text from their own perspectives.

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.

About the authors

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Linus Gedi has experience in agro-industry and particularly in post-harvest technology. Before becoming a consultant he was first a tutor and then Principal at Ilonga Agriculture Training Institute in Tanzania. For the past 25 years he has worked on various consultancy assignments, ranging from planning primary crop production, handling, storage and marketing of food products, project appraisal and evaluations. His commodity expertise includes cotton, cashew, sisal, oilseeds, grains, fruits and vegetables, beverages, fishery and meat products. From 1996-2003 he worked as the United Nations Industrial Development Organization (UNIDO) National Expert in food technology, training entrepreneurs and trainers and helping them set up small enterprises that achieve high quality production and a cleaner environment. Since 2004 he has been a consulting food technologist with the Small Industries Development Organisation, involved in training, promoting/ supporting SMEs to invest in agro-food processing and ensuring the produce quality and safe food products. He sits in various national and private advisory bodies on food and agro-industry. He is Director and Chairman of Traceability (T) Ltd, a private company that is involved in traceability and quality issues for the food industry.

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Dr (Mrs) Peggy Oti-Boateng is the Director of the Technology Consultancy Centre (TCC), of the College of Engineering, Kwame Nkrumah University of Science and Technology and provides leadership in achieving the vision and mission of TCC as a centre of excellence for research and innovation, technology transfer, consultancy and entrepreneurship. She has over 26 years' professional experience in teaching, R&D and consultancy in Nutrition and Food Technology with a passion for development, monitoring and evaluation of innovative systems for the promotion of sustainable healthcare and industrial and socio-economic growth and mentoring young scientists and engineers. She has expertise in design and transfer of:

- Technologies for the establishment of small scale enterprises for economic empowerment and job creation for rural communities;
- Development of initiatives for the commercialisation of farmer-based organisations and community-based nutrition promotion for children and women and;
- Graduate entrepreneurship development.

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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 oil processing business - with each different aspect covered in separate chapters. It is intended to be read alongside the first publication in this series: *Opportunities in Food Processing, Volume 1 - Setting up and running a small food business*, which gives further information on wider aspects of food processing.

Whether you want to start a new business or simply want to improve your existing operations, we suggest that you read both books and make notes on what you need to do in the space provided at the end of each chapter in the **READER'S 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. If an area of your operation is posing a particular problem, we recommend that you first read the relevant chapters in both books and act on the recommendations. There are a number of ways in which you can use this book to help you grasp the main points in each subject area.

First, you can look at the **TIPS FOR SUCCESS** at the start of each chapter. These provide ideas for improving a particular aspect of your business.

Next, important points and ideas are highlighted in the text using a bar symbol.

There is a **SUMMARY** of the most important aspects at the end of each chapter.

CASE STUDIES can be found throughout the book, providing real-life examples of how small-scale oil processors have overcome various problems they have met in their day-to-day operations.

Finally, 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.

Introduction 1

In most ACP countries, cooking oil has a high demand and a high added value, which makes it a suitable product for small-scale processing operations. The high added value means that a relatively small amount of oil can be produced to earn a reasonable income. The common types of cooking oil that are processed at a small scale are shown in Table 1.1.

Type of crop	Cooking oil	Speciality/ non-food oil
Almond		✔
Argan	✔	✔
Avocado (dried fruit)	✔	✔
Babassu palm kernel	✔	
Cashew nut		✔
Coconut flesh	✔	
Copra (dried coconut flesh)	✔	
Cotton seed	✔	✔
Grape seed		✔
Groundnut	✔	
Hazelnut		✔
Macadamia nut		✔
Maize germ	✔	
Marula	✔	✔
Melon seed		✓
Mustard seed	✔	✔
Olive	✔	✔
Palm fruit	✔	
Palm kernel	✔	
Pumpkin seed		✔
Rapeseed	✔	
Safflower seed	✔	
Sesame seed	✔	
Shea nut	✔	✔
Soybean	✔	
Sunflower seed	✔	

Table 1.1. Types of crops used to produce cooking oils, speciality oils and oils for non-food uses

Scales of business operation can be defined using numbers of employees and level of investment as shown in Table 1.2. There are four scales of businesses: micro-enterprises, small-scale enterprises, medium-scale enterprises and large-scale manufacturers. This book describes the important aspects of running a micro-, small- or medium-scale cooking oil business. These aspects include finding and developing suitable markets, preparing a feasibility study, selecting equipment, choosing a site and setting up the premises. Details are also given of the different technologies that can be used for extracting cooking oils; methods of processing and quality assurance, and managing finance and business operations. The case studies provide practical examples showing how others have built successful businesses making cooking oil.

Scale of business	Employee numbers	Capital investment ($US)
Micro-scale	Less than 5 employees	Less than $1000
Small-scale	5-15 employees	$1000-50,000
Medium-scale	16-50 employees	$50,000 - 1,000,000
Large-scale	More than 50 employees	More than $1,000,000

Table 1.2. Definitions of scales of oil processing businesses

Cooking oils are also used to make soap, hair oils and skin creams, both for use in ACP countries and for export. There are also a number of speciality cooking oils (such as organic virgin coconut oil, brazil nut oil, organic certified extra virgin avocado oil and argan oil) that have a limited demand in ACP countries, but are exported to industrialised countries, often to 'Fair Trade' organisations (see Annex D). These oils, together with starseed, flaxseed and safflower seed oils, may also be used as health supplements. These products are beyond the scope of this book, but sources of information are given in Annex B. There are also products known as 'essential oils' or essences (e.g. oils made from aniseed, bergamot, chamomile, sage, hyssop, juniper, lavender, mandarin, peppermint, sandalwood, tea tree and thyme), which are used both in aromatherapy and cosmetic products. These oils are produced by different processes to those used for cooking oils and they are not included in this book. References to their production are given in Annex B.

The establishment of a small-scale cooking oil business requires very careful consideration, as there are several important factors to take into account, some of which may limit its viability:

Crop supplies

Most oil-bearing crops have a short harvest season. This means that processors may have to buy crops for the entire year's production and properly store them until they are processed. This requires sufficient warehouse space and more careful production and financial planning than some other types of processing. It is also necessary to properly store crops, both to prevent spoilage and financial losses, and to prevent the growth of moulds, some of which can produce poisons that contaminate the crop. In addition, there can be unpredictable supplies and large variations in prices for the raw materials. This is because crop yields vary considerably according to the weather, rainfall patterns, and plant diseases.

> Control over raw material supplies is one of the most important factors that affects the ability to continue production and the profitability of an oil processing enterprise.

Other factors that were identified by a researcher in Tanzania are summarised in Case Study 1.1.

Case Study 1.1: Factors affecting the operation of small oil mills

Sunflower oil production has great potential in Tanzania because of the availability of the raw material and the growing market for sunflower oil in the country. SMEs that are involved in sunflower oil production have the challenge to increase production of good quality, safe oil for consumers who are becoming more health conscious. The challenges to increased performance of enterprises include:

- Availability of affordable credit for financing investment and working capital.
  Enterprises need to upgrade their technology, but also to improve the equipment, layout and plant sanitation.
- Fluctuating production of sunflower seed affects its availability. This is because production is rain-dependent and hence raw material prices fluctuate with changes in seed availability, also affected by competition from buyers that export the sunflower seeds.
- There is a need for training in production management and quality assurance to ensure the quality and safety of products. There is also a need for better training of enterprises in business planning and marketing.
- The quality and availability of packaging materials is a challenge. At present, products are packaged in generic (common) plastic containers that have many other uses. There is need to customise the packaging to create a brand identity for each of the producers.

Economic factors

Although cooking oil has been produced using traditional technologies for millennia in many areas, these processes are often very slow, extract a small percentage of the available oil, and use a considerable amount of energy for heating. Improved extraction technologies can increase oil yields, reduce fuel consumption and enable higher production rates. However, the local economic situation is very important, and the viability of improved technologies in one economic context does not ensure that it can be achieved in a neighbouring country - or even a neighbouring community. The success depends on the processors' ability to pay for the improved technology, and having facilities for local maintenance and repair of equipment. It especially depends on the value that can be added to crops by processing, the skills of the processor to make good quality oil, and to manage the enterprise effectively. In some areas, sales of oil alone are not profitable and it is the contribution to income from oilcake by-products that makes the overall business profitable.

> It is necessary to look closely at each individual situation to decide whether small enterprise.

Demand for refined oils

In many ACP countries, the majority of people, especially in rural areas, prefer the taste of traditionally produced unrefined oils, whereas more wealthy urban consumers and commercial customers such as bakeries and food service outlets (see Chapter 2, Section 2.2) have a greater demand for refined oils that have a blander flavour. The refining stage is more difficult at a small scale of operation and this may limit the ability to supply the refined oil required by these customers.

Competition from large-scale producers and imported oils

In many ACP countries, large-scale factories produce cooking oil more cheaply than small-scale producers and these companies may also have large advertising budgets, which make competing against their products more difficult. Aggressively marketed, low-cost and attractively packaged oil can be a serious threat to the survival of small-scale producers.

Cooking oil is one of relatively few foods that is traded internationally on a large scale. Worldwide production of cooking oils has increased dramatically in the last 50 years, but the biggest increases have been from temperate crops, where economies of scale have favoured the competitors of ACP producers: Brazil and the USA are the world's main soya producers, Canada and EU countries produce rapeseed, and Malaysia for oil palm in vast plantations. In the face of this competition, small-scale farmers and modestly sized estates in ACP countries find it difficult to compete. Tropical crops such as coconut, sunflower and groundnut now have about half of the world market compared to 50 years ago. Several factors have led to the decline of vegetable oil production in the tropics in general and the ACP countries in particular. Coconut and oil palm harvesting are labour-intensive, whereas soybean and rapeseed harvesting are highly mechanised. Soybean and rapeseed oil are also produced under policies that support farmers in industrialised countries, and these oils have been sold at prices below the cost of production of tropical oils. The pressure to liberalise trade and open home markets to foreign competition have resulted in subsidised low-cost imports at the expense of ACP farmers and processors (although the low prices may benefit ACP consumers). As one researcher for this book noted: "The company was vibrant and did well until 2007, when a change in government policy to open door importation of cheaper oils created unfavourable competition for local production". Lack of investment in plantations and processing plants in ACP countries has also resulted in reduced yields, quality and productivity. In addition, the large scale importation of cooking oils by relief agencies for feeding programmes and dumping of cheap oil from industrialised countries can undermine the market for locally produced oils.

Case Study 1.2: Competition from imported oils

The edible oil industry in St. Vincent and the Grenadines was once a thriving concern, with several estates supplying the raw material (dried coconut kernels) to several factories and was an exporter of coconut oil up to the 1980s. However, the increasing importation of cheap soybean and other vegetable oils, coupled with misleading claims about dangers of coconut oil and rising raw material costs, eventually led to the collapse of the industry in the late 1980s. The last factory at Arnos Vale closed its doors around 1982 and was dismantled, making way for a supermarket car park.

Policy environment

The ability of small-scale processors to profitably produce cooking oils depends in part on the policies adopted by their government. ACP governments can have different policy agendas that have an impact on the success of small-scale oil processing. For example, where the policy is to generate foreign exchange earnings, the government may support the establishment of a large-scale centralised oil production factory to produce refined cooking oil that is suitable for export. Producer prices may be kept artificially low in order to compete in international markets. Under this type of policy environment large scale oil refiners take advantage of a monopolistic control over oilseed supplies and pay lower prices to farmers. Inevitably, some of this refined oil is sold locally in urban shops and supermarkets, where it meets the needs of the urban population and competes with unrefined oils produced by small-scale producers. In these situations, rural oil producers can find it difficult to compete because their traditional techniques are more labour intensive and inefficient.

There may be other reasons, such as wider socio-economic benefits, for establishing a small oil processing business, in addition to generating incomes for the owner and employees. For example, in many ACP countries large oil processors do not address the demand for oil in rural areas, where customers typically buy it in small amounts. A small-scale rural oil business can meet this demand, and can also create additional benefits to rural populations, while operating profitably (see Case Study 1.3).

Case Study 1.3: Benefits of small-scale oil processing

In Zimbabwe, the oil market was dominated by four major producers, based in urban areas but failing to supply rural communities. Given that the oilseeds are grown in the rural areas, and that a market exists there, it made sense to look into decentralised oil production.
Small-scale mills are commercially viable, returning an annual average of 51% on typical investments of between US$ 17,000 - 22,000, with profits of 21% on sales.

The socio-economic benefits of the mills are also significant:

> A typical mill employs ten people on a permanent basis and three temporary workers with an average monthly income that is two and a half times the rural average.

> The mills offer a ready cash market for sunflower crop. A typical mill buys several thousand dollars worth of sunflower per year from six hundred and fifty farmers.

> Other beneficiaries are schoolchildren who collect bottles for recycling, fuelwood suppliers, and (local) maintenance workshops that repair the mills. These amount to a further twenty five beneficiaries, earning several hundred dollars per year from a mill.

> Benefits accrue to the community through cheaper oil of high quality. Typically the sunflower oil is cheaper than the refined blended oils produced by the major four oil companies. It is estimated that several thousand dollars worth of benefits are shared between an average of 732 households per mill, through lower costs
(From Whitby and Sunga (1995) in Annex B).

- The enterprise is among the largest producers of palm oil because of its production capacity and the quality of the oil it produces. In addition, it helps to alleviate the problem of unemployment because it uses a lot of manpower in the region.
- The Oil Mills Co-operative was originally a collection of eighty women who processed palm oil using laborious traditional oil extraction methods. In the District Assembly's efforts to enhance palm oil production, increase productivity, and increase income generation for women, it sought technical and financial assistance for the women through technology upgrading and credit provision. An NGO came to their aid.
- The business is recognised as the best producer of palm oil in the town because of its high production capacity and the quality of oil that is produced. In addition, it helps alleviate the problem of unemployment because it uses a considerable proportion of manpower in the region.

If government policies are designed to increase oil consumption and improve the nutritional status of rural populations and low-income households, or to improve incomes to farmers, they are more likely to support small-scale processing. For various reasons, large-scale centralised oil producers cannot or choose not to supply low-cost oil to rural areas. This may be because of higher transport costs for oil distribution; the costs of refining and packaging the oil make it too expensive for rural or low-income households; or a high demand from urban supermarkets and/or export buyers who are willing to pay the higher prices. In this policy environment, small-scale oil producers can compete effectively to meet the demand from rural consumers for low-cost unrefined oil. This is because they have lower transport costs for moving crops to rural or peri-urban oil mills, reduced packaging and marketing costs by selling oil directly to local consumers or supplying retailers in re-usable oil drums. Large numbers of small-scale oil producers also create a more competitive market for crops, which benefits farmers' incomes and may encourage them to expand crop production. The availability of locally produced oilcake by-products also stimulates animal, milk and egg production, which can help improve the nutritional status of rural populations and/or increase incomes to farmers. Improved small-scale oil processing can therefore increase the availability of oil in the diet and generate income in rural areas.

Some countries have centralised and controlled agricultural marketing policies and pricing structures, which are designed to protect the incomes of poor farmers. However, if farmers are obliged to sell their crops to a marketing parastatal, this can increase the price of raw materials to oil processors because of the additional transport, storage and administration costs. In some cases this can make processing unprofitable, especially if the price of cooking oil is also state controlled.

Other uses for oils

Oil production for biodiesel is increasing in some ACP countries, which may reduce the availability of crops for cooking oil production, or increase the prices for raw materials and hence affect the profitability of small-scale operations.

Summary

In summary, there are many political and economic factors that affect the potential for success or failure of a small-scale oil processing enterprise, and many of these are very specific to individual ACP countries and even to regions within a country. It is therefore important for potential oil processing entrepreneurs to carefully assess their local situation before investing in the business to ensure that it can be profitable. Details of the factors to take into account are given in subsequent chapters of this book, which should be read alongside the companion publication: Opportunities in Food Processing - Volume 1: Setting up and running a small food business.

A fictional conversation below shows the type of answers that a new entrepreneur might give to some important questions about small-scale cooking oil production, and indicates the chapters of this book that contain the information to answer these questions.

Small business adviser	Potential entrepreneur	Aspect to consider	See chapter
Why do you want to start a cooking oil business?	Because I think people really want cheaper cooking oil	Market	2
Who else makes cooking oil?	My friend Amos	Competition	2
Where will you set up your business?	At home in the back yard	Premises	3
What equipment will you need?	The same machines as Amos has	Equipment	3
Where will you store the raw material?	I'll rent a shed	Crop storage	4
Have you thought about how much product will be in each pack?	I'll see what bottles are available	Packaging	5
Will the quality of the oil be OK?	Well I hope so	Quality assurance	5
Are the water and electricity supplies OK?	Sometimes	Services	6

How much oil will you produce?	Maybe as much 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 Amos	Experience	6
Have you been trained at all?	I told you, I watched Amos	Expertise	6
How much will the oil cost?	I'm not sure, but less than the price of oil in the shops	Pricing	7
Where will you get the capital?	What's that?	Finance	7

Marketing and selling cooking oil and by-products

2

Tips for success

The following tips were provided by successful oil processors in ACP countries:

- ✔ Think about who your consumers will be and select sales outlets that they will use. If you want to sell to institutions or other companies, get to know their buyers.
- ✔ Get to know the market and your competitors.
- ✔ Remember it is the final consumer not the shopkeeper who decides whether to buy your product.
- ✔ Target different types of market to spread the risk.
- ✔ Calculate the amount that you can sell per month and only supply quantities that will sell within the shelf life.
- ✔ Use promotions to help retailers sell your products. They want to make a profit too.
- ✔ Advertise using media that your customers will see and hear.
- ✔ Build a business image and keep it. Use the label to display the business logo and pay as much as you can afford for the label.
- ✔ Aim to please: customer satisfaction is very important for the growth of the business. Make sure that everyone in your business is focused on your customers.
- ✔ Handle complaints promptly to maintain your reputation.
- ✔ Keep a close watch on sales and be in regular contact with your key customers.
- ✔ Don't compromise on quality.
- ✔ Protect your brand. Unpredictable quality is a sure way to ruin your business.
- ✔ Consider having two brands: premium and budget if raw material quality is variable. It is better to have consistent second quality than top quality that is variable.
- ✔ Attend any local courses in order to improve your business.

- ✔ **Finally**: Read Sections 3.1, 3.3, and 9.1-9.4 in Volume 1: Opportunities in Food Processing - setting up and running a small food business.

2.1 Introduction to marketing and selling

Some oil processors confuse marketing with selling, but the two are very different. Marketing is deciding what to do to meet customers' needs and how to make a product more competitive. Selling is the action that results in a customer buying a product (e.g. taking telephone orders or visiting shops and taking orders, delivering to customers, selling from a factory shop, or bidding for a government supply contract).

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

A simple definition of marketing is:

> 'Seeing your product as your customers see it
> and doing something about it to make more money'

or:

> 'The management process that identifies, anticipates and satisfies customer requirements while making a profit'

The first definition emphasises the importance of getting to know what customers need, whereas the second definition emphasises that marketing is an ongoing process, rather than something that is done when a business first starts (see also Griffith (2002) in Annex B for further information). The marketing process is summarised in Fig 2.1.

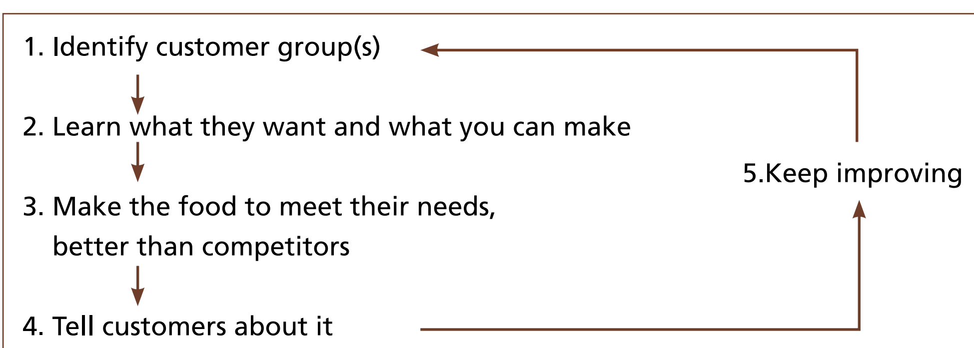


Fig. 2. 1. The marketing process (From Griffith (2002))

2.2 Market Segments

2

One of the first activities when planning an oil processing business is to decide who will be the target customers[1]. A Market segment is a term that describes an identifiable group of customers. The different types of market segments for cooking oils can be described in five main groups (Table 2.1):

1. Retail
2. Food service
3. Wholesale
4. Institutional, and
5. Food businesses.

Market sectors/Types of customer	
Retail	
Supermarkets	• Men or women • Children and young people • Rural, peri-urban or urban households • Wealthy or less wealthy families • People interested in 'healthy' foods • People with special dietary needs • Office or factory workers
Shops	
Kiosks	
From own factory shop	
Service (or 'custom') oil milling	
Food service businesses	
Tourist hotels/lodges	
'Fast food' outlets or take-aways	
Cafes, restaurants	
Street food vendors	
Wholesalers	
Institutional	
Schools	
Hospitals	
Military/police barracks	
Other food businesses	
Bakeries	
Snack food makers	
Street food vendors	
a)	b)

Table 2.1. a) Examples of market sectors for cooking oils, b) Examples of different types of consumer in retail markets

1 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. This is important when deciding how you want to sell the oil and who you expect the final consumers to be.

Wholesale, retail and food service markets

For most small-scale oil processors, the retail and food service markets are likely to be the most important in the majority of ACP countries. Within each segment in Table 2.1a, there are sub-divisions that may have different and specific needs. For example, in the retail sector, customers for oil may include owners of shops, managers of supermarkets, or street vendors who sell oil. For these customers, the marketing factors may include the quality of the oil, size of the pack, attractiveness of the label and value for money. However, the final consumers' perceptions are not just about price and quality, but may also include convenience, health or nutrition (Case Study 2.1). Producers should decide which factors are special for their product and emphasise these on the label or in their product promotion.

Case Study 2.1 Consumer perceptions

- In Tanzania there are indications of rising consumer demand for sunflower oil due to the growing health consciousness of consumers. Most of the consumers go for oil that is fresh and free from chemicals and other contaminants (i.e. pressed and filtered oil).
- Their main selling point is that consumers believe their oil to be high quality.
- The company has no established marketing plan but takes pride in the fact that it is well-known in the Ashanti region and people travel from around Asokore to buy their quality products either on wholesale and retail basis. They also sell to schools and individual consumers who visit the factory.

Retail consumers (Table 2.1b) are often women who buy oil to prepare family meals. However, women from different social or economic groups may have different requirements for a particular type of cooking oil, they may require a specific type or size of container, or have a maximum price. Hence they may buy oil at specific types of outlets: more wealthy urban consumers may use supermarkets located in large urban centres. These women may prefer to buy oil in larger bottles and use it over a period of time.

Women who have less disposable income, especially in rural areas, may buy a small bag or sachet of oil when they can afford it from a village shop or at weekly markets. Here, price is a main factor. In some countries, poorer people also buy oil from street vendors or hawkers who buy the oil in bulk and sell it in individual bags or ladled into customers' own containers. Although only a small proportion of people may buy oil each week, and the amounts that they buy are small, their large numbers in many ACP countries mean that the market size can be large (see also Table 2.4, market size).

> Consider having both a premium brand and a budget brand of oil to meet different consumer needs

In the food service sector, urban and peri-urban cafés, fast-food takeaways, restaurants and hotels are likely to buy oil in bulk, and price and reliable deliveries are more important than an attractive label when choosing a supplier. Other food service customers include producers of fried street foods (Fig 2.2) who may buy small amounts of oil each day. Their large numbers and wide geographical spread in towns, along main roads and in villages, means that this segment could be a large potential market for cooking oil producers.

Fig 2.2. Street food - fried banana chips (Photo: S. Babalola)

Institutional and industrial markets

In institutional markets, the segments may include people who buy oils to prepare foods in schools, in meals for patients in district hospitals, or for soldiers in military barracks. These customers are often professional buyers either at the institutions or at government ministries, and orders may be won by a competitive tendering process. The main factors of interest to these buyers are that they require oil to be delivered in bulk, at a low price, and with a proven ability to meet delivery requirements. Oil processors should therefore take these factors into account when deciding if this is a market sector that they can successfully target. Similar considerations apply to food company buyers (e.g. from bakeries) who buy oil as an ingredient for their products. Again, low price and the ability to meet bulk delivery requirements on time are their main requirements.

Case Study 2.2: Examples of choosing market segments

The company has been aggressive in marketing a range of its products and now has 5% of the vegetable oil market in Ghana. It sells to a number of individuals and large national and multinational companies both in Ghana and exports to other African countries, the EU and the US, for food processing, pharmaceuticals and soap making.

Mr R has a wide range of customers such as market women who retail the oil, local restaurants, paint producers, schools and individual households. He also sells to other oil refineries that blend the soybean oil with either groundnut or coconut oil for shallow frying in restaurants.

Mr B runs the only oil refinery in Kumasi and as a result offers services to other local oil processors that request refining of crude palm oil, coconut oil, palm kernel oil, sunflower oil, groundnut oil and shea butter. He has a good strategic marketing plan that is constantly being reviewed to make the company competitive.

The company produces unrefined soybean and groundnut oils for both the local and West African markets.

90% of groundnut oil and 80% of palm kernel cake are sold to the European Union.

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, medium and long term periods.

Markets for by-products

The only by-product that has a large market as human food is the oilcake produced after groundnut oil extraction. This is used by bakers to make groundnut flavoured biscuits, and as an ingredient in soups and stews in some ACP countries. All oilcake by-products are used as a component in animal feeds, including poultry rations and cattle feed. They are usually sold to animal farmers, either in sacks or in bulk without packaging. Other by-products from coconut oil production are shown in Chapter 6, Fig. 6.3, and by-products from palm oil processing are described in Chapter 4, Section 4.5. The sale of by-products can be very important and in many small businesses these sales make the difference between profitability and losses.

2.3. Market research

Market research is the process of identifying the most suitable market segments for a cooking oil business, and these may be within a local community or further afield. Many small-scale processors can identify local customers' needs by talking to them informally, but they find it more difficult to identify the needs of customers who are outside their community. To do this, processors need to gather information, both on the needs of the different types of customers and also on competitors. Getting this information involves conducting a *market survey* and also getting information from written sources, such as newspapers or trade reports (see also Section 2.4).

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. This is because they will then properly understand their customers' needs, who are the competitors, and how the markets for oil actually operate. If necessary, processors can get assistance from advisers or university marketing staff on how to conduct a market survey (see *Opportunities in Food Processing* Volume 1, Section 3.3).

A market survey is used to get information about who will buy the oil, when, where from, how much and for what price. Surveys can also be used to get detailed information on the quality that customers expect from the oil they buy. A convenient way of doing it is to use simple questionnaires (Tables 2.2 and 2.3) to ask a selection of people for their views on:

1) The product and its quality, and
2) Market size and value[2].

Product quality: Questions can focus on what are the things that customers like or dislike about existing products (either those of competitors or a producer's own products) or samples of a new product that a producer has made.

Question					
1 Which type(s) of cooking oil do you buy most often?	Write types of oil(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 oil you buy?					
2 What do you think about the taste?					
3 Is it clear 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 oil that you buy?	Write answers				
9 Is there anything else about the oil that you would like to see improved?	Write answers				

Table 2.2 Example of a consumer survey questionnaire on the quality of competitors' cooking oils

2 Market size is the total weight or volume of oil bought per month or per year, and market value is the amount of money spent on the product each month or year.

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 oil?	17	22	21	0	0	60
What do you think about the taste?	7	8	19	24	2	60
Is it clear enough for you?	7	10	22	21	0	60
Do you think that the quality is good for the price you pay?	2	8	20	21	9	60

Table 2.3. Analysis of a survey on the quality of competitors' oil

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 in Table 2.3, the answers show that 65% of people (17 plus 22 out of 60) found the colour of the oil to be good or very good, 43% (24 plus 2 people out of 60) did not like the taste of the oil, with some commenting that it tasted rancid (see Annex A) and 35% (21 out of 60) thought that the oil was too cloudy. Half of the people interviewed did not think the quality of the oil was good value for money. Results like these show that a potential market exists for a product having a better quality, or a similar quality that has a lower price.

Market size and value: A different set of questions is needed when assessing the size and value of a market for a particular product. Further information on how to calculate market size and value is given in *Opportunities in Food Processing* Volume 1, Section 3.3. Examples of calculating the size of a cooking oil market are shown in Case Study 2.3, 2.4 and Table 2.4 (see also dealing with competitors in Section 2.7).

Category of customer	Number in category	Purchases (Litres/month)	Total demand (Litres/month)
Low paid	20650	0.2	4130
Medium paid	768	2	1536
High paid	60	2.6	156
		Total	5822

5% of total market demand = 291 litres/month

Table 2.4. Calculating the size of the cooking oil market (Adapted from Potts and Machell (1993) in Annex B)

The numbers in each category in Table 2.4 are from official statistics and the amount of oil that each group of customers would buy is an average of the information from interviews with 50 households. Low income households preferred to buy oil twice per month in 100 ml amounts, whereas medium- and high-income households could afford to buy one-litre bottles of oil every fortnight. A realistic starting point for a small-scale producer is 5% of the calculated demand, which would result in sales of nearly 300 litres per month.

Case Study 2.3: Markets for cooking oil

The following are examples of markets that were described by small-scale oil processors in a number of ACP countries:

- In Tanzania, the enterprise produces sunflower oil in 1-litre and 5-litre containers, and more rarely in 20-litre containers that are demanded by groceries to dispense in small units of 50 - 100 ml to customers. The main sales outlets are groceries, wholesalers and individuals. Many of the customers collect their supplies at the factory gate. As yet there are limited threats from sellers of imported brands of oil. The clientele of this enterprise have the confidence that it produces pure sunflower oil, which is its main selling point.
- The company produces a variety of different oils and oil blends for both local and international markets.

- The market for sunflower oil is attractive in Dar es Salaam, especially among middle class people who associate the oil with health improvement. Buyers of the product are both retailers and wholesalers. The owners believe they are able to reach 10% of the sunflower oil market in Dar es Salaam and hope this will increase as they get more experience in the market.
- The group sells 540 litres of groundnut oil per month. Of this, about 320 litres are sold by the group members at the local market and about 210 litres are shipped to wholesalers in nearby markets at Bohicon, Abomey, Dassa, Dantokpa and Porto-Novo. Besides oil, the group also sells groundnut cake in these markets.
- The enterprise sells 1100 barrels of palm oil, each having a capacity of 200 litres, per year. The oil is sold to the wholesalers in Nigeria and in closer markets at Ikpinlè, Pobè, Sakété, Porto-Novo and Takon. Partly this is for cooking oil and partly for cosmetic companies in Nigeria.
- For many years the company has been aggressive in marketing its products and now has about 2% of the soybean oil market and 4% of the soybean cake market in Ghana. The company has plans to expand its business and increase its revenue by establishing a refinery.
- Demand is very high and for this reason, there is no competition between different palm oil producers. The enterprise sells 850 litres of palm oil per year in nearby markets. Oil is also sold to wholesalers in Nigeria.
- The company has not embarked on any advertisements or promotions, but relies on the quality of their product for their promotion. The products are sold in markets in Ejura, Agona and Asokore, with the Ejura market being used by buyers from Burkina Faso and Togo. The premium quality palm oil is sold to marketers who package it for supermarkets and for export; the medium quality is sold for local cooking oil and the low-grade oil is sold for soap making.
- Part of the production is for the cooking oil market in Benin and Nigeria. Another part is used by cosmetic companies in Nigeria to make soap. The enterprise also sells other products like palm nuts to palm kernel oil producers.
- The company has a large distribution network and sells on a wholesale basis to the armed forces, hotels, restaurants, shops, schools and hospitals.

Case Study 2.4: Calculating the size of the cooking oil market for hotels and restaurants

Interviews were held with 16 hotel and restaurant owners in the town and 10 (62.5%) said they would buy the oil at the stated price. Their demand for oil (per owner per month) was between 11 litres and 25 litres with an average of 14 litres per month. Using a telephone directory we found that the total number of hotels and restaurants in the town and surrounding areas was 148. Then we calculated the total demand for oil by multiplying: (Total N° owners) x (% who said they would buy oil) x (average demand per month).
This gave us the following demand = 148 x 0.625 (or 62.5%) x 14, which equalled 1295 litres of oil per month.

When interviewing retail or wholesale customers, market survey questions may include for example:

- Which types or groups of consumers buy oil from you?
- Which groups buy most oil?
- Which types of consumer pay the best prices?
- What characteristics do these groups of consumers share?
- Are there other similar groups of consumers that you know about?
- Have you considered selling to these other groups? If not, why?
- What do people currently buy? (i.e. what are the competitors doing?)

The more people that are interviewed in a survey, the more accurate is the information, 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.
Considering the information from market surveys on both product quality and market size and value enables an oil processor to make decisions about the way the business will operate to meet customers' needs. For example:

1. Who will be your customers (e.g. businesses, institutions, private individuals)?
   This allows decisions to be made on creating a product that has the flavour,

colour etc. required by the customers, developing an attractive package (packaging type and label design) and suitable oil quality. This also helps decide the types of advertising and promotion to use to reach the intended customers.

2. What are the average income levels of your intended customers and the amounts of oil that they buy each month?
   An idea of the importance of oil in total family expenditure allows decisions on setting a suitable price (pricing is described in Chapter 7), and producing and supplying a uniform quality product in the amounts required (deciding the size of the packs). It also allows decisions on the amount of production required per month, leading to decisions on the size of equipment required.
3. Where are your customers located (e.g. urban, rural, which towns, near to the production site?).
   This allows decisions on the geographical locations of sellers you choose to use or where to locate new sellers, the distribution methods to use and who will do the distribution. It may involve deciding how to negotiate with wholesalers, retailers, distributors, hotel and restaurant owners etc. who will sell the product (e.g. what to offer them that is better than their current supplier).

It is important to note that the success of an oil processing business is very site-specific, and other market-related information that may be important includes:

- Amounts of oilseeds already produced and who produces them (estates or smallholder farmers), is there an under-supply or over-supply of crops?
- How easily can customers be reached by road or rail or across borders?
- The amount of oil already available, including imported oil, products from large factories, small expellers in provincial towns and home production. Is there any under-utilisation of existing processing facilities or are there any processing constraints?
- How oilseeds are currently used, including the importance of other products (such as soap, cosmetics and biodiesel) and the amounts of oilseeds that are used by these producers.
- The effects of government policies, including subsidies, controlled prices, taxes, import restrictions and exchange rates, and the effect of any proposed or likely changes in policies.

2.4. *Marketing mix*

When information about who are the main customers, where they are located and how they buy their oil is added to information about the quality and price that consumers expect, the result is known as the *marketing mix.* This is often described as the '4Ps' - **P**roduct, **P**lace, **P**rice and **P**romotion. Examples of components in a marketing mix are described in Fig. 2.3 and further information is given in *Opportunities in Food Processing* Volume 1, Section 9.2.

Product	**Place**
Better quality Better appearance More attractive packaging Clearer labels More nutritious More varieties 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

Figure 2.3. Examples of factors to take into account in a marketing mix

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

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.

Product

Decisions by processors on how to sell their products, and to whom, are part of the marketing strategy. The simplest form of selling is from bulk containers into customers' own containers, or sales of packaged oil from a small 'factory shop' at the front of the processing unit. These methods can also result in the lowest cost for consumers, and may give a high profit for producers. Alternatively, a processor may make one range of oils that is sold in attractive bottles to wealthy urban consumers and another that is sold in drums to bakers or restaurants. 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 (see also Fig. 2.4).

Place

Each market segment may require different types of distribution: for example, in urban areas a processor may be able to supply supermarkets and shops directly from the factory, or use a wholesaler/distributor to supply more distant retail stores. Similarly in the food service sector, 'fast food' takeaways are mainly found in large urban centres, whereas hotels, restaurants and lodges are found in urban and peri-urban areas, or in rural areas that have tourist developments. These are often supplied by specialist wholesalers. In rural areas, retail distribution is via wholesalers or traders who transport oils to rural towns (together with all other goods that are sold in village shops). The owners of village shops and kiosks then visit the rural towns to buy stock, often using public transport. The method of distribution therefore also affects the type of packaging that is suitable for the different customers (e.g. bottles or bulk drums of oil).

Price

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 Fig. 2.4). As each seller requires a profit for handling, stocking or transporting the foods, it is clear from Fig. 2.4 that the less direct routes from producer 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 institutional buyers or wholesalers that have control over a large part of the market. Distributors may add a higher percentage than other groups to account for the high transport costs in most ACP countries, whereas street traders and kiosk owners usually have the lowest profit of any group.

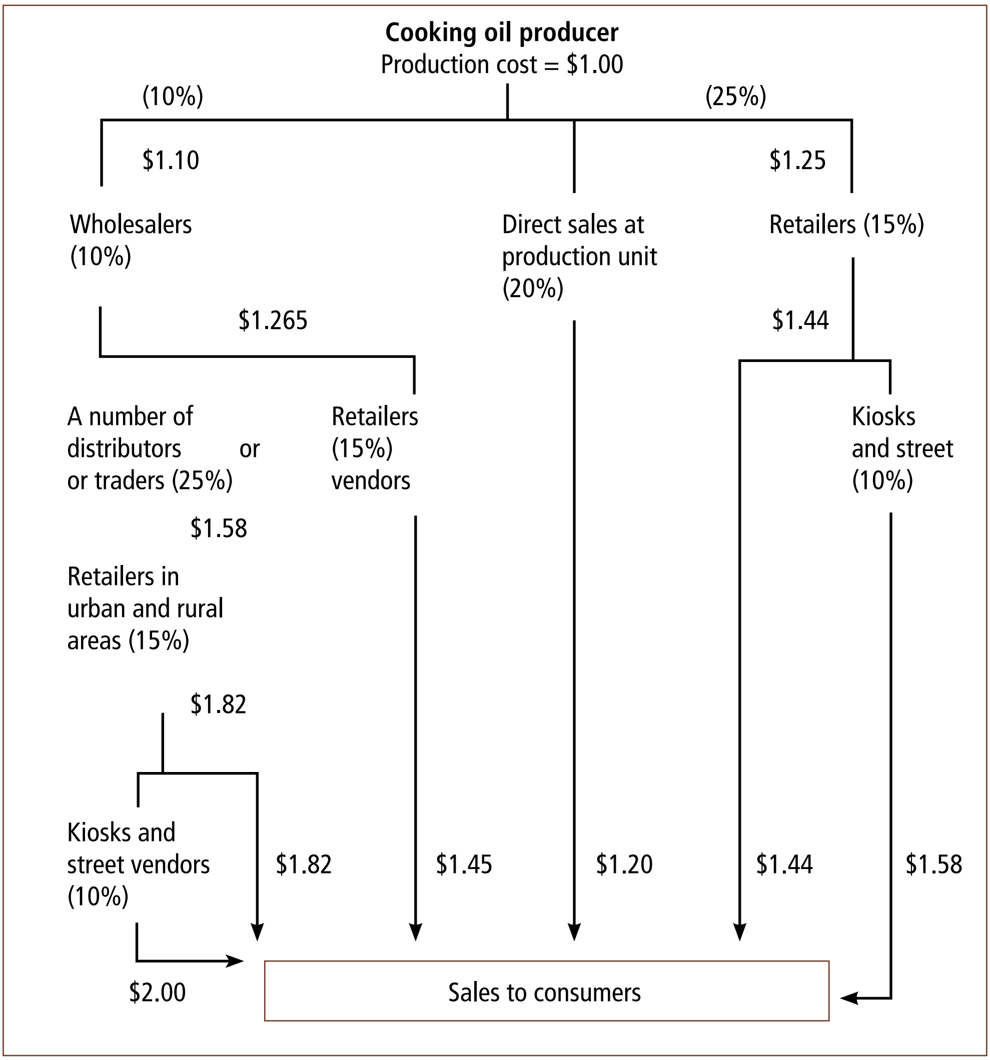


Figure 2.4. Examples of sales routes from a cooking oil producer to the final consumers
Percentage figures are profit at each stage; prices are unit sale price to each group

Case Study 2.5: Direct selling

Customers buy the oil with their own containers. The producers store their processed oil in plastic containers while awaiting retailers and wholesalers. Villagers visit the oil mill and Mrs L measures out the oil into the bottles that they bring.

Promotion

The types of promotion that are available to oil producers are as follows (in order of cost, with the cheapest first):
- Personal contacts.
- Feature articles in newspapers, magazines and trade journals.
- Free samples or special promotions in retailers' shops.
- Posters and leaflets.
- Signboards.
- Participation in trade fairs.
- Adverts in newspapers, magazines and trade journals.
- Adverts on radio and television.

The types of promotion that are selected are different for each market segment. For example, rural customers are unlikely to have access to television, radio or to newspapers. Posters or signboards in villages and special leaflet promotions in village shops are likely to reach more people. In urban retail markets, personal contacts with shop and supermarket owners, cooking demonstrations using the oil, free samples or in-store promotions may be more effective. If a radio, television or printed advertisement is considered, it is important that it addresses each of the following questions:
- Who do you want to see or hear the advert? (use different adverts for different target groups).
- How will you attract their attention? (e.g. bold colours or photographs on printed materials, a catchy tune on radio or television, or using a well-known musician).
- What do you want them to learn about the product or the company? (e.g. what is new, different or special? Is there a special low price offered for a

limited time, a prize competition etc.?).
- Where will they see or hear it? (e.g. at home via newspaper or radio, or reading posters in shops).
- When is the best time for them to receive the message? (e.g. before or after pay day).
- What do you want them to do next? (e.g. if you want them to buy the product, tell them where, if you want them to contact the company, tell them how to).

Case study 2.6: Promotion and advertising

The following are examples of promotion used by small-scale oil processors in a number of ACP countries:

- They often participate at trade fairs and this is probably their major effort to advertise their product. It appears the driving force for participation at trade fairs is to be able to sell their products and become better known.
- Once, in 2008, the enterprise sponsored a local football tournament and results were not bad because there was a message to many more customers that they were producing high quality sunflower oil.
- Currently they depend on door-to-door promotion to retailers.
- The company paid for posters to be printed advertising its products. These are on display in all the retailers in the town.

2.5. Packaging and brand image

The appearance of a package is the first point of contact between a retail consumer and the producer, and it is therefore part of the marketing strategy (this is less important in other market segments (Table 2.1) where bulk packaging is used). For retail sales, processors should decide on the image that they wish their products to have, and this is largely due to the type of packaging selected (see also Chapter 3, Section 3.5). The label is a very important way of creating an image. It not only gives 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 both the retailer and the final consumer. For example a well-designed label (Fig. 2.5) can convey an impression of high quality 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. In view of the importance of labels, producers should pay the highest price that they can afford to obtain the best possible quality of label.

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 Fig. 2.5.

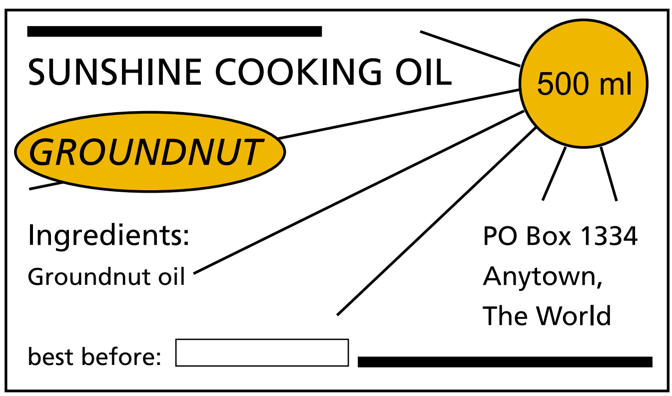


Figure 2.5. A simple design for a cooking oil label

Colour can be used to produce either a realistic picture (full colour printing) or 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 can have a direct effect on peoples' perceptions of the product. For example in some areas, browns and greens are associated with 'nature' or a natural product, and can convey an image of health and good quality. In others, bright oranges and yellows can either mean excitement, or cheap, low quality products.

A 'logo' helps consumers to identify 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*. When products are displayed in retail stores alongside those of competitors, including imported brands, the package and particularly the label has to compare favourably with the others before consumers will choose it.

> If first-time buyers are attracted by the package and enjoy the product, they will continue to buy the same brand and develop a loyalty to it provided that it has a consistent quality and it is affordable and considered to be value for money. These repeat buyers are essential to build up sales of a product.

In some ACP countries there are legal requirements on the design of the label and the information that is included (Chapter 5, Section 5.9). The following information is the minimum required on oil labels in most countries:

- Name of the product.
- The ingredients (i.e. type of oil). Normally nothing is added to the oil (see Annex A).
- Name and postal address of the producer (to allow consumers to return the product to the manufacturer in case of problems).
- Net volume of oil in the pack.
- A 'best-before' or 'sell-by' date (Note: 'Best-before' date means that the oil is safe to eat after this date but may have changes to its flavour. 'Sell-by' date is an instruction to retailers to take the product off the shelves after this date).

In addition, the producer may wish to include storage information or instructions on storage after opening, examples of recipes in which the product can be used, or a bar code for sales in larger supermarkets. To obtain a bar code, the producer should register with the local office of the organisation GSI (further information at www.gs1.org/barcodes/need_a_bar_code).

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 for a label. 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 minimum 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.

2.6. Customer care: how to find and keep customers

Many oil processors fail to realise how important it is to develop a good relationship with customers and to develop a good reputation for looking after them. There is no point spending money trying to get new customers if the existing ones are dissatisfied. The main concepts of customer care are:

> Every oil processor should recognise that their customers are the most important people in their business.

And:

> A business will only survive if its customers are satisfied with the product and the service and come back for repeat purchases.

To achieve this, oil processors must develop attitudes, ways of thinking and actions that reflect the importance of their customers, and they must focus on satisfying their customers' needs. For example:

- Talk to customers and find out what they like and dislike about the level of service you provide.
- Develop customer-orientated attitudes so customers feel valued when you deal with them.
- Make sure that all actions taken by your staff reinforce the idea that 'the customer comes first' or 'the customer is king'.

The two most common complaints by customers are that a processor supplied oil that did not meet the agreed specification, or that the delivery was not on time. All complaints should be dealt with efficiently, promptly and fairly; if a complaint is handled properly the customer is likely to respond positively and feel that their complaint has been taken seriously.

When a complaint is dealt with fairly, it can turn a problem into a benefit, and help develop customer loyalty.

Satisfied customers may also tell others about the treatment they have received and so generate new customers (and of course the opposite is true: if customers are dissatisfied with the way their complaints are handled, they may tell others not to buy from this processor again).

A dissatisfied customer is many times more likely to tell someone about poor service than a satisfied customer will talk about good service.

Further details are given in *Opportunities in Food Processing* Volume 1, Sections 9.1-9.3. Case study 2.7 gives examples of different approaches to customer care by oil processors.

Case Study 2.7: Customer care

The following are examples of methods used by small-scale oil processors in a number of ACP countries to take care of their customers:

- Feedback is mainly from customers, and is mainly to compliment them on the quality of the oil. Except for a few customers who complain of the 'sunflower' flavour. The enterprise consulted with experts on how to eliminate this, and now the problem has been reduced substantially.
- They are quite flexible and willing to respond to customers' needs. At present, they pack oil in 5 and 20 litre plastic containers, which are the most popular among retail customers. Occasionally, 1 and 2 litre packs are needed.
- The company maintains a very strategic close relationship with its customers. They regularly visit them and discuss how to serve them better. This close relationship and discussions on what could be done to achieve a win-win situation has helped a lot in maintaining a low rate of payment defaulters.
- Because of the high quality of oil, trust has been established between the enterprise and the wholesalers, and they deposit funds in advance before getting the product.

- The company has good relationships with customers by keeping in touch often and keeping customer complaint records. The owner said: "I believe that the customer is always right and I always try to ensure good customer relations". He is able to keep customers by producing and supplying high quality oil, timely deliveries and affordable prices.

2.7. Dealing with competitors

The actions of competitors are critical to the success of an oil processing business. If a new producer starts up in business, it is unlikely that the competitors will do nothing: for example, they may react by offering loyalty bonuses to retailers who continue to promote their products, or introducing special offers, reduced prices, or increased promotion. An oil producer should therefore be constantly aware of the changes that competitors make to their businesses in response to his or her actions and take steps to deal with the changes as they occur.

Oil processors should recognise that there are different types of competitors: producers that make different kinds of oil are known as *type competitors*, whereas different manufacturers of the same type of oil are *brand competitors*. The strategy for dealing with competitors is different in each case. For example, when competing against different types of oil, a processor may want to emphasise differences in flavour or provenance (e.g. organic, non GM etc.), or health benefits (see Annex A) of his or her products compared to those of competitors. However, take care with health claims; they must be substantiated. When competing against brand competitors who make the same type of oil, a more attractive label and/or price may be more effective. This is known as *product differentiation* and it involves finding something different about a product that will make customers buy it in preference to those of competitors. This can also involve additional benefits or services to customers, such as free delivery to shops or a special discount for regular orders. This will help to distinguish an oil processor from competitors and help to develop customer loyalty (see also 'Customer Care', Section 2.6).

Case Study 2.8: Competitors

- The main competitors in the market are local brands. There are also other imported palm oils that are sold cheaply and hence tend to be a threat to their products, especially among low-income customers. As a strategy to compete, the company had to slightly lower the price of their products.
- The demand for palm oil is very high. For this reason, there is little competition between different producers and they can all sell everything they produce.
- In 2008 the company cautioned the government to be careful of large imports of oil from South East Asia that could create unfair competition for the local market. This, as predicted, has adversely affected local edible oil processing and marketing in Ghana and more widely in West Africa.
- The main competitors of Mr B's company include multinational companies such as Unilever and he is aware that he cannot compete with them when it comes to packaging, so he sells oil in bulk containers of 20 litres or more for repacking in stores.

A convenient way for an oil processor to compare his or her business to those of competitors and decide how to deal with them is to use a SWOT analysis (**S**trengths, **W**eaknesses, **O**pportunities and **T**hreats). Details of how to do this are given in *Opportunities in Food Processing* Volume 1, Section 3.3. A SWOT analysis needs detailed information about competitors, and producers can get this information from the following sources:

Discuss sales of different brands with owners of sales outlets. Which products are getting popular and which are going down? What types of consumers buy particular products and how often? Does the seller put on any special displays for some suppliers? What do they think about a new product and do they think they will sell a lot of it?

Look at advertising and retail displays of competing producers and get a copy of their price lists.

Ask the local Employer's Federation or Chamber of Commerce for any information they have on the market for similar products.

Visit trade fairs and talk to other producers and their customers.

Look in trade journals, manufacturers' association magazines and newspapers for information about the market and the activities of competitors.

Case Study 2.9: Strengths and weaknesses

- Their major strengths are their physical location and their ability to produce good quality palm oil and palm kernel oil using high quality crops. Their weaknesses are due to being managed as a cooperative, which poses a number of difficulties with production, credit management and maintenance of equipment. They do not have unified pricing and marketing strategies and are always at the mercy of wholesalers and retailers who dictate prices for their products.
- The strengths of the business are the readily available supply of good quality crops and the new machinery. The weaknesses are the ever-increasing price of electricity and fuel which makes competition against imported oils ever more difficult.
- The location of the oil mill is in vicinity of a sunflower growing area and has a plant with adequate capacity, although they have not managed to fully utilise it yet. However, two weaknesses are being far from their major markets and the uncertainty of electricity supplies that affects production.
- The location of the plant in the vicinity of the target market (i.e. middle- and high-income consumers) is its main strength.

When the SWOT analysis is completed, an oil processor 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 compared to mine?
- What can I do to make a product that is better than those of competitors?
- What are competitors likely to do if I introduce a new product?
- Why would customers want to change in my product?
- What offers or incentives do competitors give to retailers or other buyers?
- Can I offer anything better?

It is important to be honest and realistic when doing these evaluations. Producers 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 it cannot make the planned sales and income, and is forced out of business.

Many small-scale processors who were interviewed for this book complained about the activities of 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. 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 genuine small-scale processors:

- Develop good relationships with customers, treat them with respect and deal with them honestly. Agree contracts with retailers/wholesalers and crop suppliers.
- Deliver what is promised and on time.
- Do not make false claims in promotional materials. Prepare a product guarantee that is written on the label and accept liability for any substandard products.
- Do not spread rumours about competitors.
- Find out from customers and trade associations what competitors are doing and saying.
- Identify competitors' strengths and weaknesses and use this information to be 'one step ahead' of them.

Details of contracts, product guarantees and product liability are described in *Opportunities in Food Processing*, Volume 1, Sections 4.1-4.7.

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.

Summary of the chapter

✔ Conduct market research to find information about what consumers want.

✔ Consider all types of markets for cooking oils (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 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 to those of competitors and emphasise the benefits in your product promotions.

✔ 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 focus on meeting their needs.

✔ Keep in regular contact with customers and make sure they are satisfied with your products and service.

Entrepreneur's checklist

❑ Do you know precisely what type of customers and consumers you are targeting?

....

❑ Do you know the size of the market, your share of the total, and how much it is worth?

....

❑ 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 package and label?

....

❑ Are your prices competitive?

....

❑ Have you got the most effective promotion and distribution to reach your intended consumers?

....

❑ How can you improve your promotion and reach more consumers?

....

❑ Do you know who your competitors are and what they are doing with their businesses?

....

❑ Have you done a SWOT analysis?

....

❑ What changes can you make to your business to improve customer care?

....

Reader's notes

Please use this space to write your own notes on Chapter 2.

Setting up production 3

Tips for success

The following tips were provided by successful oil processors in ACP countries:

- ✔ Choose a location that has good road access. If electrical supplies are not reliable make sure you have enough money to install a generator.
- ✔ Select a building that has enough space for workers to move around easily and not get in each other's way.
- ✔ Seal up any cracks in walls and floors and ensure that all windows and doors are insect-proof.
- ✔ Seek advice to find the best sources of equipment and packaging.
- ✔ Do not buy equipment that is too large if your sales are low. It is better to start small and increase the production capacity later when sales increase.
- ✔ Train operators to use equipment safely.

Finally

- ✔ Read Sections 5.1-5.4, and 6.1 in Volume 1: *Opportunities in Food Processing - setting up and running a small food business.*

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, Sections 5.1-5.3. In this section, the specific requirements for oil processing facilities are described in more detail.

Case Study 3.1: Getting started

- The enterprise is owned by Mr. K a former civil servant turned entrepreneur, who is also the sole director. It employs 20 workers and a manager who has 20 years' experience as a businessman. It started operations in 2002 processing sunflower seeds, with the seedcake by-product being sold as animal feed. He started the new business because of the success of other oil millers in the region, the presence of good varieties of sunflower, and a growing demand both locally and from other regions in the country. It took him 3 years to realise the investment from conception of the idea to start-up. At present, they have under-utilised capacity that they wish to optimise, but raw material supplies are limited.
- The enterprise producing sunflower oil is owned by Mr. Y who is the sole director of the company. The idea of starting an edible oil plant resulted from a search for income generating activities. The fact that sunflower oil prices were ever increasing on the market encouraged him to try this area of processing. It took about a year to make the idea implementable and the business started in January 2009. It is located 30 km north of Dar es Salaam and has three full-time employees. Funds for the investment were raised from sales of farm produce, another business that he undertakes.
- The enterprise is a private owned family business, with Mr. and Mrs. M as the shareholders. It is located 8 kilometres from the centre of Dar es Salaam city. It is a micro-business started in 2003, after the wife had attended a food processing course conducted by the Small Industries Development Organisation. The idea lived with her for at least two years, but once she had training she decided to start at a very small scale. With a ram press she can process a bag of sunflower seeds per day (in 8-10 hours) that yields about 18 litres of crude sunflower oil.
- Mr R is the owner and production manager of the oil mill. He is a Chartered Accountant by profession and while offering financial services to small- and medium-scale food processing businesses, he realised that small-scale oil processing was lucrative but there were very few practitioners. He studied the market and established his oil processing business in 1997. He realised that vegetable oil extraction and soap making are two major income generating activities for women in rural communities, but using traditional technologies is labour intensive and economically not viable. He therefore established a 500 kg/day oil processing business, which was later increased to two metric tonnes per day.

- Six years after conceiving the idea, the farm was established by the owner, who is a management consultant with a non-governmental organisation. His uncle has been a palm oil producer since 1984, which allowed him to receive some advice to set up his farm in 2000. He has received training from the Agricultural Research Centre to establish the palm oil plantation and develop oil extraction. He started with 1.5 Ha and currently the farm extends over 40 Ha of oil palm trees.
- He contacted the Technology Consultancy Centre of the Kwame Nkrumah University for training in oil extraction. He was leased an oil expeller to start a business producing 25 litres a day which increased to 200 litres a day in 1994. He also went to the USA on a study tour of food processing industries to investigate the possibility of linking into export markets for his products. He changed from a limited liability company to a Public Company by shares in March 2004 and registered it on the Ghana Stock Exchange.
- Mr B, the Managing Director, offers advice to those who want to go into an oil processing business: they must start at a small scale and grow; they must produce good quality products, competitively priced and delivered in a courteous and professional manner; they must secure for investors an optimum return on their invested capital; they must create an environment where staff are provided with the opportunity to develop their maximum potential; and the company should contribute to the welfare of the community in which it operates.
- The oil processing plant was set up in 1995 by an American NGO in collaboration with two Ghanaians. The cooperative had eighty members (60 women and 20 men) and has been in operation since then producing palm oil and palm kernel oil. The founding members received financial support for the building and equipment from the NGO through the Agricultural Development Bank and they were trained by the Technology Consultancy Centre. The Association was registered with the District Assembly as a farmer-based organisation in 2004 to benefit from micro-finance schemes. The cooperative was well managed until one of the founder members died and the other travelled overseas. This created a lot of anxiety since none of the group members felt competent enough to take up the management of the organisation. This resulted in a decrease in membership and currently the cooperative has about 50 workers who work independently using the common production facilities with their own capital.

3.1 Selecting the location

The best location for an oil mill is determined in part by the following factors:

- Closeness to the source of crops.
- Closeness to customers for both oil and oilcake by-product.
- Cost of transport.
- Local availability of services (especially electricity and equipment maintenance workshops).

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 less expensive. Also, the level of rent, cost of land and labour are generally lower in rural areas, and there may be more buyers of oilcake for animal feed compared to urban centres.

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

- Access to markets and the cost of distributing oil (e.g. dry season access only, especially if urban customers are the main market (Chapter 2, Section 2.2)).
- Ease of access for production staff (poor public transport, long distances down access roads).
- Damage to products, especially if glass containers are used for oil, due to potholes.
- Increased costs of supplies of spare parts for equipment and other materials.

In addition, the provision of services in rural areas is often substandard or intermittent. Electricity is required for some types of oil processing equipment, and if this is not available or reliable, there are additional costs of a generator plus the cost of transporting fuel to operate it. These are additional expenditures that would be less likely in an urban location. There are also potential marketing disadvantages of processing in a remote area, but these depend on the degree of customer contact required. For example, supplying customers through wholesalers can be handled from a remote processing plant, whereas direct sales to urban customers require a closer and more frequent contact. For the above reasons, many oil processors 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, closeness to buyers of animal feeds that use oilcake, closeness to urban customers for oil, better provision of services and maintenance workshops, and lower costs than urban locations.

Case Study 3.2: Choosing a location

- The oil mill is established on an acre of land 10 kilometres from Kumasi which makes it strategic for selling to market women and schools in the city.
- The choice to locate the plant 35 km from Dar es Salaam was very strategic. It is easy to transport the product to hotels on the beaches north of Dar es Salaam and also to cater to the growing number of middle- to high-income customers who are concentrating in the corridor to Bagamoyo 64 km north of Dar es Salaam.
- The enterprise is located on a farm and the main activity is production of palm oil from an oil palm plantation of 152 hectares. The enterprise also produces 'cake timber' by mixing palm kernel shells and palm fibres with mud to be sold as fuel, and the culture of oil palm trees.
- Initially the oil mill was set up in an old government shoe factory that was leased out when the government Industrial Holding Companies went bankrupt. As the company grew bigger, the management bought 4.5 acres of land on the outskirts of Kumasi to set up its refinery in 2007. Now it operates at two premises: the old factory which has a capacity of 50 metric tonnes of crude oil per day and the refinery which has a capacity of 10 metric tonnes per day.
- The main activity is the production of palm oil from its 20 Ha palm oil plantation. Mr K. inherited the plantation from his father and expanded it to include the processing plant in 1996.
- The location for the plant was selected because it is close to a lake, as palm oil production requires a lot of water.

3.2 Design and construction of the building

Although very small oil processing enterprises exist in some areas, operating from the family home, for most businesses there are a range of features that are needed in an oil processing unit, which means that a special building is required. The features required in all food processing buildings are described in *Opportunities in Food Processing* Volume 1, Section 5.1, and this section outlines the type of facilities that required for oil processing.

In general, a building for oil processing should have enough space for all production to take place without congestion, and for separate storage of crops, packaging materials, oil and oilcake byproduct (Fig. 3.1). The investment should be appropriate to the size and expected profitability of the enterprise, to reduce start-up capital, the size of any loans and depreciation and maintenance charges (see Chapter 7). A summary of the design and construction features of a small oil mil is given below.

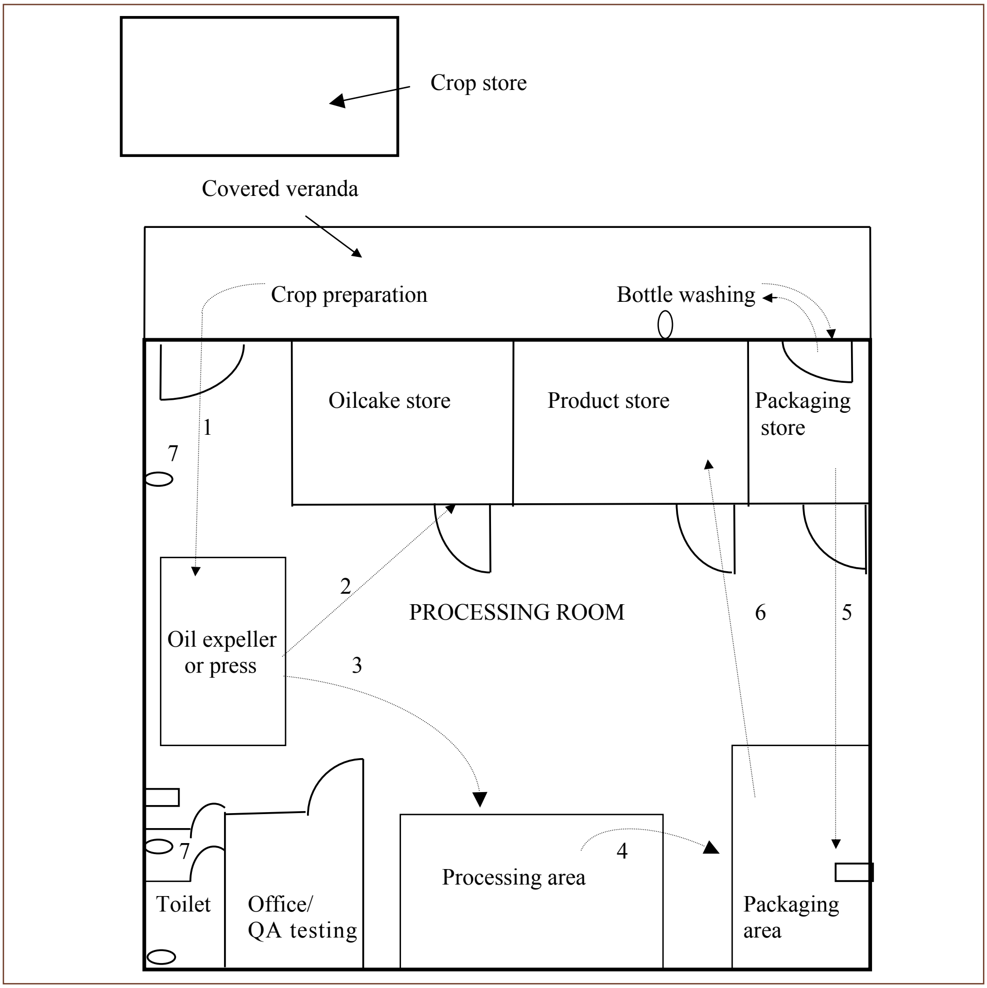


Fig. 3.1. Layout of a building for oil processing

Key:

1 Prepared raw materials in after cleaning/conditioning

2 Oilcake bagged and sent to oilcake store

3 Oil to processing area for temporary storage in oil tank and filtering

4 Filtered oil to packaging area

5 Bottles and cardboard box from packaging store

6 Packaged product to store for distribution

7 Hand washing

▭ = power point

⬯ = water tap

Roofs and ceilings

Fibre-cement roof tiles offer greater insulation against heat from the sun than galvanised iron sheets do. It is particularly important to make working conditions more comfortable when processing involves heating, for example in preparing groundnut flour, or heating oil to remove water. Alternatively, heating oilseed flour or oil can be carried out on a covered veranda to minimise problems of heat in the processing room. Panelled ceilings should be fitted to prevent contamination of products by dust falling from roof rafters, and there should be no gaps or holes in the ceiling that could allow rodents or insects to enter the room.

Walls

All internal walls in the processing room should be rendered or plastered so that there are no cracks that could harbour insects. High-level vents in walls, screened with mesh to prevent insects, allow heat and steam to escape and encourage a flow of fresh air through the processing room. The lower area of walls (to at least one metre above the floor), which is most likely to get dirty, should be either painted with waterproof white gloss paint or tiled with glazed tiles. In some ACP 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 can readily contaminate products and windows should therefore be fitted with mosquito mesh. This allows them to be left open and 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 room. Thin metal chains or strips of material that are hung vertically from the door lintel deter flying 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 or oilcake, and all storeroom doors should therefore be close-fitting and kept closed.

Floors

The floors of processing rooms and storerooms should be constructed using good quality concrete, smooth finished for easy cleaning, and without cracks that could harbour insects. The material should ideally be non-slip to prevent operators slipping in any spilled oil, and should not absorb oil (e.g. industrial glazed tiles).

Electricity

All electric power points should be placed high enough above the floor so that there is no risk of water entering them when washing the floor or equipment. Ideally, waterproof sockets should be used. It is important to use each power point for one application and not plug multiple machines into one socket, which risks overloading a circuit and causing a fire. Some types of oil extraction equipment require a three-phase power supply and this should be installed by a competent electrician, with the load evenly balanced across the three phases.

Water

Large amounts of water are required for some types of oil processing (e.g. palm oil and palm kernel oil) and a guaranteed supply is necessary. Where water is not piped, such as when a processing unit is located in a rural area, it is necessary to set up a supply for the unit (Fig. 3.2).

Fig. 3.2. Example of a water tower constructed in a palm plantation to supply a palm oil processing unit (Photo from J. Hounhouigan)

3.3 Layout of equipment and facilities

The different areas required for oil processing are shown in Fig. 3.1, and different stages in a process should be physically separated wherever possible. The layout shows how the raw material moves through the process and through the room without paths crossing, to reduce the risk of cross-contamination from crops to the product.

Toilets and hand-washing facilities 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 oil processing, although a separate table for conducting quality assurance checks or check-weighing bottles of oil (Section 5.7) should be located in the office or in a separate area of the processing room.

3.4 Selecting equipment

The types of equipment required for oil processing are described in Chapter 4. There are low-cost types of equipment for operation at a micro-scale (see Table 1.2) that are affordable to many individual entrepreneurs. The equipment for small-scale operations is more expensive but it is often within the range of more wealthy entrepreneurs, groups of people, or it can be purchased with a loan. Many small-scale entrepreneurs in ACP countries have little choice when selecting oil processing 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 it creates 'bottlenecks' and inadequate production rates if it is too small. Equipment should be the correct size for the intended scale of production (obtained from the feasibility study, *Opportunities in Food Processing* Volume 1, Section 3.1). Before buying equipment, an oil processor should calculate the required size (the capacity or throughput in kg or litres per hour) of each piece of equipment, which should be matched to the others. An example of how to do this is shown in Case Study 3.3.

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

Case Study 3.3: Calculating the size of processing equipment

The company produces 20 - 40 tonnes of unrefined oil per day and has the capacity to refine 25 tonnes of oil a day. However, due to irregular supplies of crude oil the refinery produces 10 tonnes of refined oil per day.
Currently the company has a crushing capacity capable of producing one metric tonne of crude oil per day during the peak soybean season using six expellers. However, the installed capacity is three metric tonnes per day. It is operating below capacity due to inadequate raw material supplies and the high cost of electricity to run all the machines.
They produce 110 kg of crude soybean oil and 850 kg of cake a day from 1000 kg of crop. Due to the irregular supply of soybeans the factory may produce for only four days a week.

Many ACP countries do not have local manufacturers of oil processing equipment and it must be imported. In some countries there are import agents in the capital city who can supply equipment. Information on equipment can also be obtained from overseas suppliers or manufacturers' associations, international development agencies, university food technology departments or trade sections in embassies of other countries. Development agencies and trade associations may allow access via their computers to the Internet to locate equipment suppliers. When ordering imported equipment, it is important to describe the specific application for which the equipment is to be used, and to specify the size (capacity or throughput), single or three-phase power supply, and the number and types of spares required.

Case Study 3.4: Finding suitable equipment

- Membership of trade associations has enabled the owner to share experiences between producers, and gives the possibility to purchase equipment together at reduced cost.
- The owner of the enterprise is a member of the cooperative of village agricultural producers. This association has allowed him to participate in meetings to exchange experiences among producers. He also benefits from the group purchasing equipment at reduced cost and from exchange trips.

All types of oil processing require basic equipment such as buckets, tables 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 wooden legs should be painted with gloss paint for easier cleaning. Scales are needed to weigh crops, oil and oilcake by-product. Ideally, two sets of scales should be used: one set of small battery-operated or mains-powered electronic scales (0-5 kg with an accuracy of +/- 1g) to accurately weigh bottled oil, and a second set of mechanical scales (0-50 kg with an accuracy of +/-200g) for larger amounts of crops and oilcake. It is also possible to calibrate scoops, jugs or other measures, so that they contain the correct quantity of material when filled level with the top. In production operations, scoops are faster than weighing, but operators should be carefully trained to ensure consistent measurements.

Because of the risk of causing rancidity in oils (Annex A), copper, brass or iron fittings, including nuts, bolts, washers etc., should not be used in any equipment that is in contact with the oil or crop. Only food-grade plastic, aluminium or stainless steel should be used. The principles of hygienic design and methods of construction for food processing equipment are described in Chapter 4 and in *Opportunities in Food Processing* Volume 1, Section 5.3.

3.5 Selecting packaging materials, filling and sealing equipment

There is a limited range of packaging materials that can be used to package oils in ACP countries. At the smallest scale of operation, oil processors may sell oil into customers' own containers or package it into sealed or tied polythene bags. These packs do not withstand damage if oil is to be transported to wholesalers or retailers. Glass or plastic bottles and pots are more rigid and fully sealable. Glass bottles are available in countries that have a glass-works, or an established import system. Because they are heavy and bulky, glass containers are expensive to transport long distances and because they are fragile, the level of breakages can be high on rough roads. Plastic bottles (Fig. 3.3) are becoming increasingly common because of their lower costs compared to glass. The 'PET' type plastic that is used for fizzy drinks is most suitable. Plastic pots are used less commonly for packing oils, usually when bottles are not available.

Fig. 3.3. Plastic packaging for cooking oil (Photo from L. Gedi)

Metal oil cans (5 - 20 litres) made from steel that is coated with tin are purpose-made for distributing oils (Fig. 3.4); the tin coating protects the oil from rancidity (Annex A). However, new cans are not widely used by small-scale oil processors because of their high cost, although they may reuse cans from imported oils. Processors sometimes use 50 - 200 litre steel drums (Fig. 3.5) to supply bulk buyers such as wholesalers or institutions. Where drums are used, there should be a system in place to return them for re-use. However, it is essential that all traces of old oil are removed before they are refilled because old oil will accelerate the development of rancidity in the fresh oil. Plastic (high density polyethylene) drums are a suitable alternative provided that the plastic is food-grade material (this is usually white, but processors should check with the supplier because some white plastics are not food-grade). Oils should not be stored in jerry cans made from coloured plastic that are intended for water. There may be pigments and softeners in the plastic that can dissolve in oil and produce an unpleasant taste (or taint) or even cause illness. However, in practice these are often the only available containers in some ACP countries.

Fig. 3.4. Oil cans used to distribute cooking oil
(Photo from Abrinsky)

Fig. 3.5. Oil drums of this quality should not be used to store and distribute cooking oil
(Photo from J. Hounhouigan)

Processors should contact local packaging manufacturers or their agents to find the types of packaging materials that are available in their area. Additional information that relates to specific products is given in Chapter 4, Section 4.5, and marketing aspects of packaging are described in Chapter 2, Section 2.5.

Case Study 3.5: Packaging

- There is a system for packaging oils into 5- and 10-litre bottles or 25-litre drums.
- The enterprise has limited capacity to influence which packaging material it uses, but so far the containers that are available have been satisfactorily used to contain and market the product. The choice of packaging materials is limited because there are only a few manufacturers of containers in the country, who mainly sell generic types that are used by many processors - not only those making food but also others who produce chemicals such as disinfectants, detergents and paints. These are plastic and contain 0.5, 1, 2, 3, 5, 10 or 20 litres. The choice of size depends on the market requirements for the oil.
- They package refined oils into 1, 2, 5 and 10 litre bottles as well as 25-litre oil drums.
- Mr S said: "Good quality packaging for oils is a challenge in West Africa. There is no industry producing printed polythene containers and no glass bottles. These materials are bought in Nigeria or Ghana. The same thing is true of packaging equipment. The problem we have is the quality of old bottles, which can break easily".

3

Bottle washing

In many ACP countries small-scale processors have to use recycled glass bottles to pack their oil. It is very important that bottles are inspected as they may have been used to store liquids such as kerosene or even pesticides. Any suspect bottles must be rejected. The next step is to wash the bottles with a detergent, either by hand or using a rotary bottlebrush (Fig. 3.6).

Fig. 3.6. Rotary bottle cleaning brushes (Photo from Sanbri)

A bottle washer (Fig. 3.7) is used to rinse detergent from the bottles. They are inverted over vertical pipes that are welded or soldered onto a larger base pipe, which is connected to a water supply.

Fig. 3.7. Bottle washer (Photo from P. Fellows)

Great care is needed to ensure that bottles are thoroughly dried before re-filling with oil. Any traces of water in the bottles will accelerate the development of rancidity. Both new and re-used containers should always be sealed with new caps, lids or corks to create an adequate seal that prevents moisture or air from contacting the oil during storage.

Filling

Bottles or bags are filled by hand at a small scale, using funnels to increase the speed of the operation. A higher filling rate can be achieved using a plastic or stainless steel bucket or tank that is fitted with several taps to allow simultaneous filling by different operators. It is important that the taps have 'gate' 'ball' or 'butterfly' type valves (Fig. 3.8) and not domestic taps, which are more difficult to clean properly.

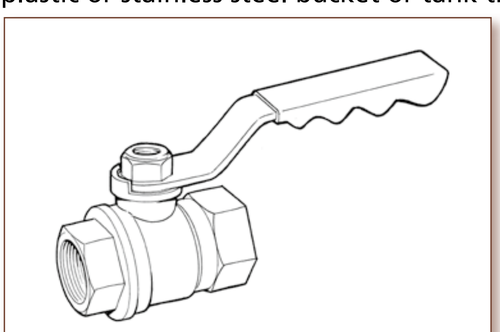


Fig. 3.8. Suitable valve for an oil filler

Filling by hand relies on the judgement of the operators to consistently fill the correct volume. Dispensers (Fig. 3.9) contain a piston that measures out the same amount of liquid into each container and so these do not rely on the operators' judgement. Small versions may be available at pharmacies in capital cities, but equipment to dispense larger volumes may need to be imported.

Fig 3.9a). Dispenser for filling oil - range 100 - 1000 ml, typically 600 bottles/hour. (Photo from Alan Brewis), b) Manual filler for filling up to seven bottles - the lever on the right moves the piston, centre (Photo from Franklin Murphy)

Sealing

Plastic bags are either tied into a knot by hand or using a simple applicator for adhesive tape (Fig 3.10). These methods do not fully seal the bag and there is a risk of oil leakage. A better seal is obtained using a heat sealer, fitted with a broad heating bar to produce a wide (3 - 5 mm) seal (Fig 3.11). These machines heat and press the two edges of a plastic bag to melt and weld the two layers together, thus fully sealing the bag. It is important that there are no smears of oil on the inside of the bag where the seal is to be made, as this will prevent a proper seal from forming. The sealer should have a thermostat to adjust the sealing temperature, and an adjustable timer to control the time of heating.

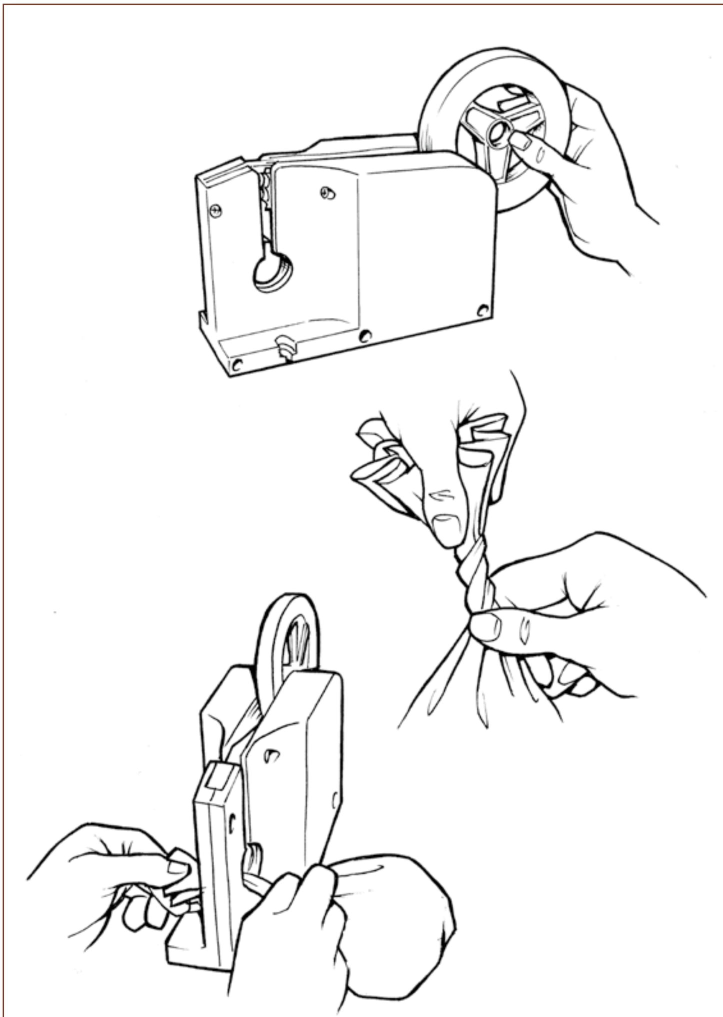


Fig. 3.10. Use of a simple applicator for sealing plastic bags with adhesive tape

Glass bottles can be sealed with one of a number of different types of caps. Metal caps include Crown caps or Roll-On-Pilfer-Proof (ROPP) caps (Fig. 3.12). Hand-operated Crown cappers (Fig. 3.13) 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 or lowering two handles that force the cap onto the bottle. ROPP sealers (Fig. 3.14) press the sides of the metal cap into the glass thread to form the seal. Alternatively, bottles can be sealed with corks using a corking machine (Fig. 3.15). When the lever is lowered it squeezes the cork and pushes it into the bottle neck, where it expands to form a tight seal.

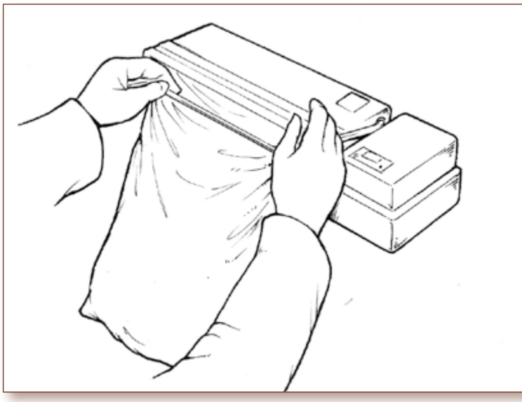


Fig. 3.11. Heat sealer for plastic bags

Fig 3.12. Caps for sealing bottles: a) Crown cap, b) metal roll-on-pilfer-proof (ROPP) cap, c) plastic ROPP cap (Photos from P. Fellows)

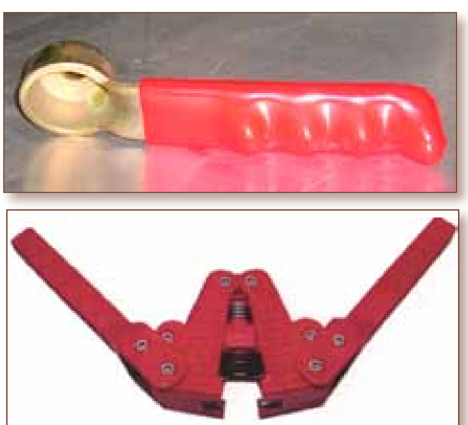


Fig 3.13. Crown cappers (Photos from P. Fellows)

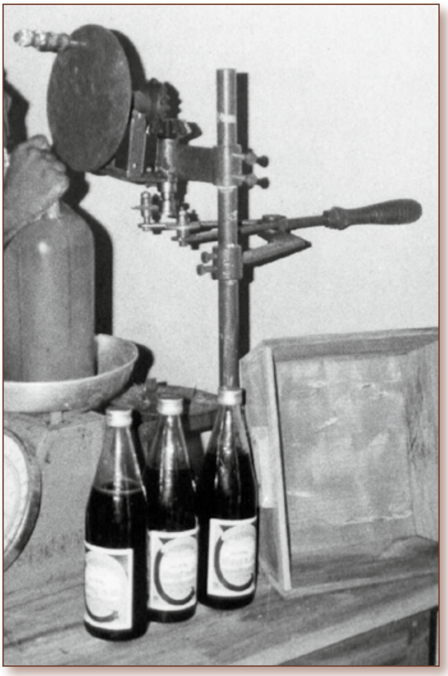


Fig 3.14. ROPP sealer
(Photo from P. Fellows)

Fig 3.15. Corking machine (Photo from P. Fellows)

Plastic bottles are capped manually by screwing the cap onto the bottle (Fig. 3.12c). ROPP caps are available and are preferred to simple push-on caps. A capsule sealer (Fig. 3.16) has a thermostatically controlled heater that shrinks plastic capsules to form a tamper-evident seal on bottles. A good quality electric hair dryer can also be used to shrink capsules. Alternatively if they are available, push-on pull-off tamper evident polythene caps with tear strips can be used to seal PET bottles.

Figure 3.16. Capsule sealer (Photo from P. Fellows)

Small plastic pots can be sealed using a foil or plastic lid that is heat sealed onto the rim of the pot. Push-on lids for small pots are generally not sufficiently leak-proof and are not used to package oils, but the clip-on lids of bulk (15 - 20 litre) plastic pots are suitable.

Summary of the chapter

- ✔ Choose a location that is close to the supply of crops and maintenance engineers. Ideally it should also be close to your customers.
- ✔ Make sure that the size of the oil mill is appropriate for your intended scale of production. Leave enough space around equipment for easy access and cleaning.
- ✔ Ensure that the walls, floors and insect proofing are up to standard.
- ✔ Make sure that there is an adequate electricity supply and get a backup generator if it is not reliable.
- ✔ Take time to select equipment that is the correct size for your intended production.
- ✔ Do not forget to order spare parts to avoid downtime.
- ✔ Find out what types of packaging are available and select ones that have a low cost but are attractive to the intended consumers.

Entrepreneur's checklist

❑ Do you know precisely what type of customers and consumers you are targeting?

....

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

....

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

....

❑ Does the factory have walls and floors with no cracks? Is the insect-proofing adequate?

....

❑ Have you visited local engineering companies to find out if they can make oil extraction 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?

....

❑ Are there alternative types of packaging that are suitable for oils?

....

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

....

....

Reader's notes

Please use this space to write your own notes on Chapter 3.

Tips for success

The following tips were provided by successful oil processors in ACP countries:

- ✔ Prepare crops correctly before extracting the oil and ensure that there are no metal or glass fragments in the raw material.
- ✔ Make sure all workers are trained and understand exactly what they are doing when operating oil extraction equipment.
- ✔ Establish an equipment maintenance system to avoid stoppages.
- ✔ Visit local engineering companies. They may be able to make or repair equipment for you.
- ✔ Check with the people who buy your oil whether they want it to be refined.

Finally:
read Sections 2.1-2.4 in Volume 1 *Opportunities in Food Processing - setting up and running a small food business.*

4.1 Types of oil crops

Oils can be extracted from a wide range of oil-bearing seeds, nuts and fruits but many are not suitable for cooking. Some contain poisons or unpleasant flavours and these are used for fuel or paints. Others such as castor oil need very careful processing in order to make them safe. Such oils are not suitable for small-scale processing. Oils from other crops such as maize, cottonseed and soybean, are extracted using solvents that dissolve the oil. This method of extraction is also not suitable for small-scale operation, due to the high costs of sophisticated equipment, the need for solvents that may not be easily available, and their risk of causing fire or explosions. These technologies are only economic at a large scale. Details of some oil-bearing crops that are suitable for small-scale extraction are given below and summarised in Table 4.1, and their range of uses and oil contents are shown in Table 4.2.

Oil type	Other names	Derived from	Suitable for small-scale processing
Argan oil		The kernel of the argan nut (Argania spinosa)	Yes
Avocado oil	-	The fruit of the avocado (Persea Americana).	Yes
Babassu oil	-	The kernel of the fruit of several varieties of palm (Orbignya spp.)	Yes
Coconut oil	-	The kernel of the coconut (Cocos nucifera L.).	Yes
Cotton seed oil	-	The seeds of various cultivated species of Gossypium spp.	No
Grape seed oil	-	The seeds of the grape (Vitis vinifera L.).	No
Groundnut oil	Peanut oil, Arachis oil	Seeds of groundnuts (Arachis hypogaea L.)	Yes
Maize oil	Corn oil	Maize germ (the embryos of Zea mays L.).	No
Marula oil	-	Kernels of the Marula tree (Sclerocarya birrea).	Yes

Oil type	Other names	Derived from	Suitable for small-scale processing
Mustard seed oil	-	The seeds of white mustard (Sinapis alba L. or Brassica hirta Moench), Chinese or brown Indian and yellow mustard (Brassica juncea L.) and black mustard (Brassica nigra L.).	Yes
Olive oil	-	Fruit of the olive tree (Olea europaea)	Yes
Palm kernel oil	-	The kernel of the fruit of the oil palm (Elaeis guineensis).	Yes
Palm oil	-	The fleshy mesocarp of the fruit of the oil palm (Elaeis guineensis).	Yes
Palm olein	-	The liquid fraction derived from the fractionation of palm oil.	No
Palm stearin	-	The high-melting fraction derived from the fractionation of palm oil.	No
Palm superolein	-	A liquid fraction derived from palm oil produced through controlled crystallisation.	No
Rapeseed oil	Turnip rape oil, colza oil, ravison oil, sarson oil, toria oil	Seeds of Brassica napus L., Brassica campestris L., Brassica juncea L. and Brassica tournefortii.	No
Rapeseed oil - low erucic acid	Low erucic acid turnip rape oil, low erucic acid colza oil, canola oil	Low erucic acid oil-bearing seeds of varieties derived from the Brassica napus L., Brassica campestris L. and Brassica juncea L.	No
Safflower seed oil	Safflower oil, carthamus oil, kurdee oil	Safflower seeds (Carthamus tinctorious L.).	Yes
Safflower seed oil - high oleic acid	High oleic acid safflower oil, high oleic acid carthamus oil, high oleic acid kurdee oil	High oleic acid oil-bearing seeds of varieties derived from Carthamus tinctorious L.	Yes

4

Oil type	Other names	Derived from	Suitable for small-scale processing
Sesame seed oil	Gingelly oil, benne oil, ben oil, benniseed oil, till oil, sim-sim oil, tillie oil	Sesame seeds (Sesamum indicum L.).	Yes
Shea butter	Karité butter	Fruit of the shea nut tree (Vitellaria paradoxa (formerly Butyrospermum paradoxum))	Yes
Soya bean oil	Soybean oil	Soya beans (Glycine max L.).	Yes
Sunflower seed oil	Sunflower oil	Sunflower seeds (Helianthus annuus L.).	Yes
Sunflower seed oil - high oleic acid	High oleic acid sunflower oil	High oleic acid oil-bearing seeds of varieties derived from sunflower seeds (Helianthus annuus L.).	Yes
Sunflower seed oil - mid oleic acid	Mid-oleic acid sunflower oil	Mid-oleic acid oil-bearing sunflower seeds (Helianthus annuus L.).	Yes

Table 4.1. Sources of oils and suitability for small-scale processing (Adapted from Codex Alimentarius Commission in Annex B)

Raw material	Oil content (%)	Uses
Oilseeds		
Castor	35–55	Paints, lubricants
Cotton	15–25	Cooking oil, soap making
Linseed	35–44	Paints, varnishes
Neem	40-45	Soap making, medicinal
Niger	38–50	Cooking oil, soap making, paint
Rape/mustard	40–45	Cooking oil
Safflower	36-48	Cooking, paint
Sesame	35–50	Cooking oil, Tahini
Sunflower	25–40	Cooking oil, soap making
Legumes		
Groundnut	38–50	
Nuts		
Argan	46	Cooking oil, soap making
Coconut	64 (dried copra)	Cooking oil, hair cream, medicinal
	35 (fresh nut)	Cooking oil, body/hair cream, soap making
Marula	33-40	Traditionally used in cosmetics, as cooking oil and as a meat preservative and to treat leather.
Palm kernel nut	46–57	Cooking oil, body/hair cream, soap making
Shea nut	34–44	Cosmetics, cooking oil, soap making
Fruit		
Avocado	8-30	Cooking, cosmetics, lubricant
Oil palm	56	Cooking oil, soap making
Olive	60-70	Cooking, cosmetics

Table 4.2. Oil content and uses of different oil-bearing crops (Adapted from Practical Action in Annex B)

The crops that are suitable for small-scale oil extraction described in this chapter include avocado, coconut, groundnut (peanut), mustard, olive, palm, palm kernel, safflower, sesame, shea nut, soybean and sunflower. The methods used to extract oil from these crops are described below.

There is considerable variation in the oil content of crops. The yield of oil depends to some extent on the variety and climate, but is mainly related to the extraction efficiency of the process (% oil extracted compared to the theoretical content). One of the main factors governing extraction efficiency is the pressure applied during extraction - the higher the pressure the greater the yield of oil. An extraction efficiency of 100% can never be obtained, but many traditional methods have a low efficiency because they do not generate sufficient pressures. Typical operating pressures in different types of presses are shown in Table 4.3

Method of oil extraction	Pressure	
	psi	kg/cm2
Hand screw press	500	35
Small hydraulic press	1810	125
Ram press	2800	190
Small expeller	250	170
Medium-scale expeller	5000	540
Large commercial expeller	20,000	1380

Table 4.3. Operating pressures in oil extraction equipment (Adapted from Head et al (1995) in Annex B).

For oilseeds and nuts, the moisture content of the raw material can also have a considerable influence on extraction efficiency, and the addition of a small quantity of water to the ground oilseed (known as *conditioning*) increases oil yields. The extraction of cooking oils involves some or all of the stages and equipment shown in the flow diagram (Fig. 4.1)

Stage in processing	Equipment required
Crop storage	-
↓	
Cleaning	Winnower, sieve, washer
↓	
Decortication or shelling	Mechanical decorticator or sheller
↓	
Winnowing	
↓	
Grinding	Pestles and mortar, hammer mill, roller mill or pin mill
↓	
Grating	Manual or mechanical grater
↓	
Heating	Seed scorcher, heating pan
↓	
Extraction Presscake	Oil flotation equipment, press or expeller
↓	
Drying	Heater and pan
↓	
Filtering	Filter bag or filter press
↓	
De-odourising or decolouring (optional)	Steam vessel and vacuum pump
↓	
Neutralising (optional)	Treatment tank with stirrer
↓	
Storage of oil	Storage tank or bottles
↓	

Fig. 4.1. Stages in oil extraction

This chapter describes pre-extraction treatments to prepare raw materials (Section 4.2), the broad principles of extraction technologies used by small- and medium-scale enterprises (Section 4.3) and post-extraction treatments, including clarification and refining of oils (Section 4.4). The extraction methods for particular crops are described in greater detail in Section 4.5.

4.2 Raw material preparation

All oilseeds, nuts and fruits require some form of pre-treatment. Oilseeds and nuts should be dried, most commonly by sun drying. Proper drying is very important and the moisture content must be lowered to a level that prevents the growth of moulds, generally in the range of 5 - 15 % moisture. Adequate drying is particularly important in the case of groundnuts and coconuts as they are susceptible to the growth of moulds that produce poisons (see aflatoxins in Annex A,) that are linked to the development of cancer. Aflatoxin, if present, contaminates both the oil and more importantly the oil-cake remaining after extraction. There have been several high profile instances of deaths occurring in poultry fed with aflatoxin contaminated feed.

> Proper drying to the correct moisture content is essential for safe storage of crops

Oil-bearing fruits such as oil palm and olives should be harvested when mature, washed and handled carefully to minimise damage. All raw materials should be cleaned to remove foreign matter either by hand or with winnowing machines or sieves. If expellers are used it is vital to make sure that any hard material such as stones and metal fragments are removed as these would cause expensive damage to the machine. All oilseeds should be inspected and any showing signs of mould should be rejected (se also Chapter 5, Section 5.4, quality assurance of raw materials).

The storeroom for cleaned crops should be weatherproof, well ventilated and provide protection against rodents and insects (see Chapter 3, Section 3.2). Oilseeds should be bagged and stored on pallets. During long term storage routine store inspections should be carried out, checking for insects, rodents and the pick up of moisture by crops (see Chapter 5, Section 5.4).

Some raw materials (e.g. groundnuts, sunflower seed) require decorticating and winnowing (Fig. 4.2). The husk is removed because if left on it has no value as animal feed, it absorbs oil and it increases the weight of raw material to be transported and processed. However in groundnut processing, some fibrous material is needed to enable the oil to escape from the press or expeller (and to prevent the nuts turning into peanut butter without releasing the oil). About 10% husk is added back to the nuts. If it is much more than this it reduces the value of the oilcake as human food.

Fig. 4.2. Groundnut decorticating machine (Photo from Tiny Tech Plants (pvt) Ltd.)

4.3 Methods of oil extraction

All raw materials contain oil in oil-bearing cells that have to be ruptured to release it. The different extraction technologies are:

- Hot water flotation.
- Ghanis.
- Pressing.
- Expelling.

These are described in detail below.

Extraction by hot water flotation

This is a simple traditional technology that is used to extract oil from fresh oil palm fruits, coconuts, olives, marula nuts and shea nuts. The equipment that is used for different crops is described in Section 4.5. The grated or pulped material is squeezed through cloth to produce a ‘cream’, and the residue is rinsed with water and squeezed again. The cream is then placed in a large pan with water and allowed to simmer over a low fire or heater. The oil slowly separates and floats to the surface where it is skimmed off. After filtering through fine cloth to remove traces of plant material, the oil is dried by heating it in a pan, which boils off all traces of water.

Shelled groundnuts, sunflower seeds, safflower seeds, palm kernels and shea nuts are roasted and then ground to a flour by pounding. The mass is then mixed with water and simmered, allowing the oil to float. It is skimmed off, filtered and dried as above.

These traditional methods are time consuming and inefficient in fuel use. Extraction efficiencies are low, mainly due to inefficient pounding and grinding, which leaves oil trapped in cells that are not broken down. However, despite the limitations these simple traditional processing methods continue to be used because the cost of equipment is low.

Ghanis

The ghani is normally associated with the Indian sub-continent but it has also been used in Africa as described in a case study from Mozambique (Case Study 4.2) and also in Malawi. The extent of the use of ghanis in ACP countries is thus not clear. Ghanis consist of a large wooden or metal pestle revolving in a heavy mortar as shown in Fig. 4.3. They are used for oil crops that have small seeds, such as mustard seeds and groundnuts.

Fig. 4.3. Ghani used for oil extraction
(Photo from Tiny Tech Plants (pvt) Ltd.)

Power is provided by a large animal or by a motor. The seeds are ground by the action of the pestle, and the oil drains out from a hole in the base of the mortar. It is claimed that the oil from a cow-operated ghani retains more of the natural flavour than from a motor-powered machine because the action is slower and less frictional heat is generated.

Case study 4.1: Oil extraction using a ghani

At the end of the war in 1983 Mozambique was suffering from shortages of basic foods, including cooking oil. Although some traditional oil processing by the hot water flotation method took place, outputs were very low. We were thus surprised to see an adaptation of the Indian ghani producing peanut oil in a village. It subsequently became clear that this system had been copied and was operating in a number of other communities. The ghani consisted of a hollowed out tree trunk about 1.5m high. A large 20 cm diameter pole acted as the pestle that was attached by beams that allowed it to be rotated in the wooden mortar. Oil yields were checked and 3 to 4 kg of peanuts yielded one litre of oil in 15 minutes. It was interesting to note that little oil was produced in the first 10 minutes, after which time oil simply gushed out. The cake remaining after extraction was used in cooking traditional dishes. This is unlike the cake from large industrial plants, which is only suitable for animal feed due to the high frictional temperatures involved. We subsequently learnt that this was a traditional technology, largely forgotten in times of plentiful cheap cooking oil, and that it had been re-born out of need.

4

Screw (cage or bridge) presses

A wide range of simple batch oil presses with typical capacities of 5 - 30 kg is used in ACP countries. In general the raw material is pounded or milled prior to pressing, and it is heated to 50°C or above, which helps release oil from the cells. Presses can be purchased or made locally, and several organisations in Annex D can supply drawings that allow local manufacture. A typical press is shown in the cut-away drawing in Fig 4.4. It consists of a perforated or slotted cylindrical steel cage and a press plate that is raised and lowered inside the cage using a screw and bearing. 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 softer metal of the bearing wears and is replaced more cheaply than a new screw, which is the most expensive part of the press). Screws can be turned manually or by an electric motor that has a gearbox or pulley system to reduce the speed. A muslin or cotton bag is placed in the cage and ground oilseeds or nuts are added. The bag is closed and the press plate is lowered to press out the oil. It is important that pressing is done in short steps with the pressure increased gradually to allow time for internal pressures to equalise and for the oil to escape. The screw is then raised and the bag is removed. If the depth of the raw material is too great, oil can be trapped in the centre. In larger presses, the material is added in small quantities that are separated by press (or layer) plates made from stainless steel, plastic or painted mild steel. These plates are placed between bags of flour to reduce the thickness of layers and help to equalise pressures, increase oil yields and make it

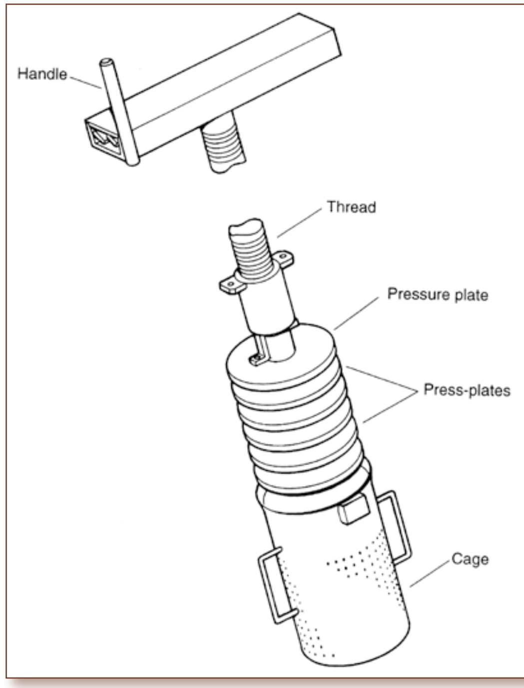


Fig. 4.4. Screw press (a) from Practical Action Publishing,(b) (Photo from P. Fellows)

much easier to empty the cage. An alternative to using a screw is to pump a hydraulic jack (e.g. a lorry jack) to move the pressure plate. Higher pressures can be obtained using the hydraulic system, but it is important to design the press so that the hydraulic jack is below the press (i.e. acting upwards) to minimise the risk of poisonous hydraulic fluid leaking and contaminating the oilseed or the oil. Ideally, all lubricating oils should be food grade.

The production rate of presses depends on the size of the cage and the time needed to fill, press and empty each batch. Hydraulic presses are faster than screw types and powered presses are faster the manual types. After extraction the oil requires filtering and possibly other secondary treatment such as de-gumming or neutralising (see Section 4.4).

Case Study 4.2: Oil extraction using a press

In Mr and Mrs M's operation, the crude oil is either filtered and packed without further treatment, or it is heated with salt, followed by washing and drying to produce semi-refined oil, and then packed. It is sold mainly to local consumers. After acquiring a 5-tonne capacity oil press complete with a filter press, they are able to produce up to 25 tonnes of oil in a month, working 10 hours per day.

The enterprise has basic plant for oil extraction; that is a seed crusher, an oil press, a filter press, cleaning screens and oil tanks (metal drums). The expeller and filter were bought locally from agents who imported them from China and India respectively.

Ram press

The ram press consists of a long lever that moves a horizontal piston inside a cage as shown in Fig. 4.5. Semi-continuous feed of raw material is via a feed hopper. The perforated cage is fitted with an adjustable *choke* at the outlet, which allows the pressure inside the cage to be adjusted. Ram presses have been shown to be more efficient than simple screw presses as higher pressures are applied and more shearing forces are involved.

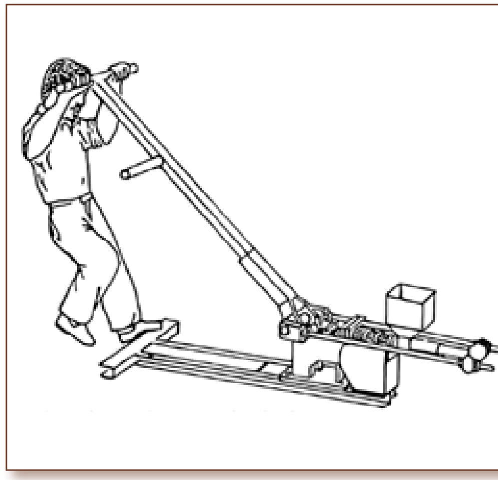


Fig. 4.5. Ram press

The technology has been widely tested in several African countries by a number of organisations, including Enterprise Works Worldwide (Annex D). The press is simple to construct and it is reported that 100 kg of softer-shelled, high oil content (40 - 45% oil) seeds from sunflower varieties can be processed per day with an extraction efficiency of up to 25%. The ram press can also be used for sesame, mustard, safflower seeds, and groundnuts. One often reported disadvantage of the ram press is the amount of physical energy involved to operate it. It is simply very hard work.

Expellers

Oil expellers may be described as an extension of the screw press and ram press technology, which are designed to operate on a continuous basis. A rotating screw (or 'worm'), can be hand-driven at a very small scale, but most commonly it is motor driven. The screw pulls the raw material from a hopper into the barrel where the seed is broken down and pressure is gradually increased as it moves through the barrel. Oil passes through narrow slots in the barrel and press cake is discharged from the end. The barrel is slightly tapered and the pitch of the rotating screw gradually decreases towards the exit end of the cage. This design increases the pressure and shear forces on the material as it passes through the machine. An adjustable 'choke' ring at the exit controls the pressure in the expeller. A medium-scale expeller is shown in Fig 4.6. Typically, the screw rotates at about 100 rpm and heat is generated due to friction between the seeds and the screw/barrel. Some designs have additional electric heaters around the barrel. The screw, choke ring and barrel all wear down and must be repaired or replaced at intervals. There must therefore be mechanical skills available locally to carry out the maintenance and repair work. Sand or grit in the raw material reduces the time between repairs from several months to as little as two weeks and proper cleaning of the raw material is therefore essential.

Fig 4.6. Small/medium scale oil expeller with capacities up to 150 kg seed/hr (Photo from Alan Brewis)

Expellers are commercially available with capacities from a few kg/hour to several tonnes/hour. This type of equipment is more difficult to construct locally in ACP workshops, unless they have skilled workers who are able to make stainless steel screws that fit closely into the barrels.

Case Study 4.3: Oil extraction using expellers

- The business operates from the owner's homestead. It is small and does not have much machinery. It has a small expeller that was imported from China. The machine was set up with a trial run by a local technician. Through experience, there have been quite a few modifications to the machine and other facilities to ensure that productivity is good. Current plans are to buy a complete oil mill that would expand production and improve operational efficiency, and possibly improve product quality.
- The Company has two seed cleaners, six oil expellers each with the capacity to produce 1000 kg of cake per hour, five 500-litre oil tanks and a 500 kg per hour feed mill for poultry and animal feed production. They have not had the need to install more storage tanks because most of the oil is produced to order.

Expellers may be operated in either a cold pressing or hot pressing mode. When used for cold pressing, the incoming seed is not pre-heated and the oil can command a premium price in specialised markets due to its superior flavour. The cake remaining after oil extraction may also be more valuable as a high quality animal feed or, depending on the type of crop, for human use (see Table 4.2). However, the amount of oil produced by cold pressing is lower than from hot pressing. Careful consideration is required of the economics of reduced yield versus the higher value of the oil and oilcake. When hot expelling, the raw material is heated to 60 - 100^{o}C, which ruptures cells and so increases oil yields. However, hot expelling results in the presence of more gums in the oil, making it unsuitable for culinary use without further refining. The cake remaining after hot expelling may also have a lower value. One option is to link two expellers: the first produces high quality, high-value culinary oil by cold expelling. The cake is then fed to a second expeller for hot expelling to extract more oil.

4.4 Oil clarification and refining

The crude oil extracted by flotation, pressing or expelling contains a suspension of fine pulp and fibre from the plant material with small quantities of water, gums, resins, colours and bacteria which make it darker and cloudy. Prior to sale, crude oil must be treated to remove these contaminants by clarifying the oil, either by allowing it to stand undisturbed for a few days and removing the upper layer, or by using a clarifier to produce a crystal clear product. It is also very important that all moisture is removed, as this will hasten the action of micro-organisms or naturally occurring enzymes that cause the development of rancidity and off-flavours (see Annex A - rancidity).

At the simplest level, the oil is left to stand for several days in a tank fitted with a drain valve in the base. Water and cellular material (often known as *foots*) settle out. The foots are drained off and the oil is filtered through muslin or fine cotton bags. The 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). This simple gravity filtration is slow and is only suitable for micro-scale production.

In small-scale oil production, a steel (or less desirably aluminium) pan is placed directly over a heater to remove water from the oil. 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. They also provide more controllable heating than pans over open fires. In rural areas, these may not be available or the electricity supply is not sufficiently reliable, and other types of fuel (e.g. charcoal or kerosene) may have to be considered. In palm oil processing, the waste material is often made into fuel (see Case Study 6.10). Generally, wood is not favoured because of the contribution to increased deforestation and the risk of product contamination by the ash. At a larger scale of operation, the oil may be treated in a clarifier that consists of a drum or tank heated by a heater or a fire. The oil is boiled, which drives off any water, and destroys enzymes and bacteria. The treated oil is then allowed to stand and the foots are removed, followed by filtration as described above. The use of a clarifier involves a considerable fire risk and it is very important that the drum has a lid to prevent the oil catching fire, but with a hole in the lid to allow steam to escape. A typical system is shown in Fig. 4.7.

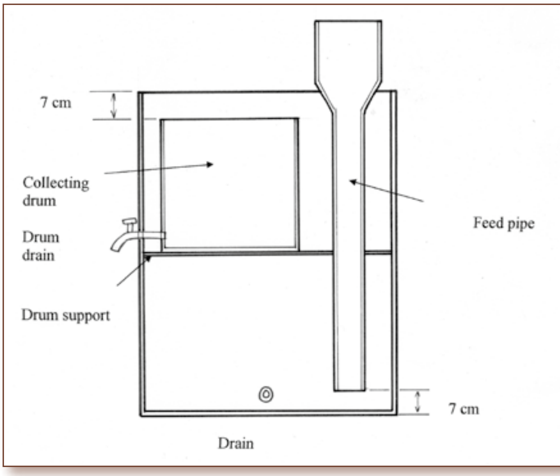


Fig. 4.7a and b. Oil clarifiers (Photo from J. Hounhouigan)

Oil treated by the simple methods described above has a moderate shelf life, but for a longer shelf life more sophisticated methods should be used. At larger scales of operation, a plate and frame filter press is used. This consists of a number of vertical grooved metal plates that are separated by cloth or paper filters. A small filter press that can house up to 20 plates is shown in Fig. 4.8. In operation, the crude oil is pumped through the filter press under pressure. Having passed through the filter sheets, the oil flows down the grooves in the plates for collection. The residue, or filter cake, builds up on the filter sheets. When the cake has built up sufficiently to fill the gaps between the plates, the machine has to be dismantled and the cake removed. A new cycle can then start. The filter cake is normally mixed with fresh raw material and re-passed through the expeller or press. Plate and frame filter presses have moderate cost, are reliable and simple to use and maintain, but they are somewhat labour-intensive. More complex, less labour-intensive filters and centrifuges are available but they are expensive and only suitable for use in large-scale oil mills.

Fig 4.8. Plate and frame filter press for clarifying oil (Photo from L. Gedi)

The oil is heated to boil off traces of water and destroy bacteria. When these impurities are removed the shelf life of oils can be extended from a few weeks to several months, provided proper storage conditions are used.

Fig. 4.9. Oil storage tanks (Photo from L. Gedi)

Refining

Small- and medium-scale producers rarely fully refine their oils. The characteristic flavour and odour of traditionally made oils is preferred by local consumers in many cases. Large-scale producers carry out several stages of treatment to produce a standard oil that has a bland flavour, and is crystal clear with a long shelf life. Some or all of the following treatments are used:

- Neutralising.
- Bleaching.

Other treatments, such as winterising, de-odourising and de-gumming are not used at a small scale because the technology is too complex and expensive. In larger operations, degumming is normally done using phosphoric acid or citric acid. Gums, proteins and trace metals precipitate out from the oil and are removed.

Crude oils may contain free fatty acids (FFAs) that develop due to oxidation and result in off-flavours. The chemistry involved is described in more detail in Annex A. They are neutralised by adding a carefully controlled amount of caustic soda (or 'lye'). The amount added is critical: too little does not neutralise all FFAs and too much causes a loss of oil yield. Efficient neutralisation depends on accurately determining the amount of FFAs in the oil. This requires setting up a small laboratory or sending samples for analysis. The measurement of FFAs is described in Chapter 5, Section 5.7. After mixing the caustic soda thoroughly in the neutralisation tank, the mixture is allowed to stand and settle out. The water phase is drawn off from a valve in the base of the tank.

Some oils that are too dark in colour can be bleached by the addition of small amounts of commercial bleaching earths or activated carbon powder. After bleaching the oil should be filtered.

4.5 Methods for extraction of different oils

This chapter concludes by examining in greater detail oil extraction from the eleven crops that are most commonly processed by small- and medium-scale enterprises in ACP countries, namely: avocados, coconuts, groundnuts (peanuts), mustard seeds, olives, palm fruits, palm kernels, safflower seeds, sesame seeds, shea nuts and sunflower seeds.

Avocado is also known as butter pear or alligator pear, or palta or aguacate in Spanish. This is a valuable crop that is cultivated in tropical and subtropical climates throughout the world. The green or sometimes purple-skinned, pear shaped fruit is around 7 cm in diameter and 20 cm long and weighs 100 - 1000g, depending on the variety (Fig. 4.10). It contains a large egg-shaped or spherical seed (or stone) surrounded by a yellow/green oil-bearing pulp. The stones contain very little oil.

Fig 4.10. Avocado fruit

Trees start to bear fruit when 3 - 6 years old and have a productive life of 25 - 35 years. They produce an average of 120 fruits annually, and commercial plantations produce 7 - 20 tonnes per ha per year. The fruit is a 'climacteric' fruit that matures on the tree but ripens after picking. The fruit is harvested for the fresh market while it is still firm, but at this stage of maturity, the oil content is about 8% and it is not suitable for oil extraction. Oil is normally extracted from fruit that is allowed to fully ripen because these have a higher oil content (up to 30%). As a cooking oil, it compares well with olive oil and is used as an ingredient in many dishes. The oil has an unusually high smoke point (255°C), making it suitable for frying. It is also used as a lubricating oil and in cosmetics where it is valued for its regenerative and moisturising properties. At a small-scale of operation, the oil is separated by drying the fruit and pressing or expelling the pulp or by hot water extraction.

Fully mature fruits are cut in half and after removing the stone, the halves are either used straight away or sun dried. For extraction by hot water flotation, the fresh or dried fruit is pulped and boiled in water, and the oil is removed by skimming. Screw or hydraulic presses can also be used, whereas expellers are used at a larger scale.

Another proposed method involves rendering, in which the pulp is heated in avocado oil to drive off the moisture. The resulting mix of oil and plant tissue is then pressed. It is claimed that this technique could result in getting up to 97% of the theoretical oil recovery (Human (1987) in Annex B). The crude oil has a green colour due to its chlorophyll content, but it can be refined by bleaching, and by alkali treatment to remove FFAs. This is essential if over-ripe or rotting fruits are used.

Coconut palm needs an average annual temperature of about 26°C, with only small differences in the length of daylight and good sunshine conditions throughout the year. It is thus found in the tropics in a zone 15 - 20 degrees from the equator, below altitudes of 750 m with optimal rainfall of 1250 - 2500 mm per year. A full-grown coconut palm (Fig. 4.11) yields 30 - 50 nuts per year, whereas low-growing hybrids usually have smaller nuts but can yield between 200 - 600 fruits per year. In a plantation, 8000 nuts per ha per year is a good harvest. On a global basis coconut is a major oil crop.

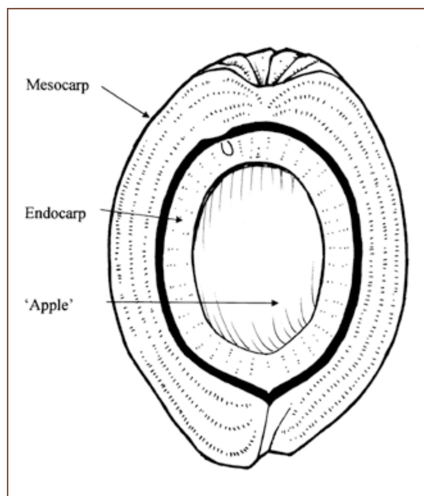


Fig. 4.11. Coconut - ripe fruit (Adapted from Rehm and Espig (1984))

To produce coconut oil, the fibrous husk is removed, the nut is then split and the white 'meat' is removed. It is either used fresh, or it is dried to make copra by sun-drying or using a simple copra kiln that is fired using coconut shells or husks. Fresh coconut meat has an oil content of 32 - 35% with a moisture content of approximately 50%. After drying to copra the moisture content falls to 6 - 9% with a consequent rise in oil content to 65 - 70%. It is very important that copra is dried rapidly to a low moisture content to avoid mould growth and the risk of aflatoxin contamination. In addition slow drying would allow the development of free fatty acids, which means that the oil requires refining and neutralisation with caustic soda.

Maximum yields are 9 tonnes of copra per ha, from which 6 tonnes of oil can be extracted. Coconut oil has a high percentage of saturated fatty acids, a high melting point (22 - 26°C) and does not easily become rancid (see Annex A, rancidity for further details). It is used for cooking, for cakes and pastries and also to make high quality soap.

Coconut oil can be made from finely-ground fresh coconut meat using a traditional hot water flotation method (Section 4.3). The oil is produced in this traditional way in the Pacific islands and in West Africa. Small hand graters are widely used to shred coconut (Fig. 4.12). It has been found that the size and shape of the serrated edge of the grater can have a considerable influence on oil yields, with finer particles producing higher oil yields. Small powered graters are used in many coconut-growing countries, often in local markets where the grated coconut is sold to customers for domestic use. The oil has a taste that is particularly preferred, but its shelf life may be less than oil produced using improved methods.

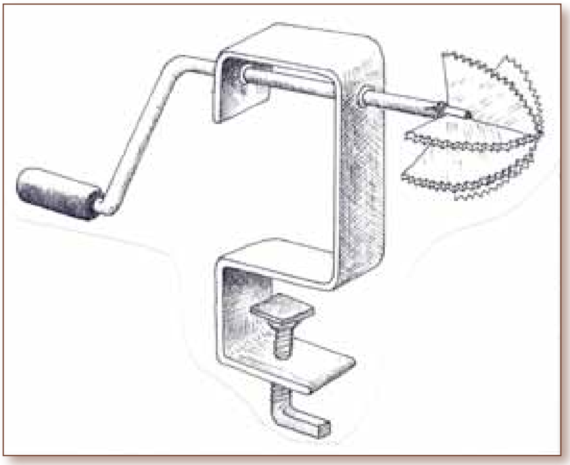


Fig 4.12. Small hand coconut grater (From Practical Action Publishing)

However, commercially the vast majority of oil is extracted from copra using expellers. It is very important that copra is cleaned to remove any stones or metal fragments because these can cause serious and costly damage to expellers. The use of magnets to remove any stray metal is highly recommended. The copra is then milled, most commonly in hammer mills or using copra breakers. Copra breakers consist of a revolving shaft fitted with blunt knives, teeth or beaters. The ground copra is then heated (commonly called 'cooking' or 'scorching') before passing to the expeller. Cookers consist of a shallow pan fitted with a slowly rotating paddle and heated by an open fire, gas or steam. After expelling, the coconut oil is filtered and if necessary neutralised to remove FFAs as described in Section 4.4.

Case Study 4.4: Coconut oil production

- While in the past the small island of St Vincent was a major producer and exporter of coconut oil, small scale traditional extraction still takes place. A dozen or so small family-based cottage enterprises still produce oil. Mrs N explained the process that she had learned from her mother, who in turn was taught by her mother. Dry coconuts are split and the white meat is removed. This is grated on a locally made grater; a sheet of metal that has been punched with a pointed tool to provide a large number of sharp perforations. The grated coconut is then mixed with an equal volume of water and strained by squeezing it through the same grater to sieve out coarse particles. The liquid is left to stand overnight often with the addition of lime juice, which helps the oil to separate. The upper creamy, oil-rich layer is skimmed off and then boiled for an hour or more to remove all traces of water. When cool the oil is packaged into clean re-cycled 750ml rum bottles. Mrs N processes 100 coconuts per month to produce about 5 gallons (23 litres) of oil. The oil has a ready market with housewives who use it for cooking and salad dressings. Some of the oil is re-packaged into smaller bottles by traders for sale to tourists who recognise its beneficial effects as a skin lotion.
- Tobago and Dominica show how efficient management and marketing can find a place for local production of coconut oil. In Dominica, the Coconut Products factory produces soap which is found throughout the Caribbean, and the Coconut Growers Association of Trinidad and Tobago successfully manufactures and sells coconut-based margarine, cooking oil, shortening, and different soaps. Its Nariel brand of edible oil is promoted as organically grown and the company is confident of substantially increasing exports in the next two years.
- In Africa, Benin is expanding coconut production to meet its own needs and to export to Togo, and Cameroon has been considering coconut production on land infected by an oil palm disease.

Groundnut has other common names, including peanut, goober pea, pistache de terre or earthnut. It is not a nut but a legume (a type of pea). It is both a food crop and an oilseed crop, and it produces a high protein meal after oil extraction. They are widely grown in the tropics and subtropics to produce yields that range from 600 - 3000 kg/ha of seeds in the shells. There are two main types: the Spanish-Valencia type that has an upright plant with pods clustered around the base of the plant, and the Virginia type in which plants have spreading runners, and have pods dispersed along root branches (Fig. 4.13). The upright type is usually used for mechanised production and the runner type in smallholder farming. Groundnuts need moderate rainfall (500 mm per annum) or irrigation, a temperature of 27 - 30°C during the growing season, and hot dry weather during seed ripening to prevent mould growth. Soil type and condition is important for groundnut production and well-drained, sandy loams are best for rapid maturation of pods and for minimising mould damage. The pods may have l - 3 or more seeds each, depending on the variety and the growing conditions. The seeds have a thin papery seed coat, which is easily removed after roasting. Seed size varies with variety, from 2000 to 3000 seeds per kg. Well-dried seed, stored in the pod under conditions of low humidity, retains its viability for 3 or more years.

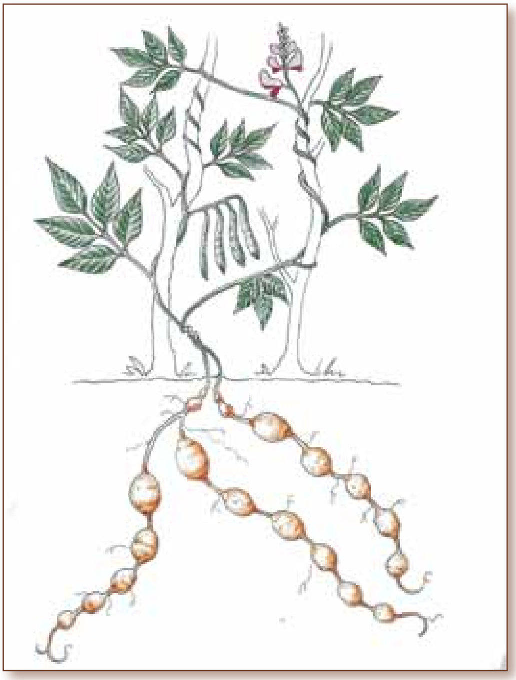


Fig. 4.13. Groundnut plant showing parts of the plant

Groundnuts and groundnut oilcake are rich in protein, minerals and vitamins. Whole groundnuts (without shells) average 25 - 30% protein, 40 - 45% oil and are rich in calcium, phosphorus, iron and the B-vitamins. The vine residues, after the pods are removed, are a good protein feed for horses and for ruminant livestock.

Correct harvesting and post-harvest drying are essential to produce high quality groundnuts. The crop rarely suffers any significant mould growth on well drained soils until it is lifted out of the ground. The entire vine with attached pods should be dried in a windrow or in small stacks around poles to minimize contact with the soil. It is very important that groundnuts are properly dried, to below 10% and preferably to 5%, to avoid the possibility of growth of aflatoxin-producing moulds (see Annex A) that make the crop unsafe for use as food or feed. Although aflatoxin is insoluble in vegetable oil and is concentrated in the oilcake, impurities in the oil may contain it, and groundnut processors should therefore be especially aware of the danger of mould growth.

Dry pods are easily removed from vines by hand or by machinery and the seeds are removed by shelling the pods (Fig. 4.14). If there is any doubt that the seeds are not sufficiently dry for safe storage, they should be placed in shallow layers on drying floors, and turned frequently until thoroughly dried. Groundnuts can be stored safely when the relative humidity of the storage room is 60% or lower. One metric ton of unshelled nuts can produce around 265 kg of oil and 410 kg of oilcake.

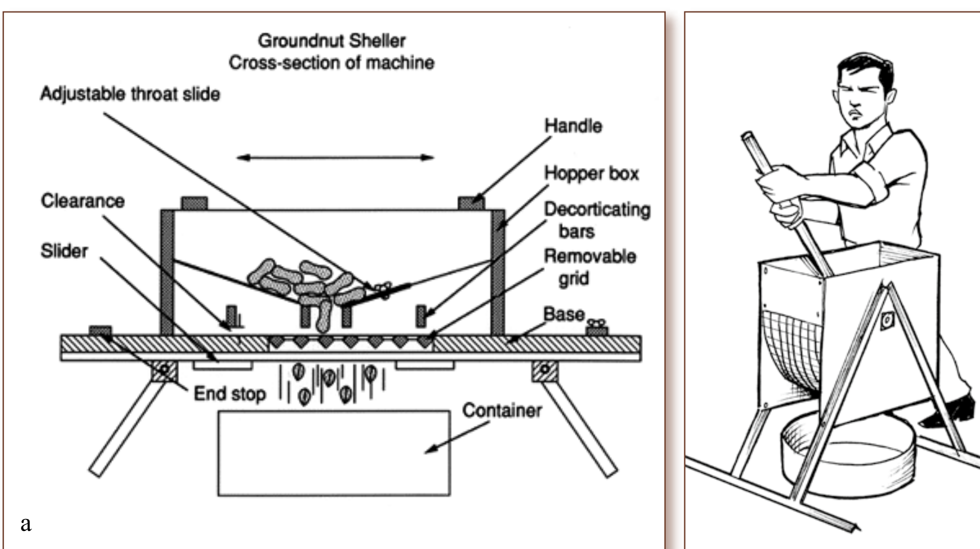


Fig. 4.14. Hand-operated wooden groundnut shellers, adapted from (a) Makoko and Balaka (1991) and (b) IDRC

Groundnut oil is extracted either by pressing or at larger scale using expellers. When using screw presses, the nuts are first shelled, roasted (Fig. 4.15) and the seed coat is removed. The nuts are then crushed to a flour (or meal) either by manual pounding or in a disc mill or hammer mill (Fig. 4.16). Water is then added to the pounded meal; as a guide one litre of water/10 kg flour. The flour is next heated in a large pan, with constant stirring, until its temperature is about 70°C, by which time it will feel quite dry. The groundnut flour is then pressed to extract the oil.

Fig 4.15. Roasting groundnuts for small-scale production (Photo from J. Hounhouigan)

Fig 4.16. Diesel powered mill for grinding groundnuts for small-scale production (Photo from J. Hounhouigan)

The oil can be left standing for 3 or 4 days to allow small particles to settle or it can be filtered in a filter press (Section 4.4). Finally, the oil is heated to remove traces of water and contaminating micro-organisms.

At larger scale, an expeller is used. Some groundnut shell needs to be added to the coarsely milled nuts in order to provide more frictional 'bite' to the revolving screw. This assists the passage of flour through the expeller and generates the required pressure.

It should be noted that the cake remaining after pressing can have a high value as a food, whereas oilcake remaining after expelling is only suitable for animal feeds, due to the higher temperatures involved, which damage the quality of the cake.

Mustard seed has long been used as a spice. Mustard plants (Fig. 4.17) are temperate crops that prefer temperatures below 25°C during growth, but breeding and selection have increased their ability to withstand higher temperatures. Optimal rainfall is around 700 mm per year. These characteristics are advantageous in tropical regions of high altitude with significant temperature variations and low rainfall. Yields range from 1 - 3 tonnes of seed per ha. The oil content of the seeds is 30 - 50 %, but can reach up to 60%.

Mustard seed oil has a strong smell, a hot nutty taste, and is often used for cooking in India and Bangladesh, but less so in ACP countries. The oil is also used for massages as it is thought to improve blood circulation and skin texture, and it also has antibacterial properties. Oil is usually extracted from mustard seed using a ghani (Section 4.2).

Fig. 4.17. Mustard plant

Olive fruit is an evergreen tree crop of the Mediterranean basin including parts of North Africa. Olive trees grow in any light soil, but rich soils may cause disease and produce lower quality oil. The trees are drought resistant, grow very slowly and can live for centuries, remaining productive for this time if they are pruned regularly. The trees are short and squat, with the trunk reaching 10 m in girth and rarely exceeding 8 - 15 m high. There are thousands of cultivars, and hybrid cultivars have been produced with qualities such as resistance to disease, quick growth and larger or more consistent crops. Fruits range from 1 - 2.5 cm in length depending upon the cultivar. They are either harvested green or left to ripen to a purple or black colour. Olive pulp contains 60 - 70% oil depending on the cultivar. Typical yields are 1.5 - 2 kg of oil per tree per year. Olive oil is commonly used in cooking, cosmetics, pharmaceuticals, soaps and as a fuel for traditional oil lamps. The oil has high levels of monounsaturated fatty acids and antioxidants such as vitamin E and carotenoids (Annex A). These properties are thought to contribute to its claimed health benefits.

There are a number of recognised grades of olive oil which command different prices:

- Extra-virgin olive oil is obtained from the fruit by pressing without the use of heat or chemical treatment. It should have a maximum FFA content of 1% and a high organoleptic score (colour and flavour measured using a taste panel).
- Virgin olive oil is produced by pressing without the use of heat or chemical treatment. The organoleptic score is slightly lower and levels of 2% FFAs are allowed.
- Refined olive oil - the oil has been chemically treated to remove strong flavours and neutralise FFAs. Refined oil is commonly regarded as lower quality than virgin oil.
- Extra-virgin olive oil and virgin olive oil cannot contain any refined oil.
- Olive oil - a blend of olive oil (85%) and virgin olive oil (15%). The olive oil component is refined and should have a maximum FFA content of 1.5%.
- Light oil - not legally defined but contains a low % of virgin oil.
- Olive pomace oil - oil extracted from the residual pomace by solvent extraction and blended with virgin olive oil.

Olives must be treated with care when harvesting and not subjected to pressure, heat or bruising, and the use of shallow containers is recommended. Damaged fruit quickly starts to ferment, which results in defective oils. Fallen fruit, picked from the ground, should be regarded as second grade and processed separately. The fruit should be moved as quickly as possible to the mill to avoid fermentation. The fruit should also be kept as cool as possible. After sorting to remove defective fruits, stems, twigs and stones the olives are washed to remove sand or soil.

Traditionally the fruits are ground in large stone roller mills. These consist of two or three heavy stone wheels which roll slowly around a granite bowl as shown in Fig. 4.18. Such mills are simple to use and maintain, release the oil in larger droplets and due to their slow action, which generates little frictional heat and produces oils with less bitterness. Stone mills are however costly to buy, difficult to clean, only work on a batch basis and have high labour costs.

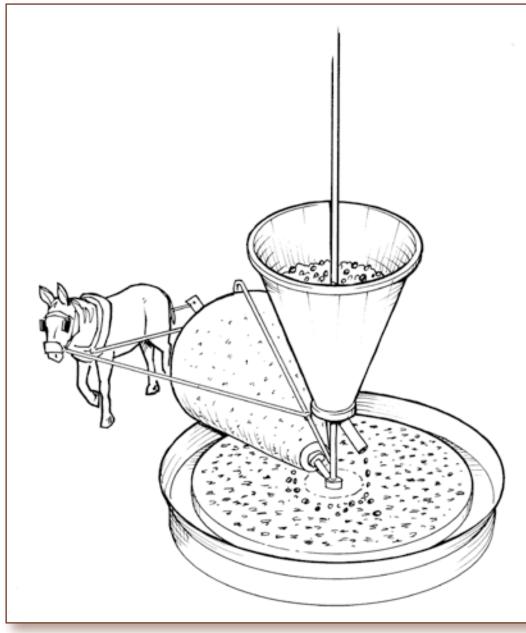


Fig. 4.18. Roller mill for pulping olives (Adapted from Pieralisi España S.)

Stone mills are now being replaced by lower cost disc or hammer mills. There are many designs of disc mill, for example: in single-disc mills, the fruit passes through an adjustable gap between a stationary casing and an electrically driven, grooved disc that rotates at high speed. Double-disc mills have two discs that rotate in opposite directions to produce greater shearing forces, and pin-and-disc mills have intermeshing pins fixed either to a single disc and casing or to double discs. These improve the effectiveness of grinding by creating higher shearing forces. A hammer mill contains a series of swinging metal arms that pulverise the fruits. Disc and hammer mills have the advantage of greater throughput and lower labour requirements than stone mills. Both however generate more frictional heat that may affect the final oil quality, and both may produce an oil and water emulsion which makes the separation of oil more difficult. The next stage is slow mixing, often called 'malaxation'. The ground pulp is slowly mixed for 20 - 40 minutes by a spiral blade that rotates in a horizontal trough. This allows minute droplets of oil to coalesce into larger drops. This is a vital step in the process and the time of mixing is very important: longer mixing times result in improved oil yield and flavour due to the pick up of minor flavour components by the oil. However, over-long mixing results in more oxidation that reduces the shelf life of the oil. The time used thus depends on the skill and experience of the mill owner.

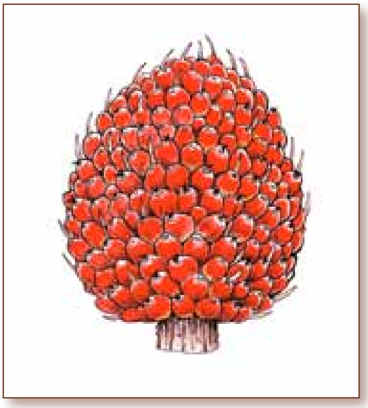
The ground olive paste is then pressed either in a screw press or more commonly in a hydraulic press. It is very important that good housekeeping rules are enforced to ensure that the press and all press mats are well cleaned to avoid the risk of rancidity in the pressed oil.

The crude oil leaving the press contains water that must be removed. At a small scale this is done by simply allowing the mixture to stand in a tank. The water and vegetable matter settles out and can be removed. Increasingly, continuous centrifugal separators are now used. These are similar to cream separators used in small-scale dairies and the spinning action separates the lighter oil from the water. Finally, the olive oil is filtered using a filter press that removes any fine suspended matter. At large scale the *pomace* remaining after pressing is treated by solvent extraction to remove the final traces of oil, but this technology is not suitable for small producers.

Oil palm

Oil palms have two main varieties: the African palm (*E. guineensis)* and the South American palm (*E. oleifera).* Both have been crossed to give a large number of hybrids. The plants need a temperature of 24 - 28°C to grow and are therefore confined to the zone between rainforests and savannahs, or moist grasslands having annual rainfall of 1500 - 3000 mm and a dry season not exceeding three months. These conditions are found between 13° north and 12° south of the equator and below altitudes of 50 metres above sea level. Wild oil palms begin to fruit after 10 years and do not give a full crop for about 20 years. Cultivated palms begin fruiting after four years, reaching their peak after 12 - 15 years, and continue bearing fruit for 40 - 50 years.

The oil palm produces large, tightly-clustered bunches of fruits that may weigh up to 40 kg on mature palms. Each bunch can have up to 4000 egg-shaped fruits, each 3 - 5 cm long and 2.5 cm in diameter. The fruit consists of a thin skin, an orange/red pulp and a hard nut containing a single kernel. Three types of fruits are distinguished depending on the thickness of the shell around the kernel: *aura* has a shell thickness of 2 - 8 mm, *tenera* 0.5 - 3mm and *pisifera*, which has no shell. These are shown in Fig. 4.19. Wild and semi-wild trees are mainly of the aura type; high-yielding varieties are a cross between aura and pisifera and produce fruits of the tenera type.



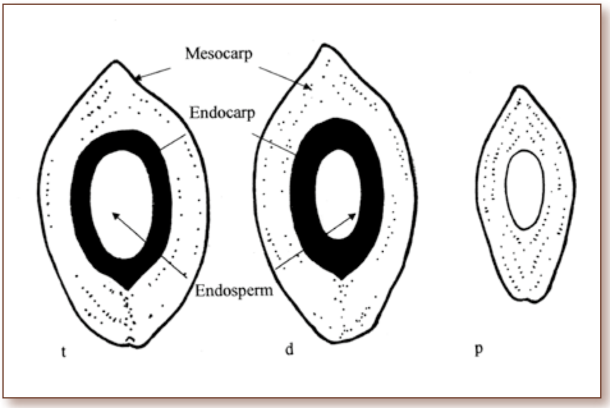


Fig 4.19. Oil palm. a) bunch, b) fruit of tenera (t), aura (d) and pisifera (p), (Adapted from Rehm and Espig (1984))

4

Oil palm fruits contain two distinct types of oil: red palm oil which is extracted from the fleshy fruit layer, (or *mesocarp*), and white palm kernel oil which is extracted from the kernel. Palm oil and palm kernel oil have very different chemical and physical properties and they are described separately in this section. The fruit pulp contains 40 - 62% oil, and palm kernels contain 46 - 48% oil, which is chemically similar to coconut oil. Yields are more than 6 tonnes/ha, which make the oil palm the highest-yielding oil plant. Typically, for tenera fruit, 100 kg of fresh fruit yields 21 kg of red palm oil and 6 kg of palm kernel oil. In West African oil palm growing countries, red palm oil is an important food ingredient, and the colour and taste of the oil from the traditional aura variety are preferred to those of the hybrid tenera variety. The taste of oil produced by traditional methods is also better preferred. In Benin, Cameroon and Nigeria about half the palm oil is produced in the traditional way, and in Ghana and Sierra Leone the amount is even higher at 70 - 90%.

Palm kernel oil is semi-solid in temperate climates due to its high level of saturated fatty acids (Annex A). The fatty acid composition means that it has a good resistance to oxidation and heat at prolonged high temperatures. This makes it an ideal oil for shallow or deep frying on its own, but it is not recommended for inclusion in deep frying oil blends because it causes foaming. The presence of natural anti-oxidants in the oil gives a longer shelf life to fried products. It is also used in shortenings (bakery fats) and for margarine and ice cream production. Palm oil and palm kernel oil can both be separated into a liquid 'olein' fraction and a more solid 'stearin' fraction by crystallisation at controlled temperatures, but this is a technology that is only suitable for large scale plants and is not small-scale operation.

Palm oil is extracted from the fleshy fruit pulp around the kernel. It is generally recommended that the fruits should be processed within 24 hours of harvesting because fruit enzymes start to produce FFAs that reduce the commercial value of the oil. It is interesting to note, however, that small-scale producers in Ghana leave the fruits to ferment for several days before processing. The reasons for this are not clear; it may be the flavour imparted by FFAs is preferred or that separation of the flesh, using a pestle and mortar is easier.

Crude, un-refined, palm oil is orange or red in colour due to its high ß-carotene content, which is a source of Vitamin A. This makes palm oil of considerable nutritional importance in those ACP countries where Vitamin A deficiency is prevalent.

The processing of palm fruit involves:

- Cutting palm bunch
- Removing the grape-stalk within 72 hours after cutting
- Weighing the fruit using scales (Fig. 4.20a)
- Sifting and sorting palm fruit
- Cooking the fruit for 1-2 hours using cookers (Fig. 4.20b)
- Kneading and pressing the cooked fruits (Fig. 4.20c)
- Clarifying the raw juice using clarifiers (Fig. 4.20d)
- Drying the oil with sterilisers (Fig. 4.20e).

Sterilisation for up to one hour in hot water or steam inactivates natural fruit enzymes that lead to the development of FFAs. At small and medium scales of operation, the bunches of fruit are held on a mesh above a tank of boiling water as shown in Fig. 4.20b.

(a) Scales (b) Steam cookers (c) motorized Press

(d) Clarifiers (e) Sterilizers

Fig. 4.20a-e. Palm fruit processing: a) scales for weighing fruit, b) steam cooker, c) motorised press, d) clarifiers, e) sterilisers (Photos from J. Hounhouigan)

After sterilisation, the fruits are stripped from the bunches. At a small scale, this is done by beating bunches with poles or by tumbling them in a revolving drum fitted with baffle plates. The next step in the process is to pound the fruit to break up oil bearing cells and help release the oil. At this stage the kernels are released and collected separately. At a small scale, pounding is carried out using heavy wooden pestles and mortars. This is extremely hard work, and motorised systems are now more commonly used (Fig. 4.21). These consist of a revolving cylinder with a shaft fitted with arms or hammers. An auger moves the fruit through the machine.

A mechanical pounder developed in Ghana is belt-driven by a 8 hp engine. It consists of a horizontal cylinder with a central revolving shaft. The shaft is fitted with metal beater arms and an auger that moves the fruit to the exit. A feed hopper is fitted to the top of the drum to which the boiled fruit is added. The machine has a capacity of 50 litres and can pound 100 kg of fruit per minute.

Fig. 4.21. Mechanical palm fruit pounder (Photo from J. Hounhouigan)

In small-scale operations, the pounded mixture of fibre and oil slurry is pressed in a screw press or hydraulic press. Sometimes the nuts are retained and only removed after pressing. Then the remaining material is re-pressed to increase the oil yield. At a larger scale, continuous expellers are used to remove oil from the fibre after the nuts have been removed. The crude oil contains water and plant cell material that has to be removed by clarification. At a small scale, this is carried out by adding water and heating to about 95°C. Oil rises to the surface and collects in a collecting tank from which it is drawn off. A typical clarification tank is shown in Fig. 4.20d.

Case Study 4.5: Palm fruit processing

With the exception of the diesel engine, all equipment in the factory was locally built by the Technology Consultancy Centre of the Kwame Nkrumah University. The main equipment is a manual press and a combined palm fruit digester and hydraulic press driven by a diesel engine. The process involves removing fruits from the bunch, sorting and boiling them, and feeding them to the combined digester and press to extract the oil. The oil is boiled with spices to enhance its taste and remove water. The fibre still contains some oil after digesting and pressing. It is covered with thick cloth for some days and then pressed using the manual press. This oil is of lower quality and it is sold to soap manufacturers.

Palm kernels are processed using a kernel cracker to break the kernel. This is winnowed manually or separated with clay solution and the kernel is roasted and milled using a corn mill. The oil is extracted using a manual press.

Finally the crude oil is filtered. It may also be refined by caustic soda treatment to remove FFAs and bleached with Fuller's earth or activated carbon.

Palm kernel oil is normally produced separately from palm oil. The kernels may be a saleable by-product for palm oil producers, or the palm kernel oil may be extracted by a different processor, such as manufacturers of frying oil blends or bakery fats. In general, palm kernel oil is not regarded as a cooking oil, but as an ingredient sold to commercial bakeries or food service outlets (see Chapter 2, Section 2.2).

Traditionally, extraction starts with shelling the nuts, which used to be done using stones or a pestle and mortar to crack the kernels. This has now largely been replaced by mechanical shelling using a palm kernel cracker (Fig. 4.22).

Fig. 4.22. Palm kernel cracker (Photo from J. Hounhouigan)

At a micro-scale, the mix of kernels and shells is separated in a 'clay bath', which is a slurry of clay and water. The density of the clay bath is adjusted so that the more dense shells sink while the lighter kernels float. The kernels can then be scooped off, washed and dried. The next step is to fry the kernels and then pound them to a paste, either manually or in a mechanical mill. The paste is mixed with water and heated which releases the oil from the cells. The oil rising to the surface is finally skimmed off.

At small- and medium-scale, palm kernel oil is now more commonly obtained by pressing in a screw press or with an expeller after reducing the size of the kernels using a hammer mill. At a larger scale, roller mills are used to flake the kernels. Roller mills have a series of heavy rotating metal rollers mounted one above the other. The thickness of the flakes is gradually reduced as it passes from the top to the bottom roller. The ground or flaked kernels are next cooked in a steam-heated cooking tank which adjusts the moisture content, breaks down cell walls and coagulates proteins, each of which makes final oil separation more efficient. In most systems, the meal emerges at a temperature of almost 100°C and 3% moisture. The ground meal is then passed through an expeller and the crude oil is collected. The crude oil contains fibre etc. that needs to be removed by a centrifuge followed by a filter press to produce clear oil.

Safflower is a temperate herbaceous thistle-like annual plant, varying in height from 30 - 150 cm. Each branch has 1 - 5 flower heads, containing 15 - 20 seeds per head. Seeds resemble small, slightly rectangular sunflower seeds, but with thicker, more fibrous hulls. The seed contains 36 - 48% oil. The plant gives yields of 1 tonne per ha in semi-arid climates and has moderately good drought- and salt-resistance, making it suitable for areas where other oilseeds are difficult to grow. Safflower oil is flavourless and colourless, and nutritionally similar to sunflower oil. It is used mainly as cooking oil, in the production of margarine, and it may also be taken as a nutritional supplement. There are two types of safflower that produce different kinds of oil: one is high in monounsaturated fatty acids and the other is high in polyunsaturated fatty acids (Annex A). The oil is extracted using the same methods described for sunflower below.

Sesame (Fig. 4.23) is known as gingelly and til or tillie in India, sim-sim in Arab countries and East Africa and ben or benniseed in Nigeria. It is probably the most ancient oilseed used by man and originates from the Ethiopian area.

Fig. 4.23. Sesame plant (a) ripe capsules (b) shoot top with flowers (Adapted from Rehm and Espig (1984).

It is an annual tropical and subtropical crop and requires hot conditions (around 26°C) for rapid germination, growth and flower formation. At altitudes below 1250m, the main distribution is between 25° north and south of the equator, but it can also be found further north and south. Optimal rainfall is 500 - 650 mm per year, but the crop is reasonably drought resistant and it can grow in areas with annual rainfall as low as 300 mm. Varieties may be classified either as 'shattering' or 'non-shattering', according to whether the seed capsules open during drying. Under optimum growth conditions, some varieties take only 3-4 months to reach maturity. Although yields can be as high as 2 tonnes per ha, average yields are 350 kg per ha because it is mostly cultivated in arid regions with poor soils. The average seed composition is 35 - 50% oil and 19 - 25% protein. The seed is sensitive to mechanical damage, and even minor damage during threshing can reduce the viability of an oil extraction process. Unrefined sesame oil has a pleasant flavour and can be used without further purification. The oil is also very stable due to the presence of natural antioxidants (Annex A). Oil is extracted from cleaned sesame seed either by hot water extraction at a micro-scale, by pressing or at a large scale using an expeller.

Shea nut trees are also known as Karité, Nku, Bambuk, or butter trees. The wild-growing tree is found in countries south of the Sahel in Africa. The tree grows to a height of 12 m and produces its first fruit when it is about 15 - 20 years old. It reaches full production when the tree is about 45 years old and produces nuts for up to 200 years.

Fig 4.24. Shea fruits, (Photo courtesy of Marco Schmidt)

The fruits (Fig. 4.24) are spherical and 3 - 5 cm long and have a thin shell enclosing a dark brown nut embedded in a sweet yellowish-green pulp. The nuts contain a butter-like yellow to ivory coloured edible fat known as shea butter. The average yield per tree is 15 - 20 kg of fresh fruit. 100 kg of fresh fruits produce approximately 40kg of dry kernels containing 40 - 54% fat. As well as being used as cooking oil, shea butter is widely used in traditional medicine as a decongestant, an anti-inflammatory and a healing salve. It is used as an alternative to cocoa butter in chocolate, and in cosmetics as a moisturising lotion for hair and skin and the main ingredient in traditional black soaps. In recent years there has been much interest in shea butter for cosmetics marketed under the Fair Trade banner.

Typically, shea nuts are first washed several times in clean hot water to remove any mould growth. They are then sun dried and after drying any blackened nuts are removed as these may contain aflatoxins. The nuts are cracked and coarsely pulverised in a hammer mill. The crushed nuts are roasted in a pan for about 30 minutes, and after cooling for 10 - 30 minutes they are milled, either by pounding in a pestle and mortar or more commonly using a mill.

The resulting paste is mixed with cold water to give a smooth, uniform dough. More water is added and slowly the oil and water emulsion begins to break down and the fat rises to the surface. At this stage hot water is added which melts the fat and allows the oil to separate. Finally cold water is added, mixing is continued and the solid fat gathers on the surface and is removed. The crude shea butter is heated to boil off the remaining water and solid residues settle to the bottom of the pan. Finally the oil is filtered through a cloth filter. The butter is then placed in moulds where, after cooling, it solidifies into blocks. Shea butter is an important fat in Burkina Faso, Mali and some other West African countries, where its special taste is highly regarded.

The application of expellers to shea butter production is being examined in Ghana for larger scale production. A quantity of shell has to be added to the powdered kernels to provide a 'frictional bite' to the expeller screw (see also groundnut processing).

Case study 4.6: Improved shea nut processing

In traditional shea nut processing in northern Ghana, a company that comprises a group of 15 to 20 women produced shea butter by the wet kneading method in the open in the shade under trees. The only mechanisation was a community grinding mill. Both productivity and oil yields were low and typically 15 women could process 6.5 tonnes of shea nut, yielding 2 tonnes of shea butter per month (an extraction rate of 28-30%). The work is hard and heavy and the workers need to work full time, five days a week to achieve the output. The process has now been semi-mechanised using equipment made by a local company. The project, supported by international and local development agencies is a good example of a private industry/local community partnership helping to alleviate poverty. The improved system uses:

- A mill, dedicated only to shea processing.
- A mechanical nut cracker.
- A motorised kneader.
- A mechanical roaster.

The same group of women, working the same hours, are now able to process 18 tonnes of nuts, yielding 6 tonnes of butter a month (an increase in butter yield to 33%). Their company now markets its shea butter mainly to the US and the project plans over the next year to disseminate the improved technology to many more groups of women eventually assisting up to 700 people in 35 communities.

Soyabean (*Glycine max)* is a legume nitrogen fixing plant, which is usually classed as an oilseed rather than a bean. It is grown extensively in the United States, Brazil, Argentina and China. The generally held view is that the extraction of oil from soya beans can only be profitably carried out at a large scale using solvent extraction. However, research for the preparation of this book has found that in Ghana small scale soya oil extraction takes place using expeller technology. Soya beans contain between 15 - 22% oil and importantly 40% high quality protein. Soya also contains several anti-nutritional components; in particular indigestible sugars that cause flatulence, and trypsin inhibitors that interfere with the absorption of certain amino acids in the protein. These factors can be eliminated by heating soybeans with wet steam.

Case study 4.7: Soybean processing

Mr N set up an oil processing enterprise in Ghana in 1997 with the aim to produce coconut, groundnut and soya oil. The initial soya oil plant had an initial raw material capacity of 500 kg/day and this was expanded to 2000 kg/day. The plant has two seed cleaners and six oil expellers with a combined capacity to produce 100 kg of cake per hour. The plant also has five 500 litre oil tanks and a feed mill for animal feed production. The oil is packed into 5 and 10 litre bottles and 25 gallon drums.

The company produces 110 litres of oil a day from 1000 kg of soya beans. The extraction efficiency is thus low compared to an efficient solvent extraction plant that would make 180 litres of oil. However it is clear that Mr N is able to produce oil at a competitive price in the local market. One reason could be his low transport costs compared to imported oil.

Sunflower is a very important oilseed crop, ranking fifth in world production. It is a temperate-zone plant and the main commercial production is between latitudes 20° - 50° north and 20° - 40° south, usually below altitudes of 1500m. It requires short, hot summers with not too much rain during flowering and seed formation.

Fig. 4.25. Sunflower plant

Cultivated sunflowers have distinctive large golden heads, commonly 10 - 30 cm in diameter (Fig. 4.25). Seeds from hybrid varieties have a thin, soft shell and a high oil content. Most indigenous varieties have thick, hard shells and relatively low oil contents, but they may be preferred by smallholders, who can save seed for the next season, whereas hybrid seeds have to be purchased every year. Local Tanzanian varieties, including 'Record' and 'Peredovik' have a thin shell and a high oil content and these are ideal for processing at a small scale.

Case Study 4.8: Quality of crops

Most of the raw material is from Singida and Dodoma (in Tanzania). Sunflower seed from these areas is soft and with a good oil content. However, over the few years of operation there has been a serious problem with the quality of the seeds.

Sunflower seed is flattish and oblong, with a wide range of colours. Average seed yields are 1 - 4 tonnes per ha. The oil content is 25 - 48%, but high temperatures during seed development can reduce the oil content to below 25%, which could make small-scale processing unprofitable. Traditional hot water extraction is still used but the extraction efficiency is low at around 38%. At small- and medium-scale production, oil is usually extracted using either screw presses, hydraulic presses, or expellers. The processing of sunflower seed involves cleaning and drying, followed by decortication because sunflower seed shells contain silica, which can cause wear and damage to expellers. This is then followed by filtering and drying the oil.

Other oil-yielding plants

Argan oil is produced from nuts of the Argan tree (*Argania spinosa*) that grow wild in semi-desert soil and once covered much of North Africa. They are now endangered and protected, and only grow in south-western Morocco. Because of this small and specific growing area, Argan oil is one of the rarest oils in the world. It has been used traditionally as culinary oil with a nutty taste and also in cosmetics, particularly as a treatment for skin diseases. The oil has 80% unsaturated fatty acids and is rich in Vitamin E and essential fatty acids, including omega-6 fatty acids (Annex A). It has attracted recent attention in industrialised countries because of its nutritive, cosmetic and medicinal properties and the oil is very valuable. Each tree produces green fruits, similar to large olives, which contain a hard nut that has up to three kernels. Approximately 30 kg of nuts are sufficient to produce one litre of oil. Traditionally, the nuts are processed in a similar way to shea nuts, and at a small scale the kernels are roasted, ground and cold-pressed in mechanical presses. The roasting contributes to the distinctive nutty flavour of the oil. The residual thick brown paste has a flavour similar to peanut butter, and is sweetened and used as a dip with bread. Fruit residues are used as cattle feed and nut shells for heating.

Castor (*Ricinus communis*) is indigenous to East Africa but has a worldwide distribution in warmer regions. Most cultivated varieties are short-lived dwarf annuals 60 - 120 cm high, but a large proportion of castor seeds (also known as beans) on local markets in ACP countries is obtained from wild or semi-cultivated plants. Yields of castor beans are 0.5 - 1 tonne per ha, but they have a high oil content (35 - 55%) and are suitable for small-scale processing. The oil is used for a variety of technical purposes but not as a cooking oil because the seeds contain a highly toxic substance, ricin, which is lethal in amounts as small as half a grain of sand.

Cotton seed (*Gossypium sp*) is a textile plant that is mainly cultivated for its lint. However, the seed contains 15 - 25% oil and produces a protein-rich oilcake, which is used as a protein supplement for cattle. The relatively low oil content of the seeds requires solvent extraction and the costs of both solvent extraction and refining make this crop unsuitable for small-scale operation.

Maize (*Zeamays L* or corn in USA) is a starch plant, but the high oil content of the germ allows maize oil to be a byproduct of the starch manufacturing industry, and it is extracted on an industrial scale using solvent extraction.

Marula nuts are processed in a similar way to shea nuts or in screw presses, and produce Marula oil that has a light yellow colour and a nutty aroma. It is traditionally used in cosmetics, as cooking oil and as a meat preservative and is becoming more important commercially as a cooking oil in Southern Africa.

Other less common oil yielding plants that are suitable for small-scale processing include a large number of wild plants that may have local importance in ACP countries, including:

- Babassu (*Orbignya oliefera*) originating from Brazil, and Cohune (*Orbignya cohune*) from Central America, are palms that have kernels that contain 60% oil, which is similar to coconut oil.
- Linseed (*Linum usitatissimum L.*) is cultivated for its fibre, but is also used as a spice and to produce oil for paints.
- Neem (*Melia azadirachta L.*) has seeds that contain 45% oil, which is mainly used for soap and medicinal uses.
- Niger seed (*Guizotia abyssinica*) is produced in India and Ethiopia and produces an edible oil.
- Physic nut (*Jatropha curcas* or Purgier) has an oil that is mostly used for soap making.

Summary of the chapter

✔ Select the correct method of processing for your crop that produces oils that meet the consumers' requirements. The chapter describes methods for Argan, avocado, coconut, groundnut, mustard seed, olive, palm, palm kernel, safflower, sesame, shea butter, soybean, sunflower.

✔ Decide whether to buy equipment from local engineering companies that can then repair or maintain it, or whether to buy imported equipment.

✔ If buying second-hand equipment, check if spares are available.

✔ Check suppliers and manufacturers websites for equipment manuals.

✔ Train workers to operate oil extraction equipment safely and using the optimum conditions to extract the most oil.

✔ Have a maintenance plan for equipment and make sure there are enough spares.

Entrepreneur's checklist

❑ Do you know the correct method for producing a particular type of cooking oil?

....

❑ Does your equipment meet your needs? If not, what steps will you take to improve it or replace it?

....

❑ Is the equipment to be made locally or imported?

....

❑ If buying second-hand equipment, have you checked if spares are available?

....

❑ Have you checked suppliers and manufacturers websites for equipment manuals?

....

❑ Are all guards in place on your equipment and are all safety features operational?

....

❑ Are staff trained to use the equipment correctly and safely?

....

❑ Is there a maintenance plan in place and a supply of necessary spare parts?

....

....

....

Reader's notes

Please use this space to write your own notes on Chapter 4.

Quality assurance and legislation 5

Tips for success

The following tips were provided by successful oil processors in ACP countries:

- ✔ Consistency is the key to good product quality. Understand how to control the process to make consistent products. Know the control points in your process.
- ✔ Quality can only be achieved and maintained through hard work and commitment.
- ✔ Ask yourself, is this product good enough for my customers?
- ✔ Do not compromise on the quality of raw materials.
- ✔ Maintain your quality standards because once customers are lost, you cannot get them back.
- ✔ Know the potential risks to your product and make sure you have systems to reduce the risks as much as possible.
- ✔ Do not forget quality assurance in the storerooms and during distribution.
- ✔ Know the food laws and take advice to make sure you comply with them.
- ✔ Teach staff to do simple checks on the quality of crops and products.
- ✔ Properly clean the equipment and the processing room each day.
- ✔ Personal hygiene should not be compromised. Provide clean uniforms, toilets and washing facilities.

Finally

- ✔ Read Sections 4.1-4.3, 6.1-6.6 and 10.2 in Volume 1: *Opportunities in Food Processing - Setting up and running a small food business*

5.1 Introduction

The quality of cooking oil is important for several reasons: the oil must of course be safe to eat; it must meet legal standards; and it must also meet consumers' ideas of good quality and value for money. Quality is therefore one component of the marketing mix (Chapter 2, Section 2.4). Laws that relate to the quality of foods in general are described in *Opportunities in Food Processing* Volume I (Section 6.3). There are also specific laws for cooking oils that are described in Section 5.9. Producers who wish to export their products must have in place quality assurance systems that meet international standards. The quality standards for bottled oils for export are also higher than those for crude oil. The standards are described in detail by the Codex Alimentarius Commission (Annex B) and details may be available from the government's export promotion or export development ministry or the Bureau of Standards.

Both the consumers' view of quality and legal quality requirements mean that oils must be safe and made to the same standard time after time.

To achieve this it is necessary to have a Quality Assurance (QA) system. Research for this book has shown that many small-scale oil processors do not have such a system in place; instead problems with quality are simply solved 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 might occur and have a QA system in place to prevent them before they arise, rather than trying to correct them afterwards.

Not only will this ensure uniform quality products, but the producer also saves money and the image and reputation of the business are protected. This chapter describes the steps needed to set up a QA programme in an oil processing unit.

5.2 Quality assurance procedures

The main quality factors for cooking oil are colour, clarity, taste/flavour and odour. Correct colour and clarity are mainly due to proper clarification after the oil has been extracted. The flavour and odour of oil depend on the type of raw material used and the extent of rancidity (see Annex A). Oil is also notorious for picking up foreign odours and flavours from materials stored nearby. The crude oil produced at a small scale is not usually refined to remove flavours and colours. It is therefore important to produce high quality oil that has no hint of rancidity or off-flavours and odours. This can be done by:

1. Control over raw material quality (buying good quality crops and storing them in a clean dry storeroom away from materials that could cause off-flavours or odours).
2. Control over processing (use crops on 'first-in-first-out' basis, only prepare enough crop for the day's production and do not store partly prepared crops, use correct processing conditions) and
3. Control over packaging and storage (clarify the oil as soon as possible and store it in clean containers, pack oil in containers that are clean and dry, fill containers as much as possible to limit the contact of oil with the air, store the oil in a cool dark storeroom).

Many producers think of quality assurance as simply testing their products (which is quality control), but a QA programme is much wider than this and should include the following components:

- Raw material inspection.
- Process control and the correct operation of equipment.
- Operator training and hygiene.
- The condition of the building and routine cleaning programmes.
- Product quality.
- Correct fill weights and sealing of packs.
- Control over storage and distribution.

These are described in the following sections.

Case Study 5.1: Importance of QA

- The following experiences of quality assurance were provided by oil processors in different countries:
- The enterprise produces 500 litres of sunflower oil daily. The unit does not have a big laboratory, but is able to conduct simple tests and standardise the product quality to ensure that there is minimal variation in oil quality.
- To ensure the quality of its oil, the enterprise receives assistance from the government supported programme for assistance to agriculture and its suppliers.
- There is a small quality control lab at the factory. The oil they produce has an acceptable quality apart from a slight beany odour. Issues of quality control are not quite strong, but they are making efforts to improve the situation.
- The mill has good prospects to enter a larger market if they continue to institute strict measures to ensure the quality and safety of products.
- Quality assurance of raw material is based on elementary knowledge gained through experience and the training they got from technicians who installed the press.
- The oil mill owners are eager to improve the quality of their product and have it certified by the national Bureau of Standards, a process they have initiated.
- Quality assurance is their key word because the company produces for particular local and niche international markets that will not compromise on quality. Products for export into European countries are subjected to very strict European quality assurance.
- "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 crops, water, packaging materials and the whole manufacturing process. "We have our own laboratory where the quality of the crops and products are analysed and samples are also sent to independent laboratories". Since the Standards Board also certifies them, they conduct random quality checks on products.
- In the Pacific region, a consultant who provides training and support to small food processing enterprises said "I make every effort to work towards Codex standards in each enterprise. I give a form to all processors

> to use as an aide memoir to set up formal cleaning procedures. We have also found that countries such as Australia, New Zealand and the west coast of the USA are tolerant to new processors even though they do not yet meet the Codex/HACCP codes".

There are many different types of QA systems, to ensure safety and quality, but the main one for small-scale oil processors is the HACCP system, which is outlined below. Others that are used by larger companies include Total Quality Management and ISO 22 000 systems and these are mentioned briefly below.

5.3 Safety of products - HACCP

In most ACP countries, the law requires that food processors produce safe foods in a hygienic way, and there are serious penalties for those who contravene hygiene and food safety legislation (see *Opportunities in Food Processing* Volume 1, Sections 6.3-6.5). Heating the oil and the low water content of oil reduces the risk of bacterial food poisoning almost completely. The most important risk is from moulds that can grow on nuts or seeds that are not fully dried, which produce a poison called 'aflatoxin' (Annex A). The safety of cooking oils can be assured by using a management method known as the Hazard Analysis Critical Control Point (HACCP) system. Many small-scale oil 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 demanded by the local Bureau of Standards or by institutional or commercial buyers of cooking oils. It is also required by most oil importers.

Hazard analysis is used to identify anything in the oil production process that is potentially harmful. This includes ingredients, storage conditions, processing conditions packaging, and actions by staff that may affect product safety or quality. A HACCP plan allows potential hazards in a process to be identified, assessed, and controlled or eliminated. In oil processing, potential hazards include poisons such as aflatoxins in the oilseeds, pesticide residues or physical contaminants (such as dead or living insects, excreta, hair from rodents, metal fragments or glass) that if eaten could harm consumers. A HACCP plan sets the tolerances that are allowed for each hazard. It also defines the criteria that are needed for an acceptable product and the controls that are needed to achieve the required quality.

The system is based on monitoring 'critical control points' (CCPs). These are points or stages in the process where a loss of control would result in an unacceptable risk to food safety or quality. The system also defines the actions that need to be taken when the results of checks on CCPs are outside pre-set limits (see Table 5.1).

Stage in process	Potential hazard	CCPs	Target and limits	Control Measures
1.Raw material harvest and storage	Contaminants, excessive moisture, causing mould growth and/or aflatoxin production.	Level of contaminants. Moisture content of crop. Mouldy grains or nuts. Aflatoxins.	Max. 2% of crop weight. 12% +/- 1% No mouldy pieces Max. 4 µg/kg	Visual checks of crop. Check moisture content of crop. Scan crop for mould growth, sieve, and check magnets
2. Raw material preparation	Excess moisture content.	Moisture content of crop.	12% +/- 1%	Moisture content of crop after pre-conditioning.
3. Oil extraction	Excessive heat, contamination by grease, copper or other metals from machinery, free fatty acids, failure to remove moisture.	Time & temperature of heating. Fatty acid content. Moisture content of oil.	80oC +/- 2 oC for 15 min +/- 2 min. Below 1.5% Below 0.1%	Monitor process conditions. Filter oil. Check moisture and free fatty acids against targets & limits
4. Packaging and storage	Excessive heat, light or air causing excess fatty acids and rancidity. Contamination from glass containers. Migration of chemicals from plastic containers.	Free fatty acids. Faults in glass. Incorrect type of plastic.	Below 1.5% None -	Keep a reference sample and analyse for free fatty acids. Check containers are clean and sound and that caps fit correctly.

Table 5.1. Examples of CCPs for cooking oil production.

Note: the figures in the table are examples only. Producers should devise suitable CCPs for their own product and process.

HACCP is used at each stage of an oil extraction process, and includes raw materials, processing, storage and distribution. Implementing a HACCP scheme involves the following stages:

1. Identify the potential hazards that could threaten a consumer and assess the level of risk for each hazard (this assessment should be made by people who have a high degree of expertise and experience in oil processing).
2. Identify the CCPs that are needed to control the hazards to assure safety. A 'Decision Tree' (*Opportunities in Food Processing,* Volume 1, Section 10.2) can be used to help decide on the CCPs.
3. Devise target levels and limits for each CCP (Table 5.1).
4. Establish procedures to monitor the CCPs, either using chemical tests or visual observations.
5. Decide the corrective actions that are needed when a result for a CCP is outside the limits.
6. Finally the system should have procedures to verify that HACCP is working correctly and record-keeping procedures to document the system and review it.

It should be clear who has the authority to make decisions in the HACCP scheme and who is responsible for checking that correct actions are taken and properly recorded. This is not just the responsibility of the owner or manager, and a QA system should be developed with the process workers so that everyone is clear about each other's role in the system (for example, in the absence of the owner, one staff member should have the authority to stop production in the case of a serious quality problem). Records should include for example, the frequency of testing and the criteria that show whether a product is satisfactory; cleaning procedures (what is cleaned, how and when it is cleaned, who cleans it and what with) and records of workers' illness or infections. Further details are given in references in Annex B.

To develop a HACCP system, most small-scale oil processors need assistance and advice from professionals, including staff at a Bureau of Standards or a university food science department who have experience of the product and the process. This type of assistance can also be provided by some manufacturers' associations.

Other QA systems

To ensure that safe, high quality oils are consistently produced, the concept of Total Quality Management (TQM) is used by larger companies in some ACP countries. The aim is to understand all aspects of the process, to put controls in place, monitor performance and measure the improvements. In outline, a TQM system covers the following areas:

- Purchasing and control of raw materials (including crop specifications, auditing[3] suppliers, crop inspection, storage and stock control).
- Process control (including critical control points in a HACCP scheme, hygienic design of the building and equipment to minimise contamination, cleaning schedules, recording production data, sampling and testing methods).
- Premises (including methods of construction to minimise contamination, maintenance, waste disposal).
- Personnel (including training in correct processing, personal hygiene, clothing and medical screening).
- Product quality standards for non-safety quality issues, monitoring of quality before distribution (including types of inspection to check quality against specifications, packaging checks, what to do with sub-standard products or customer complaints).
- Distribution (including methods to reduce damage to oils throughout the distribution chain, traceability to the day of production and product recall procedures).

The benefits of a TQM system are more cost effective production (by 'getting it right first time'); reduction in wasted materials; consistently meeting customer needs, which results in increased customer confidence and sales and fewer customer complaints; improved machine efficiency and increased production capacity. The system also results in better trained staff and their heightened awareness and commitment to quality. It shows regulatory authorities that the producer has a commitment to high quality products.

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3 Audits are the regular systematic collection of information to monitor the ability of suppliers to meet agreed standards or delivery requirements.

Larger-scale oil producers and those wishing to export their products should meet the international standard for food safety management systems (known as ISO 22 000), which was developed from an earlier standard (ISO 9001) in 2005. ISO 22 000 specifies the requirements for a food safety management system that include: 1) communication with customers and suppliers to ensure that all safety hazards are identified and controlled at each step in the supply chain; 2) management procedures that ensure effective safety systems are operated and incorporated into the overall management activities of the company; 3) the use of HACCP principles and prerequisite programmes (PRPs) that include good manufacturing practice, good hygiene practice and good distribution practice; and 4) proper environmental and waste management systems and health and safety in the working environment. Further details of TQM and ISO 22 000 are given in the references in Annex B.

5.4 Quality of raw materials

This section describes the quality checks that should be made on crops, and methods to prevent contamination. Crops should be harvested when fully mature, as they then contain most oil and it is more easily extracted. Under-ripe materials give a lower yield of oil and are more difficult to process. Over-ripe fruits are easily bruised and this allows enzyme action and bacterial growth, which reduces the oil yield and causes rancidity. Maturity is judged with experience, by the colour and size of the raw materials. Raw materials must also be in good condition because any deterioration leads to a rancid, unpleasant flavour in the oil. The processor should check that the crops are of the correct quality for processing and reject those that are not suitable. Case Study 5.4 shows an example of a quality specification for a crop.

> It is not possible to improve the quality of raw materials by processing them. Poor quality raw materials reduce the yield and quality of oils.

The main contaminants found in oil-bearing crops are:

- Foreign material (soil, weed seeds, stalks, stones, string, leaves, metal or glass etc.).
- Infestation by dead or living insects, excreta, hair from rodents or feathers from birds.
- Mould growth/aflatoxin production.
- Chemical residues (e.g. insecticides, fertilisers).
- Oil or grease from vehicles or machinery.

Seeds and nuts in particular should be cleaned using a sieve to remove soil, sand and grit, which would not only contaminate the oil but also rapidly wear out the equipment. Leaves, stalks, seeds from other plants and stones should be picked out using an inspection table and small and/or lightweight contaminants are removed by winnowing. A well-designed QA programme prevents these contaminants from entering the crop or discovers and removes them before it is processed.

> Careful inspection by properly trained staff to sort out substandard materials before money is spent 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 the greater the level of control.

Most small-scale processors buy their crops from farmers or local market traders, and therefore have little control over the way in which the crop is grown, harvested, stored or transported. Poor quality crops are one of the most common problems facing processors, especially immature crops or those that are contaminated. A great deal can be done to improve quality standards if processors discuss with farmers the quality they require in their crops and why this is important (see contracts with farmers in Chapter 6, Section 6.3).

> Contract arrangements with farmers allow greater control by processors over the quality of their raw materials.

Transport operators are paid by the weight or volume of goods carried, and they 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. Crops can also easily absorb odours from kerosene or diesel fuel and fumes, and care should be taken to ensure that these materials do not come into contact with crops. However, the power of traders and middlemen sometimes makes it difficult for processors to introduce control measures, and a better option is for processors to collect crops directly from the farmers using their own vehicles. Alternatively, they should use contracted hauliers' vehicles that have been inspected to make sure that they are clean and well maintained (Case study 5.2). 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.

Control over the quality of crop containers is part of a QA scheme, and it is preferable for processors to supply good quality sacks or field boxes for collecting crops, and possibly to employ a member of staff to check, fill and weigh containers on the farm at the time of collection.

Case Study 5.2: Quality of raw materials

- The palm fruit bunches are harvested from their own plantation or they are purchased from neighbouring plantations. In the case of purchased bunches, the enterprise organises harvesting in collaboration with the owners to ensure that only fully ripened bunches are harvested. This ensures the quality of raw materials and hence the quality of the oil.
- Their policy is to produce high quality oil and oilcake for human and animal consumption, and this requires good quality raw materials. The quality and variety of the crops are also important in determining the efficiency of oil extraction.
- Quality assurance is performed in collaboration with the National Office of Applied Food and Nutrition. The enterprise also benefits from technical assistance by the National Agro-Food Programme. The quality of oil palm trees is ensured by the suppliers, the national institution that produces and supplies oil palm plants for the enterprise's farm.
- To maintain quality the company uses good quality crops and has invested

in an ultra-modern analytical laboratory that is randomly checked by the Food and Drugs Board to retain its certificate. The company occasionally sends refined and crude oil and cake products to the Food Research Institute for analysis and the Ghana Standards Board for certification. Products that do not meet the desired quality for edible oils are sold to soap makers and paint producers at reduced prices.

The first checks on crops should ensure that they are not damaged, infected with moulds, or seriously contaminated by rats, insects, birds or foreign bodies. The percentage of rejected crops should be monitored, as this is also an important factor in calculating the true cost of useable raw materials (see Section 7.1).

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 using the calculation:

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

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 have 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 farmers or traders 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.

In contract growing of crops, 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 and proper post-harvest storage. Of these, the use of correct post-harvest storage is the most important to prevent mould growth and contamination by aflatoxins. Although pesticides use is less common in ACP countries, improper use of pesticides or chemical fertilisers can lead to 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 and training 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.

Most crops must be harvested when they are fully mature to give the best yield of oil. 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 increase processing costs because of lower oil yields. The moisture content may also be too high because the crops are not properly dried, which again allows moulds to grow and risks contamination by aflatoxins. Additionally, mould growth on a few seeds or nuts can quickly lead to infection and loss of a whole batch. If possible, the processor should work with farmers as part of a contract arrangement to specify and/or supervise harvesting at the correct stage of maturity, and also control on-farm post-harvest processing to properly dry crops and to reduce the risk of contamination. During initial inspection of crops, it is important that the processing staff are trained to remove any discoloured or mouldy pieces as these are likely to contain aflatoxins and would also lead to off-flavours in the oil. They should also remove all leaves, insects and other materials that could contaminate the oilcake after oil has been removed. Processors may wish to draw up standards for the quality of their raw materials and an example using shea nuts is given in Case Study 5.3. This is likely to be more detailed than standards used by a small-scale processor, but it gives an indication of what can be included.

Case Study 5.3: Quality specifications

An importer of shea nut kernels specifies the following quality standards.

General Requirements:
Shea kernels should come from ripe fruits collected at maturity (fallen from the tree). For a given batch, the kernels should all come from the same harvest. The fruits should be de-pulped to obtain nuts, which are boiled and dried in a way that does not compromise the quality of the kernels. The kernels should be obtained by shelling the nuts. They should have the shape, appearance and taste characteristic of the variety. They should be safe and suitable for processing for human consumption and should be free from foreign and rancid odours and mustiness. The kernels should be free from insect infestation, mites, insect fragments, excrement and rodent contamination.

Sensory characteristics:
Colour: deep tan/chestnut colour, characteristic of having undergone heat treatment.
Odour: characteristic of the product.

Physical characteristics:
The kernels should be free of living insects and fungus, noticeable dead insects, mites, insect pieces, contamination by rodents and insect damage visible to the naked eye.
Impurities: (shell debris, pieces of leaves and branches, stones): 1% maximum.
Broken kernels: 1% maximum.
Damaged kernels (mildewed, germinated and hardened/blackened): 0.5% maximum.
Shrivelled kernels: 3% maximum.
Mouldy/decayed kernels: 2% maximum.
Contamination with other nut varieties: 1% maximum.

Chemical characteristics:
The moisture content of kernels should be less than or equal to 8%.

The fat content should be 45% minimum.
Total unsaponifiable matter should range between 1% - 19%.
Free fatty acid content should all not be more than 3%.
Peroxide Value should not be more than 15 meq/kg fat.
Aflatoxin content: 4μg/kg maximum.
Kernels should not contain heavy metals in amounts that may present a hazard to human health and should not exceed the limits specified as follows:
Lead: 0.1 mg/kg
Arsenic: 0.1 mg/kg
Iron: 5.0 mg/kg
Copper: 0.4 mg/kg

Pesticide residues and micro-organisms:
Kernels should conform to the maximum limits for pesticide residues as determined by the Commission of the *Codex Alimentarius*.
The kernels must be free from micro-organisms likely to develop under normal conditions of storage and free from substances produced by micro-organisms in quantities sufficient to present health risks. Kernels shall not contain any substances originating from micro-organisms in amounts that may represent a health hazard. They should contain not more than 1×10^3 colonies for total viable count and not more than 1×10^2 colonies for yeast and mould count.

Hygiene:
The product should be picked, handled and packed in accordance with Good Agricultural Practices, CODEX CAC/RCP 6 (1972), recommended international code of hygienic practice for tree nuts; and CODEX CAC/RCP 59 (2005), code of practice for the prevention and reduction of aflatoxin contamination in tree nuts. It should be handled in accordance with suitable sections of the Recommended International Code of Practice – General Principles of Food Hygiene (CAC/RCP 1-1969, Rev. 4 (2003)).

Packaging:
Kernels must be packed in containers that preserve the hygienic, nutritional, technological and organoleptic qualities of the product. Containers must

be made from materials that do not transmit to the product any toxic substance, nor any odour or undesirable flavour.
When kernels are packed in bags of jute or polypropylene, these must be clean, sound, free of insects and sufficiently strong and properly sewn or firmly sealed so as to ensure sufficient protection of the kernels during storage, handling and transport. The materials must be devoid of chemicals not acceptable in bags used for packaging food nuts.

Bags should be labelled in conformity with the General Standard for the Labelling of Pre-packaged Foods (CODEX STAN 1-1985 (Rev. 1-1991)) in addition to the following specific provisions:
Each bag of shea kernels shall be written or printed clearly and indelibly with a non toxic ink with the following information:

- Product name: the product name should be 'shea kernel'.
- Name and address of the producer and registered trade mark of producer or packer.
- Net weight (kg).
- Batch code.
- Country of production.
- Year and month of harvest.
- Required storage conditions.

5.5 Process control

The different types of processing for oilseeds, nuts and oil-bearing fruits are described in Chapter 4. The stages of grinding seeds or nuts to a flour or pulping fruits require quality checks to ensure that uniform flour, pulp or pieces are prepared. For flours, the main QA control point is conditioning the flour by heating it with a small amount of water. The temperature and amount of water should be carefully controlled: if the temperature is too high, the material dries out and the oil can be damaged; if the material is too moist the oil yield is reduced. In practice, the checks are made by feeling the flour - it should not be too sticky (i.e. too wet) and it should not easily fall apart (i.e. too dry). This requires experience of the material by operators, and although this type of testing is subjective, experienced workers can be very accurate in their assessment. The material can also be checked by analysing the moisture content (Section 5.7).

When processing using an expeller, the operating conditions (mainly temperature and time) used in the expeller should be checked. The main control is the choke ring which is adjusted to control the pressure in the extruder. If the pressure is too high, it causes over-heating of oilseed flours that lowers the quality by developing off-flavours. If the pressure is too low, under-heating reduces the yield of oil that can be extracted. It is therefore essential that operators be trained to correctly use the expeller and to record the operating conditions for each batch.

Case Study 5.4: Process control

- The oil is filtered and quality is assured through maintenance of cleanliness and regular checks to ensure that the filter press is in good condition.
- Production of high quality oil is the hallmark of Mr K. He does this by ensuring the use of high quality crops and attention to detail during processing. For example, he makes sure that the expeller setting is correct and that the oil temperature is not too high during boiling to drive off the water.
- There is no formal system in place to check the quality of the products, but workers ensure that raw materials are always in their best condition before processing.

A record should routinely be kept of the yield of oil from the process, and this should be compared to the yield that could be expected from a particular crop. Yield is calculated as follows:

$$\text{Yield of oil} = \frac{\text{Weight of oil extracted}}{\text{Weight of crop processed}} \times 100$$

Calculation of oil yield for production control is described in Chapter 6, Section 6.4 and Table 6.1, and examples of typical yields of oil from different crops are given in Table 6.2.

Once the oil is extracted and processed, it should be packaged in suitable containers. In view of the factors that cause rancidity described in Annex A, and the need to contain the oil without leakage, suitable containers for oil include: 1) fully-sealed glass or plastic bottles, preferably made from coloured glass or plastic, or clear bottles that are kept in the dark using a cardboard box; 2) metal oil cans, where the metal is tin-coated to prevent oil from reaching the iron of the can; or 3) glazed ceramic pots that are sealed with a cork and wax stopper. Plastic bags should only be used for temporary packaging (e.g. to allow consumers to carry oil to their homes).

Care should be taken to properly clean oil containers if they are reused. A film of old, rancid oil on the inside of an empty container quickly makes fresh oil go rancid. The containers should be properly dried after cleaning to remove all traces of moisture. If correct packaging and storage conditions are not used the shelf life of the oil is reduced from many months to as little as a few days or weeks.

Oilcake should be dried to prevent mould growth and stored in a cool dark place to prevent rancidity of the oil remaining in the cake. It should be protected from insect and rodent attack using the same methods as those used for the raw material.

5.6 Operator training, hygiene and sanitation

It is essential that the building is correctly constructed (see Chapter 3, Section 3.2 and *Opportunities in Food Processing*, Volume 1, Section 5.1). Routine monthly inspections should be 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.

Good sanitation in an oil processing unit and good hygiene by operators are essential to produce high quality oils. QA procedures include proper cleaning of equipment and processing rooms, washing hands, and removal of wastes as they are produced. Together, a manager and processing staff should develop a cleaning plan and personal hygiene rules that ensure safe production. The law in some ACP countries requires processors to monitor the health of workers. If staff report a stomach illness or skin infection, it is important not to penalise them, otherwise they will hide a problem in order to be paid. They should be transferred to other jobs that do not allow direct contact with the raw material or the product (see also *Opportunities in Food Processing*, Volume 1, Section 10.3).

The manager should make sure that all staff are trained and know their own hygiene and cleaning responsibilities. There should be sufficient cleaning materials and equipment, and sufficient time for staff to properly clean machinery and processing areas after production has finished. Cleaning schedules should be drawn up and 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. If animal or insect infestation is found it should be treated immediately using traps or approved 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 window sills 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 or oilcake.

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

Where by-products are to be sold, they should be collected and stored in a separate storeroom (Fig. 3.1). If they are not sold, by-products and any wastes should be placed in bins with lids and not piled on the floor. Processors should have a management system in place to remove them from the building as they are produced, rather than letting them accumulate during the day. These materials should never be left in a processing room overnight.

Storeroom management

QA systems should be developed to monitor the types and amounts of crops, product, and packaging materials that are in storage and the time that they remain in storage. Records kept by storekeepers are described in Chapter 6, Section 6.8. Stores should be cool, dry, regularly cleaned and protected against insects and rodents. Mobile racks or steel shelving are easy to inspect and assist stock rotation. Correct stock rotation is needed to maintain the quality of materials and prevent unnecessary wastage due to deterioration of crops and to maximise profits. Weekly checks should be made on both products and raw materials. Stock rotation of products is easier to operate using date coding, and in most ACP countries oils legally require a 'best before' date (see Section 5.8). Producers can also use a date stamp on packages to identify the date of production. Control of product quality does not end 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.

5.7 Methods of analysis

The quality of crops and oils can be assessed by sensory methods (observation or tasting), or by chemical tests. For crops the sensory methods include assessing the hardness of oilseeds to see how dry they are and visually checking for mould growth. For oils the sensory quality can be assessed by examining the oil for clarity, checking the colour against colour charts to make sure it is within the correct range, and tasting the oil to detect any off-flavours, rancid taste, or to ensure that it has the required characteristic flavour. Details of methods that are used to do controlled sensory analyses are given in references in Annex B.

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

Moisture content of crops

Measurement of the moisture content of oilseeds or nuts is useful to ensure that they are within the correct range for extracting the maximum yield of oil. It is measured by drying a known weight of finely ground or chopped crop 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) three 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:

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

5

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

Aflatoxin content of crops

Although there are test kits for aflatoxins that are available commercially, they are expensive and require some scientific knowledge to use them properly. Small-scale processors should therefore periodically send samples of crops to a laboratory for aflatoxin analysis. For routine QA to screen for the presence of aflatoxins in crops, a hand-held ultraviolet light with a wavelength of 365 nm can be used to scan nuts and seeds. Any that contain aflatoxins glow with a greenish-gold fluorescence under the light. The lights are available at a reasonable cost. However, this is not an analytical method for detecting aflatoxins because the compound that produces the light is actually kojic acid rather than aflatoxin. So while the method is useful for screening crops because it will show if aflatoxin is present, it should be noted that fluorescence can also occur if there is no aflatoxin present (a 'false positive' result).

Free fatty acid content of oils

This test is a measure of the development of rancidity in oils, and can be used to assess whether the oil is fresh or too old. There is a chemical method to measure free fatty acids (FFAs) that is relatively simple once a person has been trained to use it. It requires basic laboratory equipment and access to some specialist chemical reagents. If the skills, equipment or reagents are not available, the processor should send a sample of the oil to a commercial or government laboratory and request to have an Acid Value test done.

The laboratory equipment required is as follows: a 25 ml pipette, a 1 - 2 ml pipette, a pH meter or pH test-strips, an accurate measuring scale (+/- 0.01g), a 50 - 100 ml burette and two or three 100 - 200 ml glass beakers and flasks.

Procedure

1. Mix 25 ml of diethyl ether with 25 ml of ethanol and 1 ml of 1% phenolphthalein solution.
2. Neutralise the solution with 0.1 M sodium hydroxide.
3. Dissolve between 1g and 10 g of oil, measured accurately, into the mixed neutral solution.
4. Titrate with 0.1 M sodium hydroxide solution, shaking the sample constantly until a pale pink colour does not disappear for 15 seconds.

The Acid Value is calculated as follows:

$$\text{Acid Value} = \frac{\text{Titration (ml)} \times 5.61}{\text{Weight of sample used (g)}}$$

FFAs are calculated using a conversion factor. For most oils the factor is 0.0282, but for palm oil it is 0.0256 and for palm kernel oil or coconut oil it is 0.0200. Rancidity can often be detected when FFAs are above 0.5% by tasting the oil.

More recent developments are simple test strips that change colour when dipped in the oil. The colour change depends on the amount of free fatty acids in the oil (Fig. 5.1). A reading above 2.5% FFAs indicates that the oil is unacceptable, whereas readings below 1.0% FFAs indicate a satisfactory quality. Between 1% and 2.0% FFAs would indicate that the oil may be unsuitable for retail sales, but it may be acceptable to commercial frying businesses.

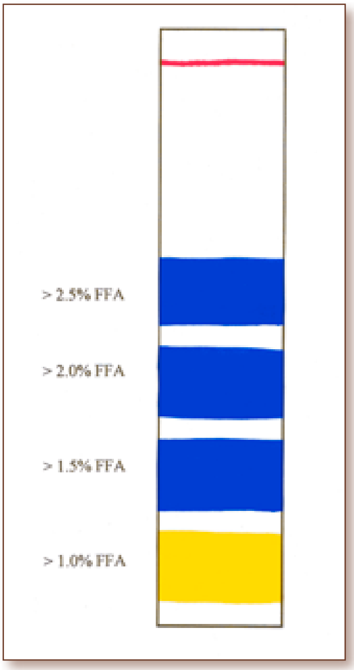


Fig. 5.1. Test-strip for measuring free fatty acids (From All QA Products)

Peroxide Value

Peroxides are chemicals that form in the oil during storage and therefore give an indication of how well the oil has been stored (low levels indicate good storage conditions). The Peroxide Value is therefore a measure of the extent of rancidity in oils after storage. The maximum level for peroxide value for edible oils is set at 10 milli-equivalents of peroxide oxygen per kilogram of oil in some countries. This standard should be checked with the local Bureau of Standards. A chemical test is possible to measure Peroxide Value of cooking oil, but this may be too complicated for small-scale processors. Samples should be sent to a local analytical laboratory, requesting a Peroxide Value analysis. An alternative is a rapid test kit that can perform 15 tests and can be used in routine quality assurance. The test has a detection limit of 0.5 milli-equivalents oxygen per kg of oil. The kit is supplied with bottles of reagents, a syringe and other equipment and instructions for use. Further details are given by the manufacturer of the test kit in Annex C.

The method is as follows:

Precaution: the test solution is dilute acid, which causes skin irritation. Gloves must be worn to do the test.

1. Add a small amount of solid reagent to a test bottle using a plastic spoon and add 2 drops of reagent solution using a plastic dropper. Swirl to dissolve completely.
2. Add 1 ml of cooking oil using a plastic dropper and add 4 ml of test reagent solution using a third plastic dropper. Close the bottle and shake for 1 minute.
3. Add 4 ml of the next test solution using a dropper and then add 2 drops of solution to develop a colour change (mixed liquid is dark blue). Close and shake the bottle up and down 10 times.
4. Add 0.5 ml of the final test solution using a syringe, close and shake the bottle up and down 10 times, and observe the colour. If it changes to a turbid, white colour, stop the test and read the result (N°1 in Table 5.2). If the colour remains unchanged (dark blue), add 0.5 ml more test solution and shake the bottle. Read the result (N° 2 in the table).

No.	Amount of solution added (ml)	Colour shown	Peroxide value	Result
1	0.5	White turbid Dark blue	Lower than 5 Higher than 5	Pass Fail (rancid)
2	1.0 (0.5 +0.5)	White turbid Dark blue	Lower than 10 Higher than 10	Pass Fail (rancid)

Table 5.2. Analysis of results for cooking oil test kit for peroxide value (rancidity).
(From Global Complex Co., Ltd)

Other analyses that require a laboratory

Moisture content of oils

The method needed to measure moisture content of oils is not suitable for use by small-scale processors and samples should be sent to a laboratory with a request for their moisture content determination using the Karl Fischer method. A simple check for moisture is to splash some oil onto a hot-plate. If it spits, there is moisture present.

There are a number of other types of analysis that can be done on cooking oils, and overseas oil importers might request these. They include the density and refractive index of the oil, its melting point, colour, Iodine Value, Saponification Value, Hydroxyl Value and a measurement of unsaponifiable matter (Table 5.5). None of these tests are suitable for small-scale processors to do themselves and if they are required, samples should be sent to a reputable analytical laboratory for them to be done.

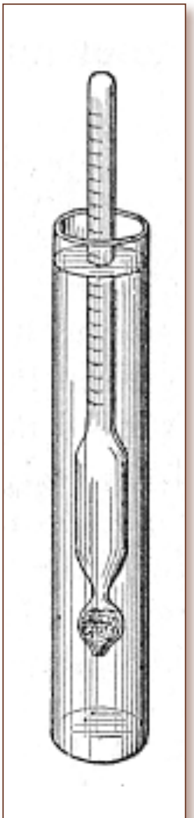
5.8 Packaging, storage and distribution

Long-term preservation of cooking oils depends on preventing rancidity by controlling the amount of air, heat and light that can come into contact with the oil during storage. The type of package that is used and the conditions of storage and distribution/display are the main factors that are used to give the required shelf life. It is important that packaging, storage and distribution are each included in a QA system.

Types of packaging

Glass bottles, preferably coloured glass that is sealed with an airtight cap, are the preferred containers for cooking oils. Glass bottles may contain splinters, cracks, or bubbles in the glass, or strings of glass across the interior. They therefore need checking more carefully than other types of packaging to prevent these defects causing serious harm to consumers. Staff who check bottles 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 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 cap to fit. It is also necessary to find the heaviest empty container to use in check-weighing. If bottles are re-used, they should be thoroughly washed and completely dried, and inspected by visually inspecting them and smelling them to ensure that they do not contain any residues, before filling with oil. Glass is a foreign body hazard. A glass breakages procedure should be devised as part of a QA plan to manage breakages effectively and provide assurance that no glass fragments can enter the product.

Fill weights and sealing



The check-weight is the weight of the heaviest container plus the weight of oil when the bottle is filled. In most ACP countries it is an offence to sell an under-weight or under-volume product, and over-filling the bottles means that a producer is giving product away. The capacity of a bottle can be found 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 of water. However, because oil is sold by volume, the check-weight needs to be converted to volume using the density of the oil. The density of oil can be measured using a hydrometer (Fig. 5.2). Note: the density of oil varies with each type of oil and the temperature at which the density is measured. The range is from 0.91 to 0.93 g/ml at temperatures of 15 - 25°C, compared to water, which has a density of 1.00 g/ml. It is therefore important that the readings taken using a hydrometer are all at the same constant temperature. Ideally, the temperature of the oil should be controlled by immersing the sample container in a thermostatically controlled water bath.

Fig. 5.2. Hydrometer for measuring the density of oil

Oil has a lower density than water and the volume of oil should be calculated as shown in Table 5.3.

Type of oil	Density (g/cm3 or g/ml)	Temperature at which density measured (oC)	Volume (ml) of 100g of oil
Coconut	0.919	20	108.81
	0.925	15	108.11
Cotton seed	0.915	25	109.29
	0.926	15.5	107.99
Groundnut/peanut	0.912	25	109.65
	0.913	20	109.53
	0.917-0.921	15.5	109.05 - 109.64
Maize	0.921 - 0.925	15.5	109.64 - 108.11
Olive	0.910 - 0.915	25	109.89 - 109.29
	0.918	15	108.93
Palm	0.9210 - 0.9240	15.5	108.58 -108.22
Palm kernel	0.912	15.5	109.65
Rapeseed	0.913 - 0.917	15.5	109.53 - 109.05
Safflower	0.924 - 0.928	15.5	108.23 - 107.76
Sesame	0.920 - 0.924	15.5	108.70 - 108.22
Soya bean	0.924 - 0.928	15.5	108.22 - 107.76
Sunflower	0.919	20	108.81
	0.924 - 0.926	15.5	108.23 - 107.99

Table 5.3. Conversion of weight of oil from check-weighing to volume of oil
(Adapted from Elert in Annex B) Density of cooking oils, The Physics Factbook, Edited by Glenn Elert, at http://hypertextbook.com/facts/2000/IngaDorfman.shtml)

During production a random sample of bottles should be checked for fill-weight using a check-weighing scale (see also *Opportunities in Food Processing* Volume I, Section 6.6). At the same time the label should be checked to ensure that it matches the product inside, and that the use-by date and batch code numbers are correct.

Lower cost alternatives to glass are plastic bottles but these should not be re-used. There are fewer potential quality problems with plastic bottles, and routine QA checks are mainly to make sure that they contain no foreign bodies, such as insects or dirt. Some micro-scale producers sell oil in polyethylene bags, but these do not offer protection to the oil against light, heat or air and can only provide a short shelf life. They are acceptable for small quantities of oil that will be used by the consumer within a few days, but they are not suitable for distribution and retail display. Apart from visual examination, the procedures and equipment for testing plastic films are likely to be too expensive for most small 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 (Annex B).

Value is added to the oil 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 oils.

Storage and distribution

Oil may be stored in bulk containers away from light and sources of odours, but it is advisable to pack it in retail containers as soon as possible so that it does not deteriorate before it goes on sale. Bottles of oil should be stored in lightproof cardboard boxes on pallets in a storeroom. The storeroom should be cool and dark with a good ventilation to maintain a flow of air and with protection against insects and rodents. The cardboard boxes also protect bottles of oil from damage during transport, when they are distributed to sales outlets. Checks should be made to ensure that retailers and other customers sell the oil before its 'best-before' date.

5.9 Summary of legislation

Establishing an oil processing enterprise and factory

In most ACP countries there are laws governing the setting up, registration and operation of food processing businesses, including oil mills. 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 information below is 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). Volume 1 (Sections 6.3-6.5) also contains details of the general food regulations concerning labelling, presentation and advertisements, weights and measures and hygiene practices during food processing and handling. Legislation covering exports and international trade can be obtained from the United Nations Committee on Trade and Development (UNCTAD), and The Codex Alimentarius Commission (CAC) sets the standards for many raw materials and processed foods (see Annex B). Each member country has a local 'focal point' where information on UNCTAD or Codex standards can be obtained.

Product definitions and specifications

Cooking oils are defined by the Codex Alimentarius Commission as follows:
Edible vegetable oils are foods that are obtained only from vegetable sources.
Virgin oils are obtained, without altering the nature of the oil, by mechanical procedures, (e.g. expelling or pressing), and the application of heat only. They may have been purified by washing with water, settling, filtering and centrifuging only.
Cold pressed oils are obtained, without altering the oil, by mechanical procedures only, (e.g. expelling or pressing), without the application of heat. They may have been purified by washing with water, settling, filtering and centrifuging only.

Oils have voluntary compositional standards defined by the CAC, which may be used by commercial buyers to specify the quality required (Table 5.4). Alternatively the chemical and physical characteristics of oils may be used by larger buyers to specify quality (Table 5.5). In both cases, the tests required to make these measurements are not suitable for small-scale oil processors to perform in the factory and the tests should be done at a university or commercial laboratory. The ISO (International Organization for Standardization) reference number for each test is shown in Tables 5.4 and 5.5 so that this can be specified when ordering tests to be done by the laboratory.

The colour, odour and taste of each product should be characteristic of the oil, and be free from foreign or rancid odours and tastes.		
Test	**Maximum level**	**ISO reference number**
Matter volatile at 105°C	0.2 % m/m	ISO 662:1998
Insoluble impurities	0.05 % m/m	ISO 663:2000
Soap content	0.005 % m/m	-
Iron: Refined oils Virgin oils	1.5 mg/kg 5.0 mg/kg	ISO 8294:1994
Copper: Refined oils Virgin oils	0.1 mg/kg 0.4 mg/kg	ISO 8294:1994
Acid value: Refined oils Cold pressed and virgin oils Virgin palm oils	 0.6 mg KOH/g oil 4.0 mg KOH/g oil 10.0 mg KOH/g oil	ISO 660: 1996 amended 2003
Peroxide value: Refined oils Cold pressed and virgin oils	 up to 10 milli-equivalents of active oxygen/kg oil up to 15 milli-equivalents of active oxygen/kg oil	ISO 3960: 2001

Table 5.4. Standards for quality and composition of cooking oils (Adapted from Codex Alimentarius Commission Standard STAN 210-1999 in Annex B) - This standard is intended for voluntary application by commercial partners and not for application by governments).

	Groundnut oil	Coconut oil	Maize oil	Mustard oil	Palm oil	Palm kernel oil	Sesame oil	Sunflower oil
Relative density (x°C/water at 20°C)	0.912-0.920 x=20°C	0.908-0.921 x=40°C	0.917-0.925 x=20°C	0.910-0.921 x=20°C	0.891-0.899 x=50°C	0.899-0.914 x=40°C	0.915- 0.924 x=20°C	0.918-0.923 x=20°C
Refractive index (40°C) ISO 6320:2000	1.460-1.465	1.448-1.450	1.465-1.468	1.461-1.469	1.454- 1.456 at 50°C	1.448-1.452	1.465-1.469	1.461- 1.468
Saponification value (mg KOH/g oil) ISO 3657:2002	187-196	248-265	187-195	168-184	190-209	230-254	186-195	188-194
Iodine value ISO 3961:1996	86-107	6.3-10.6	103-135	92-125	50.0-55.0	14.1-21.0	104-120	118-141
Unsaponifiable matter (g/kg) ISO 3596:2000	≤ 10	≤ 15	≤ 28	≤ 15	≤ 12	≤ 10	≤ 20	≤ 15

Table 5.5. Chemical and physical characteristics of some vegetable oils

Additives and contaminants

In most ACP countries, the Bureau of Standards or the equivalent organisation produces lists of permitted colours, 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. The only additives that can be added to cooking oils are permitted colours and antioxidants to reduce rancidity and extend the shelf life. The permitted levels of different types of antioxidant are shown in Table 5.6. However:

> There is no reason for small-scale oil processors to include colours or antioxidants in their products if they are produced correctly.

Antioxidants		
e-number	**Name**	**Limit (Maximum** Level)
304	Ascorbyl palmitate	500 mg/kg individually or in combination
305	Ascorbyl stearate	
306	Mixed tocopherols concentrate	GMP
307	Alpha-tocopherol	GMP
308	Synthetic gamma-tocopherol	GMP
309	Synthetic delta-tocopherol	GMP
310	Propyl gallate	100 mg/kg
319	Tertiary butyl hydroquinone (TBHQ)	120 mg/kg
320	Butylated hydroxyanisole (BHA)	175 mg/kg
321	Butylated hydroxytoluene (BHT)	75 mg/kg
Any combination of gallates, BHA and BHT and/or TBHQ		200 mg/kg but limits above not to be exceeded
389	Dilauryl thiodipropionate	200 mg/kg

Table 5.6. Additives in cooking oils (From Codex Alimentarius Commission Standard 210:1999 in Annex B)

Notes:

No food additives are permitted in virgin or cold pressed oils.

Natural flavours and their identical synthetic equivalents, and other synthetic flavours, except those which are known to represent a toxic hazard are permitted.

(GMP = Good Manufacturing Practice)

Contaminants, including herbicides, pesticides, other agri-chemicals and poisonous metals such as arsenic and lead, have maximum permitted levels in specified foods. Copper and iron promote rancidity and have maximum levels in oils that are intended for export (Table 5.4) and some ACP countries may also apply these to locally sold products.

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 processor's interest to involve the local Bureau of Standards or other appropriate body at an early stage of label design. This avoids 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 Processing* Volume 1, Section 6.4), but in many countries there are also very detailed laws concerning some or all of the following aspects:

- The use of words such as *best before* and *sell by*
- Positioning of the name of the food, the best-before or 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 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 organisations.

Weights and measures

This legislation aims to protect customers from being cheated by unscrupulous manufacturers (e.g. being sold underweight packs of food). The laws require the amount of food that is declared on the label as the net weight (the weight or volume of product in a pack) to be the same as that which is actually in the pack. However, it is recognised that not every pack can be filled with exactly the specified weight or volume because both machine-filling and hand-filling of containers creates some variability. There is therefore 'Average Weight' legislation that allows some variability in weights or volumes within specified limits, and processors should check with the Bureau of Standards to see whether this is in force in their country. If it is not, all bottles should be slightly over-filled (e.g. by 1%) to ensure that there is no risk of prosecution.

Other information required on labels

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. Nutrition information on a label may also include a list of vitamins, but claims that are not allowed include those that say a food is 'wholesome', 'healthy', or can 'cure disease'. Packaged oils should show the name and address of the producer, and the type of product on the label. A date mark (use-by date) is required if products are expected to have a shelf life of less than 12 months.

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 should be defined
- 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 rodents and insects and removal of wastes.

Processors should contact the Bureau of Standards, Ministry of Health or other organisation responsible for hygiene and sanitation to find out the specific local requirements.

Storage and distribution of oils

The Codex standards for storage and distribution of oils (Table 5.7) are advisory, but they are a sensible standard for oil processors to aim for. There is no legislation in most countries on the conditions for storing and transporting oils, but it is in the oil processors' interest to maintain temperatures as low as possible, without using refrigeration, and to store the oil away from sources of odours.

Oil or fat	Storage and bulk shipments		Loading and Discharge	
	Min °C	Max °C	Min °C	Max °C
Coconut oil	27	32	40[1]	45[1]
Groundnut oil	Ambient	Ambient	20	25[2]
Maize oil	Ambient	Ambient	10	20[2]
Olive oil	Ambient	Ambient	10	20[2]
Palm oil	32	40	50	55
Palm kernel oil	27	32	401	45[1]
Safflower oil	Ambient	Ambient	10	20[2]
Sesame oil	Ambient	Ambient	10	20[2]
Shea nut butter	38	41	50	55
Soya bean oil	Ambient	Ambient	20	25[2]
Sunflower oil	Ambient	Ambient	10	20[2]

Table 5.7. Temperatures during storage, transport, loading and discharge (Adapted from Codex Alimentarius Commission in Annex B) Standard CAC/RCP 36)

Notes

1 For warmer climates, the loading and discharge temperatures for coconut oil and palm kernel oil are Min 30°C, Max 39°C or ambient temperature.

2 It is recognised that in some cases the ambient temperatures may exceed the recommended maximum figures shown in the Table.

Summary of the chapter

- ✔ To obtain high quality raw materials, consider contracting farmers or making formal agreements with suppliers.
- ✔ Check all raw materials to ensure they have the required quality.
- ✔ dentify control points in your process to assure product quality. Do not forget storage and distribution.
- ✔ Develop routine cleaning programmes and ensure they are properly done.
- ✔ Develop routine methods to assess product quality. Decide which ones can be done at the oil mill and which ones need to be done at a laboratory.
- ✔ 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 similar organisation if you are not sure on any aspect of quality assurance.

Entrepreneur's checklist

❑ Do you routinely check the quality of your raw materials?

....

❑ Do you use this information to improve supplies?

....

❑ Do you have contracts with farmers or suppliers? If not, have you assessed the benefits of agreeing contracts?

....

❑ Do you know what the control points are for your product?

....

❑ Do you know what to do if the product is outside the control limits?

....

❑ Do you have routine cleaning schedules? Are they satisfactory to meet the regulations?

....

❑ Do you routinely check the quality and the fill weights of your products?

....

❑ Does your labelling comply with the law?

....

❑ Do your operators understand hygiene and sanitation rules?

....

❑ Do you know which tests are needed for your products?

....

❑ Can you analyse your products yourself or do you need to send samples to a laboratory?

....

❑ Do you know where to get advice on the law relating to your products?

....

❑ Do you have the necessary approval and certificates?

....

Reader's notes

Please use this space to write your own notes on Chapter 5.

Managing production 6

Tips for success

The following tips were provided by successful oil processors in ACP countries:

- ✔ Start small, get the experience and capital and then expand.
- ✔ Use only good quality raw materials.
- ✔ Be ready to delegate duties to others and play a supervisory role.
- ✔ Build good relationships with your staff.
- ✔ Employ skilled workers or train your staff to bring them up to standard.
- ✔ Make workers feel part of a team, they will be more responsible, and pay them well.
- ✔ Give your staff allowances or training - it helps to motivate them.
- ✔ Proper record keeping is vital. Keep records of everything and take time to analyse them.
- ✔ Be honest and dependable - give people what they ask for.
- ✔ Have timely maintenance done by qualified people.

Finally

Read Sections 4.1-4.7, 6.1-6.6, 8.1-8.2 and 10.1-10.4 in *Volume 1: Opportunities in Food Processing - Setting up and running a small food business*

6.1 Production planning

Oil processing can be a highly competitive business, and good production planning and management are needed to control product costs, maintain output and increase profitability (see also Chapter 7, Section 7.2). The main considerations in production planning are:

1. Calculating the required production rate to meet the anticipated demand for oil.
2. Finding sufficient amounts of raw materials that have an acceptable quality and price to meet production requirements.
3. Ensuring sufficient supplies of packaging.
4. Proper staff recruitment and training.
5. Maintenance of equipment to prevent breakdowns and ensure uninterrupted production.
6. Record keeping.
7. Business productivity improvement.

Planning is essential, not only when a business is being set up, but also for daily operation.

> Good production planning makes the best use of people, materials and equipment.

It also helps the entrepreneur to:

- Think ahead about the business to prevent problems arising during its operation.
- Avoid 'bottlenecks' in the process, or running out of raw materials or packaging.
- Predict the growth of the business and decide what actions are needed to increase production to achieve it.
- Know if the production plan will allow a business to make profits in the future.

Some small-scale oil processors fail to adequately plan their production. As a result, production may have to stop because of a lack of spare parts to fix a broken machine, or running out of labels or bottles. In the authors' experience, these failures in production planning are the most important reason for a business to operate below its expected capacity, which can have serious consequences for profitability. For example, the following sequence of events can take place:

- Production stoppages cause low production rates, which mean that the fixed costs (see Chapter 7, Section 7.1) become a relatively large proportion of total costs.
- The business simply does not make enough products, and hence does not receive sufficient income, to cover fixed costs and make a profit, or even to pay the bills (i.e. production falls below the break-even point (Chapter 7, Section 7.3).
- The producer may react by increasing the price for products to generate more income - but the product then becomes over-priced and uncompetitive.
- In extreme circumstances the producer reaches credit limits with suppliers, who refuse to supply inputs, and the business fails.

The questions below illustrate some of the planning decisions that need to be taken in an oil processing business to prevent these types of problems and maintain production above the break-even point.

1. What are the expected sales for next week or month?
2. What production will be needed to meet the expected orders?
3. Are enough stocks of raw materials and packaging available for next week's or next month's production and are they of the correct quality?
4. Are the equipment and utilities ready for the expected production levels?
5. Are enough trained workers going to be available, or should extra workers be hired for the week?

Each of these aspects is described in more detail below.

6.2 Expected sales

Sales people gather orders from customers, and the manager should ensure that they discuss with production staff the amounts of oil required each week to meet the orders. Then production staff draw up a production plan showing how much product should be made during the next few days or weeks. The production manager can then arrange for the necessary amounts of crops, packaging and labour to be available to meet the orders (Fig. 6.1). Clearly, the more notice that can be given of anticipated sales, the easier it is to plan the production.

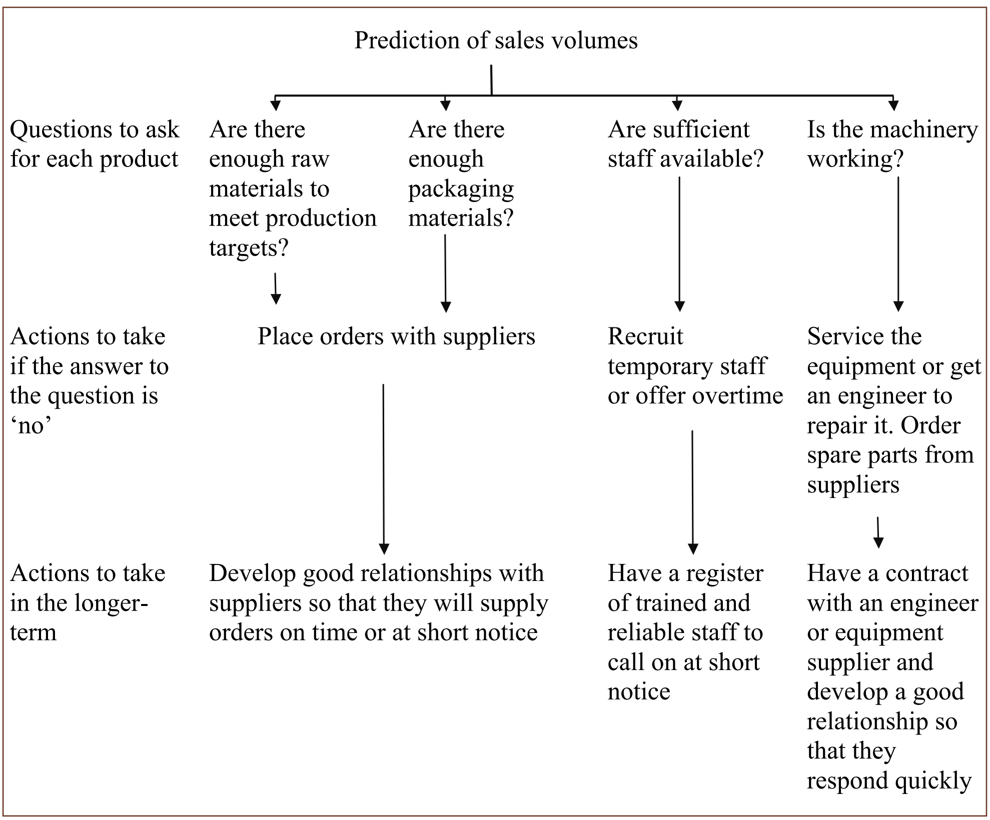


Figure 6.1 Planning production based on sales predictions

This process not only allows managers to plan the production levels for the near future, but also to monitor long-term trends. Sales staff should discuss the popularity of products with retailers and customers (see market surveys (Chapter 2, Section 2.3)), to find out whether demand for a product 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 production plans to cope with expected changes in demand - e.g. by investing in larger equipment to allow higher production rates.

6.3 Inputs of raw materials and packaging

The need to secure a supply of raw materials, often for a full year's production, can be a significant problem, and is always a large investment by an oil processor. It may require careful negotiations with farmers or other crop suppliers, such as cooperative marketing agencies, parastatal organisations or seed merchants. Ideally, there should be strong, trusting relationships between suppliers and oil processors, which bring a number of benefits to each:

- There is reduced uncertainty in both the costs to the processor and income for the farmers.
- Reduced buying costs, compared to buying from wholesale markets (or for micro-scale producers, from retail markets).
- Better production planning and cash flow management because of guaranteed raw material supplies, which may sometimes be paid for in instalments as they are used throughout the year.
- Better understanding by farmers of processors' quality requirements to give an assured supply of high quality raw materials.
- Increased incomes to farmers from guaranteed sales of crops.

The most important component of any agreement with farmers is the price offered by the processor for the crops. A number of arrangements are possible: for example, in *contract growing* schemes, the processor sets a fixed price and the farmers have a guaranteed income. However, under this type of contract farmers do not benefit if the market price rises. If prices rise, farmers may renege on an agreement 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 (they may not be able to sell their crop), but it also gives them the opportunity to get the full market price for part of their crop. It may be necessary for a processor to have this type of agreement with several farmers to be able to obtain enough crops for the required production level.

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 6.1 and Fellows (2001) in Annex B). Where these types of arrangements are not possible or have failed, an alternative is for processors to invest in growing their own crops. Clearly this increases the start-up and operating costs of the business, although it does give the processor greater control over the amount and quality of crops supplied to the oil mill. For example, Potts and Machell (1993) (Annex B) calculated that approximately 40 - 50 hectares of groundnuts that yield 400 - 500 kg/hectare are needed to supply one oil press for one year.

Case Study 6.1: Raw material supplies

- To ensure that varieties with high oil content are used, the company has suppliers whom they trust. The quality of crops is fairly constant because they are obtained directly from farmers who grow a particular or a preferred variety in the northern regions of the country. The company also pre-finances outgrower farmers to produce for the factory.
- Mr and Mrs M grow at least 20% of their own sunflower seeds that are needed and with other purchases there is adequate supply of sunflower for the enterprise.
- Due to financial constraints, it is quite burdensome to keep a stock of seeds. Therefore the effect of fluctuating prices during the year could sometimes increase production costs substantially. Future arrangements may involve farmer contracts to ensure that the crops have a more average price that will not be painful to the enterprises, but will also give the assurance of sustainable supply.
- (In Malawi) operating at a level of 10 batches per day, 106 kg/day of groundnuts are needed, and assuming a 5-day week and year-round processing, the annual requirement will be 25,440 kg of crop. The supply of raw material and the market for the product are the two key factors involving external players that are critical to the success of the enterprise.

All efforts should be made to have some degree of control over the supply of raw materials, by agreeing a supply contract so that groundnuts can be purchased monthly. Groundnuts are harvested once a year and if a whole year's supply has to be purchased at one time, then a larger loan will be needed which may make the business unprofitable. An accessible supply throughout the year, either from smallholder farmers or a centralised marketing agency, is preferable. But it is essential to obtain an agreement to secure regular supplies before starting the enterprise. (From Potts and Machell (1993) in Annex B)

- The main raw material is sunflower seeds that are purchased locally. They prefer the soft black varieties, which are rich in oil and easy to extract. Seeds are procured packed in jute or sisal bags.
- The company has the capacity to produce a number of oils from seeds and nuts and has a big export market, with possibility of expansion on its 4.5 acres if land. Its main weakness is the low asset base, which makes it difficult to stock up on raw materials for many months' production.
- Procurement of both raw materials and packaging materials is done on a need basis. There are no contractual arrangements as yet.
- The enterprise uses sunflower seed of high quality from Dodoma, Singida and Iringa. This is the reason for producing high quality oil. Nonetheless, availability of sunflower seeds is limited and this contributes to the low capacity utilisation of the facility.
- According to the owner, the ability to identify quality raw materials is his main strength and the sunflower variety Serene is the most sought after as it is rich in oil.
- The seeds are supplied in 60-70 kg bags and on average each bag yields 18 litres of filtered oil.
- The enterprise produces 25 barrels (5000 litres) of palm oil per day during periods of high production. During this harvest season the fruits ripen quickly, hence the high levels of oil production. After this period production falls gradually and in this period of downtime in the rainy season the enterprise produces food crops (maize, cowpea, groundnuts, cassava).
- There are no contract agreements with suppliers of raw materials. Processors visit nearby villages to purchase palm fruit bunches. The company processes all varieties of oil palm but prefers palm fruits that have small kernels that give the highest yield of oil.

Packaging

The main packaging options for cooking oil are glass or plastic bottles (PET with polythene caps) for retail sales, metal cans or drums for wholesale or institutional customers, or plastic bags at a micro-scale of production (see also Chapter 2, Section 2.5). This is reflected in the costs of packaging that were reported by processors who were interviewed for this book: some reported packaging costs to be as low as 5% of total production costs, whereas others reported the cost to be 20-30%. In many ACP countries there are difficulties in securing reliable supplies of packaging materials. To overcome this some processors keep large amounts of stock to protect themselves against failure in supplies that would lead to production stoppages. These large expenditures may cause cash flow difficulties because cash is tied up while stock that has already been paid for is waiting to be used. Smaller enterprises may buy packaging materials in small quantities more regularly to overcome cash flow problems. However, this is a more expensive way of buying than bulk buying. There is also a constant risk of production stoppages if a supplier runs out of materials and stocks cannot be quickly replaced. The problem of how much stock to hold can be partly addressed by adequate financing that is available in phases to meet planned shortfalls in cash flow, and by periodically buying materials in bulk.

Case Study 6.2: Packaging supplies

- Packaging materials are purchased from wholesale dealers in Dar es Salaam. They have no designs that are specific to their company, but use what is supplied or available in the market. Plastic containers of different sizes are used. Common ones are 5 and 20 litres. Forward planning of purchases helps them to avoid shortages of packaging materials that could disrupt production.
- The filtered oil is packed in plastic ‘gallons’ and the press cake is packed in sisal or polysacks. The latter are normally reused bags.
- Packaging is a big headache and they have tried to get special plastic oil bottles but there are no local suppliers. They have also tried to import directly but the minimum order is too large. Instead they now use plastic drinks bottles, which are attractive with the new label they have designed.

6.4 Calculation of production rate

There are two factors that control the amount of oil that can be produced each day to meet the sales demand: the production rate (or *throughput*) of the equipment or process, and the yield of oil.

> Throughput is the amount of crop processed per hour.
> Yield is the amount of oil extracted per kg of crop.

The throughput determines the time required to process a given weight of crop, and it depends mainly on the size of the equipment (Chapter 3, Section 3.4) and the efficiency of work organisation. When planning the process, it is necessary to calculate the capacity of each piece of equipment needed to achieve the planned production rate. Decisions include whether to buy a single large machine or several smaller ones to achieve the planned capacity.

Using shea nut as an example, the yield of shea butter (kg of fat extracted per kg crop x 100) is either 15-45% using traditional methods of extraction or around 60% using improved methods (Table 6.2).
If 75 kg of crop are processed and the losses during sorting and preparation are 6%, the yield of fat is calculated as follows:

Weight of useable crop	= 75 kg - 6%
	= 75 - 4.5 kg
	= 70.5 kg
Expected yield of fat using traditional methods = 30%	
Therefore, weight of fat	= 70.5 x (30/100)
	= 21.15 kg
Expected yield of fat using improved methods = 60%	
Therefore, weight of fat	= 70.5 x (60/100)
	= 42.3 kg

Table 6.1. Calculation of yield of oil or fat from raw materials

The production rate also depends on the yield of oil from the crop. The method for calculating the yield is shown in Table 6.1. Typical yields of oil from different crops are shown in Table 6.2, but processors should conduct trials

6

with their own equipment and procedures to find the range of oil yields that they can expect to get. Knowing the yield, the data from production trials then allows processors to calculate the amount of crop that should be used each day to meet target sales of oil. The method is shown in Table 6.3.

	Moisture content (%)	**Oil/fat content (%)**	**Yield of oil (%)**
Avocado	69	11-28	40-44
Coconut (fresh)	40-50	35-40	55-62
Copra	3 – 4.5	64-70	50-60
Groundnut (shelled)	4	28-55	30-40*
Mustard	7	30-50	45-50
Oil palm	-	56	11-20*
Olive	70	20	80-90
Palm kernel nuts	6.5	46-57	45-49
(shelled)	5		(47-51)
Safflower	5	30	40
Sesame	40 (fresh)	25-50	45
Shea nut	7-9 (dried)	34-45	15-45* 60
Sunflower	5	25-50	20-30*

Table 6.2. Oil contents and oil yields from different crops (Adapted from Practical Action, Kailis and Harris, (2007), Poku, (2002) and Sekaf Ghana Ltd in Annex B).

*Traditional methods. All % figures are based on crop weight.

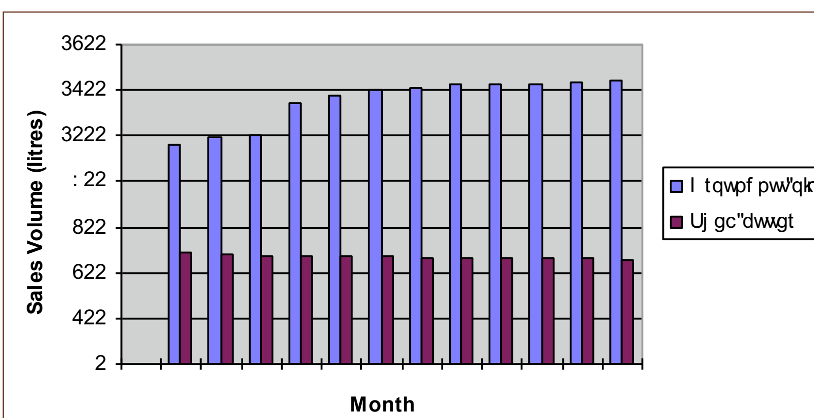


Fig. 6.2. Example of a sales chart

Using shea nut as an example, the target sales for each month during a year (Fig. 6.2) are shown below. The required weight of crop is found using the extraction rate of fat in Table 6.2 (assuming traditional method of extraction) as follows:

The total weight of crop required per month = target sales x (100/ extraction rate) + % losses

	Weight of shea butter required (kg)	Extraction rate (%)	Weight of crop required (kg)	Losses (%)	Total weight of crop required per month (kg)
January	440	30	1467	6	1555
February	440	30	1467	6	1555
March	430	30	1433	6	1519
April	430	30	1433	6	1519
May	430	30	1433	6	1519
June	430	30	1433	6	1519
July	425	30	1417	6	1502
August	425	30	1417	6	1502
September	425	30	1417	6	1502
October	425	30	1417	6	1502
November	420	30	1400	6	1484
December	420	30	1400	6	1484
Total weight of crop required for one year's production (kg)				18161 kg or 18.2 tonnes	

Table 6.3. Calculation of the weight of crop required per year

In the example in Fig. 6.2, assuming average sales of shea butter of 430 kg per month, and assuming that production takes place for 8 hours each day for 20 days per month, this requires a minimum production rate of 21.5 kg per day (430/20) or around 2.7 kg per hour (430/(20 x 8)). If two people produce shea butter in 5 kg batches, taking 90 minutes per batch, this gives a production rate of just over 3 kg per hour and 24 kg could therefore be produced per day (3 kg/hour x 8 hours), which exceeds the target demand. The corresponding figures for groundnut oil in Fig. 6.2 are average sales of 1240 litres per month, daily production of 62 litres and a production rate of 7.75 litres per hour.

The 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 if there are regular power failures or other production stoppages.

The production rate is also used to decide the number of packages that are required each day, the number of workers and their different jobs. Using shea butter packed into 100g packages as an example, the number of packs required per day is found as follows:

$$\frac{\text{Amount produced (kg)}}{\text{Net weight in pack (kg)}} = \frac{21.5}{0.1} = 215 \text{ packs}$$

These calculations are used to see whether it is possible to extract and package sufficient oil with the available staff in the time required, whether it is possible to build up stocks of products (e.g. by the operation of more shifts to meet any increase in demand), or whether it is necessary to employ more staff to meet the anticipated demand.

Case Study 6.3: Production, storage and packaging

The mill is able to process 40 bags of sunflower seed per day. This yields about 800 litres of oil.
The plant is able to produce 360 litres a day through a single shift.
The enterprise produces 100 litres of palm oil per day during periods of high production when the fruits ripen quickly. After this the production falls gradually. During the period of downtime which is the rainy season, the enterprise devotes its time to other food crops and the production of palm wine.
They have very large storage facilities for both seeds/nuts and spent cake. The store can hold over 3,000 hundred kilo bags of groundnuts and other oilseeds as well as thousands of bags of spent cake. The company also has eight 500-litre oil tanks.

A note on losses

Nearly all oil processing results in losses of material. Different types of oil-bearing fruits, seeds and nuts have different levels of wastage and it is necessary for an entrepreneur to do trials to calculate the actual amount of wastage experienced with the particular crop varieties and with the particular processes that are being used. Since losses have a significant effect on the total cost of production, they should be monitored and the process should be managed to ensure that they are as low as possible.

The main ways in which losses can be reduced include contracts with reliable suppliers to ensure low levels of poor quality raw materials, and well-managed production using trained staff and quality assurance procedures to reduce wastage. This is especially important during later stages of processing when the extracted oil has a high added value. Feedback from small-scale oil processors shows that raw material costs represent a significant proportion of total production costs (mostly between 50-80% although some producers reported 10-30%). Raw material costs therefore have a significant effect on the profitability of the business. It is important to ensure that materials are checked for the correct quality and quantity upon delivery. Details of quality assurance checks are given in Chapter 5, Section 5.4.

Most crops are purchased from suppliers either fresh (e.g. palm fruits, olives or coconuts) or already dried (oilseeds and nuts). Therefore the processor knows the weight of crop (minus any losses) that is available for processing. An exception is where a processor buys fresh crops and dries them for storage. For example, coconuts are often bought fresh and dried to make copra for later processing. The amount of dried crop can be calculated using the method shown in Table 6.4.

	Weight (kg)	Moisture content (%)	Solids content (100 – moisture content) (%)	Weight of solids (kg)
Coconut before drying	50	45	55	27.5 (55% of 50 kg)
After drying there is no loss of solids (only water is removed) and the moisture content has been reduced to 4%. Therefore the solids content has increased to (100 – 4) = 96% and this still equals 27.5 kg of solids				
Copra after drying	?	4	96	27.5
Therefore: The weight of product after drying (the yield) = (100/96) x 27.5 = 28.6 kg				

Table 6.4. Calculating the yield of copra after drying coconuts

6.5 Uses for by-products

The main by-product from oil processing is oilcake, and most types of oilcake are used as animal feeds (either poultry rations or a component of ruminant feeds) or as fuel. Groundnut oilcake can also be used as a food ingredient provided that it is not scorched by overheating during processing (Chapter 4, Section 4.3). It is used for example as an ingredient in biscuits, snackfoods and traditional soups. The nuts from shea, palm fruit and olives can be used as fuel, and the hulls from sunflower seeds can be used as chicken litter. In Benin, fibres and palm kernel shells are mixed with mud to get a 'cake timber', which is used as combustible fuel for cooking the palm fruit (Fig. 6.3). There are many uses for coconut by-products as shown in Fig. 6.4.

Fig. 6.3. 'Cake timber' - a waste product from palm kernel oil processing that is used as a fuel (Photo from J Hounhouigan)

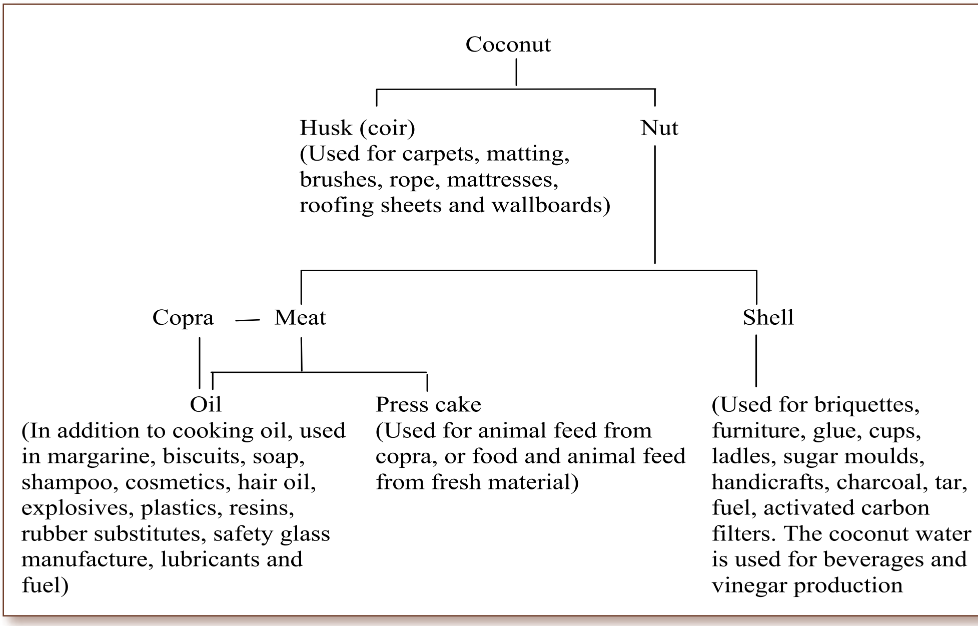


Fig. 6.4 Uses for coconut by-products

The amounts of by-products vary according to the type of crop being processed and the yield of oil, but they can amount to large quantities of material that must be disposed of. An example in Table 6.5 shows the weight of by-products produced from a unit that processes 120 kg of groundnuts per day for 20 days per month. The income from sales of by-products can be very important to the profitability of an oil mill (Chapter 7, Section 7.2), especially groundnut oilcake, which has a higher value as a food ingredient than other types of press cake.

Weight of crop processed per day (kg)	Oil extraction rate (%)	Weight of by-products per month (kg) (120 x (100-30)/100 x 20)	Weight of by-products produced per year	
			kg	tonnes
120.0	30	1680	20,160	20.1

Table 6.5. Weight of oilcake by-product from a small mill that processes 120 kg groundnuts per day

6.6 Staff recruitment and training

Roles and responsibilities within the business

The characteristics of an oil processing business vary greatly according to whether the venture is undertaken by individual households, farmers/farmer groups, rural communities or urban dwellers, traders, women, or formal established co-operative societies. Each group has different access to funds, transport, information, skills and communications. All of these considerations influence the cost, size and complexity of the business.

Case Study 6.4: Management of business operations

The following experiences of managing a small oil mill were provided by processors in different countries:

- Day to day operation and management of the enterprise rested with the directors, who also direct and carry out marketing. The enterprise is a member of the Tanzania Food Processors Association, although they have yet to reap many benefits through their membership because the Association needs strengthening to attract more members who can contribute to it sustainably.
- Provided a technology is viable and sustainable…the particular technology is often a neutral factor in the subsequent success or failure of the enterprise. From our experience, it would appear that other factors, such as the form of ownership, business management, marketing expertise and the location of the enterprise, are often more critical areas than the technology itself. (From Reeve (1995) in Annex B)
- Day to day management of the mill is vested in a manager, but major decisions are made by the owner/director.
- The owner is an experienced farmer and has opted to diversify and add value to his farm produce, which he used to sell to the market as unprocessed seeds. His vision is to combine farm oilseed production and processing, and in this way he has high spirits, wanting the oil mill to grow into a major business in the future.

- The group is located in the centre of Benin and has 22 members, with a majority being women producing groundnut oil, groundnut cake and local soap.
- The owner of the palm oil company was previously a quality control officer in a public palm oil enterprise. He started his own business five years after the inception of the idea, and has been operating for six years.
- The company employs forty workers (29 male and 11 females) with a seven-member board of directors. It also engages qualified auditors, solicitors, registrars and bankers. The board of directors makes long-term decisions about the company while the management team makes routine daily management and production decisions.
- The operation of the production facility is by collective responsibility and the cooperative's 50 workers operate independently with their own capital and pay less than 0.5% for the use of the facility. This is a major weakness because access to credit is difficult and this affects the volume of products obtained. Also, the lack a unified marketing body affects their pricing and prices are determined by the wholesalers and retailers.
- With business development and financial training and strategic thinking, cooperatives can work as an entity to manage their business as individuals with collective liability, access credit, upgrade technology and engage in group marketing.

Managing an oil processing enterprise means having full control over what is happening in the business and the capacity to view the enterprise as a whole. The manager's responsibilities include different aspects of the overall running of the business; for example:

- Staff recruitment and training.
- Purchasing raw materials and equipment.
- Planning finances, financial management.
- Managing the production and sales staff.
- Preparing production and marketing plans.
- Planning for future developments.

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 business, 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 (e.g. specialised training to operate and maintain an oil expeller).

Manpower (or 'human resource') planning 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 in creating a skilled and committed workforce. 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 4.6. 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.

Case Study 6.5: Staff recruitment

- When considering whether the enterprise will work, the form of ownership and organisation must be considered from the start. A group should include people with appropriate skills to negotiate a loan, purchase equipment and raw materials, organise production, marketing and record keeping. An overall manager to co-ordinate all the activities may be chosen from the group or be employed by the group. An incentive related to profits can work well as part of the salary. (From Potts and Machell (1993) in Annex B).

- The enterprise employs only three persons and the directors; hence there is not any elaborate workers' plan. Recruitment was based on the level of education and the ability to take instructions and perform the required tasks.
- Previously the enterprise had no formal recruitment procedures. The owners employed family members and friends who may or may not have had the right expertise. This has now changed and recruitment is done by advertising the positions, conducting interviews and offering the job to the most suitable applicant. As a result, the company now has a qualified technician, an experienced manager and a trained workforce. The company employs only literate staff that have secondary school certificates. Both men and women are given equal opportunity. All employees are entitled to annual, sick and maternity leave.
- Over 60% of the workers have a minimum of secondary school leavers' certificate, 20% are either polytechnic or university graduates and the remaining staff are unskilled. Many of the workers were recruited from the community with family members in the managerial positions.
- The company recruits people irrespective of age or educational background, provided they are ready to work.
- Most of the labour force is recruited locally and given in-house training. This way the firm is able to have an employment package that reduces labour migration. Occasionally the labour force is given vocational training and other benefits are medical care and a food allowance.
- Workers are recruited based on their level of knowledge of oil production. The enterprise has 15 permanent workers and 10 occasional workers.
- The enterprise is run as a family business; hence the operators are family members who are trained on the job. The business does not have a business plan except for a daily operations plan, which are just guidelines given to the operators.
- The company has a seven-member Board of Directors and employs fifty-five workers (20 male and 35 female). The factory manager, accountant and production manager are family members.
- Currently, in Mr and Mrs M's business the enterprise employs three workers on a full-time basis. Occasionally casual labour is hired for tackling specific assignments.

There is a widespread and serious problem in many ACP countries to identify and retain skilled and reliable staff for oil processing businesses at all scales of operation. Although many 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 6.6).

In oil processing, each day's work initially involves preparation of the raw materials and then move through processing to packaging in a sequence of stages:

Sorting > Crushing > Pressing (or expelling) > Heating > Filtering > Bottling.

It is therefore important to organise production to ensure that the necessary inputs are available at each stage when they are required. 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 done each hour during the day, the number of people involved with each activity and the sequence of work that individuals do during the day. For example, this can be done using three teams of people; at a typical small scale of operation, this would involve two people per team, although the number of people in each team can be changed depending on the scale of production. Staff in one team are engaged in preparing raw materials for processing (e.g. sorting, crushing and heating oilseeds) for 2-3 hours to produce sufficient material for a day's production. Once they have finished this work they can assist with heating the oil and filling it into containers. There are two teams involved in pressing: team N° 1 presses batch N° 1 while team N° 2 prepares batch N° 2 and so on throughout the day, alternating the work so that the press is in constant use. This level of staffing is reduced if an oil expeller is used instead of batch pressing (see Chapter 4) because only one person is required to load crop into the expeller and monitor its operation. An activity 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. It can also be used as a basis for training in each job and it should be constantly reviewed to optimise production efficiency.

The role of the supervisor is to organise the work for all the staff, including cleaning and maintenance duties. This person should also keep records of daily production schedules, staff attendance, amounts of oil and oilcake produced, amounts of stock, and amounts removed from stock (see Section 6.8). In very small operations the supervisor may also be responsible for sales of oil and oilcake if they are sold from the production unit. In other situations, a salesperson has responsibility for promotion of products, keeping records of sales, collecting cash from sales and giving it to the manager on a regular basis.

Staff training

Depending on the particular ACP country, labour costs can be a relatively low proportion of total production costs. Oil processors interviewed for this book reported labour costs to be between 12% and 30% of total production costs, although one producer reported it to be as low as 2%. Many owners of small oil processing businesses refuse to train their staff because they are worried that experienced or skilled staff will ask for higher pay or will move to a competitor. These 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. To be successful, a business needs well-trained staff that are motivated to work for the company.

> Staff development is an important aspect of business planning, and the owner should be willing to invest in 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 can take two forms: it either involves the new employee working immediately in his or her normal job under the supervision of more experienced workers, or secondly the employee can do different jobs to gain experience of the whole operation. If staff are trained to do different jobs, the business has greater flexibility to deal with absenteeism, holidays etc. Case Study 6.6 illustrates some experiences with staff training and motivation. Further information is given in Fellows, Battcock, Azam-Ali and Axtell (1998) in Annex B.

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.

Staff gain satisfaction from their jobs if they receive reasonable pay and have good working conditions. Management methods should 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 oil processors include:

- Competitive salaries and regular review of salaries, prompt pay and extra rewards when the business does well.
- Paid overtime.
- Paid leave and holidays.
- Interest-free and flexible loan facilities for school fees, funerals, 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[4], or a proportion of salary held for medical support costs.
- Uniforms, aprons, head scarves and work clothes provided.
- Toilets and washing facilities with hot water.
- Transportation to work or transport allowance.
- Representation or attendance at staff meetings.
- Gestures such as a small birthday present to improve staff morale.

4 In many ACP countries, staff are required to undergo a medical examination to obtain a health certificate for working with foods.

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

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 permanent workers contracts of employment. They should encourage a sense of status and pride at all levels to help employees identify themselves with the business. Further details of employment contracts are given in *Opportunities in Food Processing* Volume 1, Section 4.6.

Case Study 6.6: Staff motivation and rewards

- Staff benefits are built up with the basic pay, and include food and transport allowance.
- The director manages the enterprise and decides the remunerations. Workers are provided with a glass of milk and midday meal, and other benefits are determined from time to time, based on performance.
- Although members of the cooperative group are not paid for their labour, they benefit from the mutual aid provided by the group and financial contributions in the event of a death or other family problems.
- The workers have individual/personal health insurance and social security.
- Workers are recruited based on their level of knowledge in oil production. The enterprise has 30 permanent workers and 180 occasional workers. They benefit from help and support from the enterprise when they need assistance (e.g. for illness, family ceremonies or deaths).
- The workers have health insurance, social security, prescribed annual and sick leave and consolidated salaries that include food, clothing and transport allowances.
- The workers automatically receive assistance with food during the production season and sometimes get payday advances when they are in trouble (illness, death in the family etc.). As the owner is a traditional healer, the worker receives almost free treatment for illnesses.
- The workers enjoy benefits including sick and annual leave, paid holidays, health care benefits when needed, food allowances and a good welfare scheme.

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.

> All staff should be properly trained to carry out potentially dangerous operations.
> It is important to have a regular maintenance programme for oil processing equipment that would be dangerous if a failure occurred.

Unsafe working conditions can also arise due to poorly designed workplaces (e.g. lack of adequate lighting, poor ventilation, slippery floors or steps due to oil spillages) 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.

Case Study 6.7: Safety

- The management insists on safety measures to ensure the safety of both workers and machinery and equipment.
- We emphasise that boiling the oil is dangerous and the workers should take special care and wear protective gloves.

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. Fewer accidents also reduce production losses, repair costs, extra costs of training new staff and medical bills. Simple precautions are listed in Table 6.6. A major cause of accidents is improper adjustment and maintenance of equipment, such as poorly aligned drive belts on machinery, removal of guards over drive belts, use of incorrect spare parts, or failing to use the correct tools for the machine. Temporary electrical installations are one of the most frequent causes of injury and include:

- Use of electric cables without proper insulation.
- Lack of protective covers on switches, fuse-boxes etc.
- Use of un-earthed equipment.
- Unauthorised additions to circuits resulting in overloading and fire risk.
- Bridging over fuses.

All electrical fittings should be installed and maintained by a competent and qualified electrician.

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 or a fire extinguisher.

Water should never be used to extinguish an electrical fire.

There is also a potential risk of fire and/or burns when conditioning some types of oilseeds and groundnuts, and when heating oil to remove moisture before packaging (Chapter 4). The heater and the containers are both hot and should be handled carefully using heat-resistant gloves. Oil should not be heated to a temperature that is significantly above 130°C during processing, and it should never be allowed to reach its smoke point (see Annex A), above which it could catch fire and cause damage to facilities or injure operators.

Safety tips for oil 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.
4. Only one person should operate a machine at any one time.

5. 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.
6. 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.
7. 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.
8. Use charts hung on the wall near each machine to show safety precautions.
9. 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.
10. Never allow staff to clean, adjust or lean over moving machinery.
11. Do not allow them to leave a running machine unattended.
12. Encourage operators to report any loose parts on a machine.
13. 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'.
14. Do not allow anyone to touch inside electric equipment while it is connected.
15. Regularly check the cables of electrical appliances to ensure that outside covers are not broken and wires are not exposed.
16. Prevent staff from running inside a building.
17. Immediately clean up any oil on the floor using sawdust, sand, husks etc.
18. Clean the building each day.
19. 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.
20. Make sure that there is at least one working fire extinguisher and a fire blanket. Ensure that everyone knows what to do in the event of a fire.

Table 6.6. Safety tips for oil processing

6.7 Maintenance of equipment

Machine breakdowns reduce the output from an oil mill and increase production costs. Lack of maintenance is one of the most common reasons why small-scale oil processors have machinery breakdowns. Poorly maintained machines are also a potential hazard to operators, reduce the yield of oil, and can contaminate products with metal fragments. Proper maintenance ensures that machinery operates correctly and safely, and prolongs its life; so 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 availability of spare parts and the speed at which repairs can be done by a competent local mechanic or workshop, as well as the value of the spares that have to be held in stock.

> As a minimum, managers should monitor the state of equipment that is likely to wear out. As experience of the rate of failure accumulates over the years, they should buy spare parts or have the machine serviced when the failure of a part is anticipated.

A summary of the spares and maintenance requirements of oil processing equipment and the cleaning required is shown in Table 6.7.

Type of equipment	Spares/maintenance required	Cleaning
Boiling pans	-	After use with detergent and clean hot water
Bottle washers	-	Weekly with detergent and clean water
Bottle cappers	-	Weekly with detergent and clean water
Expellers	Bearings. Oil the bearings and check the screw for wear.	After use with detergent and clean hot water with particular attention to cleaning the barrel and screw
Fillers	-	After use with detergent and clean water
Fruit pulpers	Motor drive belt. Monthly check belt tension, condition of bearings	After use with detergent and clean hot water with particular attention to cleaning the screen
Oil filters	Filter cloths.	After use with detergent and clean water, followed by sterilisation using dilute bleach or boiled for 10-15 mins and dried.
Oil presses	Periodic check for wear on screw and bearing.	After use with detergent and clean hot water
Heat sealers	Heating element.	Remove any burned-on plastic immediately
Scales	Monthly standardisation with known weights.	After use wipe with damp cloth

Table 6.7. Summary of spares and maintenance/cleaning requirements for oil processing equipment

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

- Identify priority machinery where components wear out more frequently (e.g. bearings in oil expellers or screw presses).
- Write a clear description of the procedures and standards of work expected of machine operators and maintenance workers (such as lubricating, tightening bolts, making adjustments etc.) on a daily, weekly and monthly routine maintenance plan.

- Organise a schedule and train staff to implement maintenance plans.
- Prepare a maintenance budget.
- Record inspection results, analyse the records and evaluate the frequency of
- maintenance required.
- Update procedures and standards on a continuous basis.

Maintenance and spares records (Figures 6.5 and 6.6) 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 spare parts, making sure they are available when required.

Date	Work carried out	Parts used	Cost

Figure 6.5. Maintenance record

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

Figure 6.6. Spares record

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Case Study 6.8: Installation and maintenance of equipment

- The plant layout design, equipment installation and trial runs were performed by local engineers, though the equipment suppliers also provide repair and backup services.
- Repairs on locally purchased equipment are usually done within days but repairs on imported equipment take a long time. For example, within a few months after the installation of the one million Euro oil refinery, the filtration system developed a fault that has taken a long time to fix.
- This has caused the company a huge loss because of stopped production. The loans have to be repaid, workers salaries have to be paid and taxes must be settled. This has put a lot of strain on the company and they are hoping production will pick up again.
- Facilities available for production include a screw press and cloth filter press that were bought from China and installed by local technicians, who also provide an on-call repair and maintenance service. In addition the oil tanks were fabricated locally.
- The new refinery was installed by Italian consultants. Although manufacturing engineers abound in Ghana, the foreign consultants were engaged because the loan criteria require that equipment must be purchased from an EU country and installed by the supplier.
- The frequent breakdown of processing equipment is a major challenge for the company.

6.8 Record keeping

There are three sets of basic records that should be kept by the owner of an oil processing unit: 1) financial records, 2) those that relate to the production of the products and 3) sales records. Financial and sales records are described in *Opportunities in Food Processing* Volume 1, Section 7.4 and in Chapter 7. The section below describes production records that are commonly kept. 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 the information in their head and do not keep written 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 in Table 6.8.

Case Study 6.9: Record keeping

- Management of stock is supported using stock control ledgers.
- They ensure that they do not keep stock for a long time in storage, and they follow the principle of first-in-first-out stock control.
- They have very good accounting and financial control. They have a computerised accounting system with debtors' and creditors' records, and debt collection is rigorous.
- With their training in book keeping they are now able to keep records and make projections. They also keep good records of raw materials, production costs and stocks of oil and have engaged 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 recover outstanding debts. This might need several visits but most of the time she is able to collect the money without a problem.

Value of record keeping	Costs of record keeping
Accurate records allow: • Detailed knowledge about the operation of the business. • Identification of trends. • Accurate control over finances. • Control over product quality. • Identification of individual costs to allow changes to a process to optimise profits. • Keeping track of money owed to the business. • Evidence for tax authorities (this may be a legal requirement). • A factual basis for product pricing or salary levels. • Knowledge of, and avoidance of, theft.	• 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.

Table 6.8. Value and costs of record keeping

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 learn their job. The oil mill owner should employ people who have the skills and aptitude to do the work, but should also put in place a system of checks against theft to ensure that one person does not have responsibility for a whole area of business activity. For example the person who is 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 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.

6.9 Business productivity improvement

The companies that assisted in the preparation of this book ranged in size from 3 to 30 permanent employees, with some employing up to 180 temporary seasonal workers. The businesses varied greatly in their productivity and there was no straightforward relationship between the number of employees and the amount of oil produced each day. The efficiency of the processes in the different businesses therefore varied considerably.

> Improving efficiency in a process involves reducing wastage of time, materials and space, or unnecessary movement of foods, staff or equipment.

The companies provided details of the types of activities that they have employed to improve their productivity as follows:

- 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 Fig. 3.1 in Chapter 3, Section 3.2).

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

- Actual usage of raw materials per kg of product.
- Cost of packaging per kg of product.
- Labour costs per kg of product.
- Energy used per kg of product etc.

Any changes that are introduced to a process can then be assessed in terms of these costs to make sure that they have improved the productivity of the process. Productivity can also be improved by increasing the amount of production for the same costs or by reducing production costs - for example by changing the design of the product, changing raw materials suppliers or work organisation.

Reducing the cost of services

The cost of electricity, fuel and water was reported by processors to be 9-30% of total production costs and transport was between 19 and 27%. The main reported problem is interruption to the supply of electricity, which can stop 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). 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. to pre-heat water to wash equipment).
- Building in the flexibility to use alternative energy sources when installing new equipment so that it can use the most environmentally suitable and cost-effective fuels.
- Use energy-efficient stoves and roasters. Using oil processing wastes or fuel from local briquette makers rather than fuel-wood (Table 6.9).
- Use local suppliers of raw materials that can be delivered by animal cart, 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.

Crop	By-products	Uses
Coconuts for coconut oil	Husks, shells, coconut fibre, coconut cake	Coir for matting, fuel/ charcoal, animal feed
Groundnuts for groundnut oil	Shells, groundnut cake	Mulch/litter, particle board, human consumption or animal feed
Mustard seed for mustard oil	Cake	Animal feed
Oil palm fruit bunch for palm oil	Bunch, fibrous residue and sludge	Fuel, fertilizer, fibre (traditionally for human consumption and animal feed)
Palm nuts for palm kernel oil	Shells, palm kernel cake	Fuel/charcoal, animal feed
Rapeseed for rapeseed oil	Cake	Animal feed
Sesame seed for sesame oil	Sesame cake	Human food or animal feed
Shea nut for shea butter	Cake	Fuel
Soybeans for soybean oil	Soybean cake	Human consumption or animal feed (when free of trypsin inhibitor)
Sunflower kernels for sunflower oil	Husks, sunflower cake	Fuel, filling material, polishing material, fibre for animal feed

Table 6.9. Uses for by-products from oil crops

NB: oilcakes that contain high levels of protein are too rich to be fed directly to animals. They should be mixed with starchy and fibrous materials in feedstuffs to be properly digested by animals. Handbooks on animal husbandry provide detailed information on how to prepare animal feeds using oilcakes as ingredients.

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Companies reported different methods of increasing efficiency by reducing wastage (Case Study 6.10).

Case Study 6.10: Improving productivity, reducing wastage and using by-products

- Packaging materials are purchased from wholesales in advance to avoid shortages that would disrupt production. Bulk purchasing has helped to reduce production costs.
- The company runs two shifts as a means of increasing production, maximising input of skilled labour and reducing the downtime of machinery.

- There are developed links with feed manufacturers and cattle keepers who collect the husks for making animal feed compounds, and the soap stock from cleaned oil is used for soap-making. As such there is no pollution from the unit and all wastes are properly disposed of.
- The main by-products of the mill are seed cake that is readily sold as animal fed and husks that are used as mulch by gardeners. As regards plant sanitation, the company abides by the national food laws and municipal regulations for waste disposal.
- The company generates 30% of its energy through the use of bio-fuel generated from waste produced during processing.
- Poultry farmers and feed mill owners buy the oilcake for animal feeds.
- The oil palm stalks and waste from winnowing are used for composting and the compost is used as organic fertiliser in the oil palm plantation.
- Factory waste is disposed off just as domestic waste. The main waste is the oilcake from groundnut, copra and palm kernel but all these are sold to poultry farmers and animal feed producers all over the country. Waste water is directed into the main drain. Disposal is not a major problem yet, but it could be in future because the Environmental Protection Agency is implementing strict disposal legislation.
- Waste palm materials are used to make compost, which is used as organic fertiliser for the oil palm plantation. Palm nuts are crushed, sorted and then sold to producers of palm kernel oil. The fibres that remain after oil extraction are mixed with a portion of the mud to make fuel that is sold in the local market.
- In order to improve the productivity of his plantation, the enterprise owner fertilises the trees after weeding. The types of fertilisers are compost made from a mixture of palm grape stalks, wastes from winnowing and animal waste.
- There is a good use of palm kernel shell, which is used for firing the boiler.
- There is hardly any waste from the oil processing unit. Poultry and piggery owners buy the oilcake. Waste water is disposed off in the main drain without treatment. The company is aware of the environmental regulations and they do their best to adhere to them.

Summary of the chapter

✔ Use sales information to plan daily and weekly production.

✔ Have long-term plans for 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.

✔ 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 packaging.

✔ Consider making agreements with both suppliers and buyers to assist production planning.

✔ Think carefully before employing friends and relatives. Select the best people for the job that you can afford.

✔ 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 oil mill is safe for workers and that all machinery has guards that are in place.

✔ Have a regular maintenance programme for all machinery and equipment.

✔ Keep production records and use them to improve the process.

✔ Invest in ways to save energy and reduce water consumption.

✔ Develop ways of improving the productivity of both staff and machines.

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 your product by:

❑ Securing raw materials 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 that 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

....

Reader's notes

Please use this space to write your own notes on Chapter 6.

6

Planning and managing finances 7

Tips for success

The following tips were provided by successful oil processors in ACP countries:

✔ Have sufficient money available to buy crops during harvest to process throughout the year.
✔ If you don't have much capital, start small.
✔ Do not rely solely on loans; have your own money too.
✔ Do not take money for personal use out of the daily takings, have an allowance instead.
✔ Check the cost of producing your product whenever there are changes in the price of raw materials, electricity or other costs. This will help you decide when you need to raise your prices.
✔ Keep records of all expenditure to reduce your tax bill.
✔ Book-keeping should be carried out every day.
✔ Motivated workers contribute to profits.
✔ All activities, including quality assurance and cleaning, are a cost, so keep a record of everything.
✔ Get advice from an accountant who is familiar with tax laws.

Finally

✔ Read Sections 7.1-7.5 and 8.1-8.2 in Volume 1: *Opportunities in Food Processing - Setting up and running a small food business.*

Financial calculations are important both when starting an oil processing business, to find out whether it is likely to be profitable before making an investment, and also during the operation of the business to monitor performance. This chapter examines the aspects of financial management that are relevant to oil processing businesses. Further details are given in *Opportunities in Food Processing*, Volume 1, Sections 7.1 - 7.5 and 8.1 - 8.2.

7.1 Financial Planning

The first step towards operating a successful oil processing business is 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* is used to find out about the different components of the proposed business (see *Opportunities in Food Processing,* Volume 1, Section 3.1). When this information is written down, it is known as a *business plan* (Table 7.1). To make sure that funding is sufficient, the initial financing should be based on a detailed feasibility study that takes all costs into account. Case Study 7.1 illustrates the value of conducting a thorough feasibility study before getting started.

Component	Examples of aspects to include
Background to the business	Name, address and contact numbers of business owner, type of product proposed. Any relevant experience of the owner.
Market Analysis	Overview of the type(s) of market for the cooking oil and oilcake, estimated present and potential demand, market segments that will be targeted, competitors, proposed market share. The main assumptions that have been made.
Site, factory layout and facilities	Location of proposed 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 (by-product use, disposal of any wastes produced, air/water pollution etc).

Component	Examples of aspects to include
Plant and equipment	Proposed production capacity, sources and costs of equipment, production inputs (raw materials, packaging), other equipment (e.g. vehicles, office equipment etc). Plan and timetable for commissioning machinery.
Staff	Production and administration staff (number of people and skills required) and training to be given. Staff recruitment plan/timetable.
Production plan, marketing plan	Production rates to meet identified demand, advertising and promotion to be done, distribution methods, sales outlets, projected increase in demand.
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, risk analysis).

Table 7.1 Main components of a business plan

Case Study 7.1: The need for a feasibility study and business plan

- Their business plan is very patchy, and it has not been done professionally. Nor is it based on in-depth market research. Nonetheless, they have attempted to improve it over time and the current one is their third attempt.
- Although the enterprise has a business plan, it is not a detailed one that could be used for the various production and marketing activities. They sometimes consult with experts to assist them to shape and develop the plan.
- To remain competitive, the company developed strategies such as pursuing rigorous quality standards, preparing for production in advance, and identifying new export markets for one of their main product lines which has great potential in the West African sub-region, Europe and America.
- As an accountant, the owner has developed a business plan for forecasting, a marketing plan and production plan. He has also prepared a financial plan to analyse the likely income and costs that the oil business would generate when he increases production. With these he is able to predict the viability of his business and expands only when he is sure

about the market, the availability of raw materials and likely increase in profit.

- The processors have obtained training that has helped the group to prepare a business plan, which is yet to be followed. The management seeks to establish contacts with oil palm producers and markets to ensure a profitable business.
- It is a registered limited liability company established in 2000. The company has a business plan that is due for revision in 2010.

Discussions should be held with as many people as possible to enable a thorough understanding of the current market situation and how the proposed venture may alter it. These discussions should involve agricultural extension agents who advise oil-crop farmers, farmers who could supply raw materials, existing traders, local engineering workshop owners who can manufacture equipment and spares or carry out maintenance, and those who can assist in marketing the oil and by-products. All of these people influence decision making, and their support is important to the long-term success of the business. For example engineering workshops should be involved as early as possible to provide realistic cost estimates for processing equipment as this will draw attention to any manufacturing constraints and the need for imported equipment. Where machinery is locally made, the manufacturer should be able to meet maintenance requirements. Details of the discussions that are required with potential customers are described in Chapter 2, Section 2.3.

Before production is established, it is necessary to work out whether the business is a good investment and what is the level of risk. This depends in part on how much money is required as a loan to get started and the terms of the loan repayment (Case Study 7.2)

Case Study 7.2: Investment and return

- At Mkhota, the risk was high because the oil press had to be operated at near maximum capacity (nine batches per day), and the oil had to be sold quickly to repay the loan. This allowed very little time for maintenance and little margin to cope with breakdowns or other external problems such as competitor activity. For this business in Malawi, it was three years before the startup capital investment of US$ 4573 was covered. This business is only marginally viable and more favourable profit is needed before starting a similar enterprise with confidence. (From Potts and Machell (1993) in Annex B)
- Using its income from sales, the enterprise has bought modern equipment and land for planting oil palm trees.

Rate of return

The *rate of return* (ROR), also known as *return on investment* (ROI) or sometimes the *yield*, is the ratio of money gained or lost on an investment compared to the amount of money invested, usually expressed as a percentage. One method to calculate the ROR (known as the arithmetic method) is:

$$\text{ROR} = \frac{\text{Final value of investment - Initial value of investment}}{\text{Initial value of investment}} \times 100$$

So for an initial investment of $200 that is worth $255 after a year (because the business has expanded and is worth more), the rate of return = [(255-200)/200] x 100 = 55/200 x 100 = 27.5%.
Clearly, the higher the rate of return the better the investment.

Technical data on equipment (throughput and yield of oil and by-products) should be combined with costs and prices to find the *net income stream*. This can highlight any obvious financial problems and it can be used to calculate the *pay-back period* (i.e. how long it takes to recover the initial investment). The payback time for a loan needed to cover the initial capital investment is

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a good indicator of the level of risk in a business (Case Study 7.3). The margin of safety (Section 7.3) can also be used to assess the level of risk in a proposed business.

Case Study 7.3: Level of risk

Weaknesses of the business include inadequate capital to procure sufficient raw materials to last the season, and limited availability of supplies of good quality sunflower seed due to competition from other big buyers who also export seeds.

Whether it is a good investment depends on local conditions. While a profit and loss statement and margin of safety are useful indicators, they cannot guarantee success. In the end, a decision has to be made based on the available information, and only when the enterprise is up and running will the actual situation be known. (From Potts and Machell (1993) in Annex B)

This information can also be used to calculate the *financial rate of return*, which an investor can use to compare other investment options. Another measure of whether the business is worth investing in is the *net present value*, which allows a comparison of the income from different projects to be made. These different measures can be used either in combination, or separately, depending on the size and nature of the investment. A *sensitivity analysis* is also important. This means that the cost and income should be recalculated, using different values for anything that is not precisely known (e.g. the number of days per year that processing can take place), or for others that are highly variable (e.g. raw material costs that may be affected by pests or the weather). The purpose of a sensitivity analysis is to anticipate as accurately as possible the costs and income before the investment decision is actually made and later to monitor the impact of changes (e.g. a sudden increase in the cost of fuel or electricity).

Start-up costs

Start-up costs (Table 7.2) are those costs that are incurred when starting a business before there is an income from the sale of products. There are two types of start-up costs: 1) *fixed capital*, which is needed to buy equipment and spares and build or rent a suitable building, and 2) *working capital*, which is needed to buy sufficient crops and a stock of packaging materials, to hire and train the staff, product promotion etc. Further details are given in *Opportunities in Food Processing,* Volume 1 Section 7.2.

Fixed capital	Amount	$	Notes
Equipment			
Roller mill		2500	Including cost of transport and installation
Heating pans x 2		200	
Heater		400	
Oil press		1500	
Ancillary equipment		750	
Spares		250	
Sub-total		5600	
Building		4000	
Total fixed capital		9600	
Working capital			
Husked groundnuts			
Batch quantity (kg)	10		
Losses (%)	6		From grading and milling
No batches/day	10		
Days worked /month	23		
No months' supply of nuts	1		Assuming that income after one month will pay for nuts
Cost of shelled nuts ($/kg)		1.05	Delivered to site
Monthly supply of nuts		2438	Batch quantity x (100 + losses)/100 x batches/day x days/ month (i.e. 10 x (6 + 100)/100 x 10 x 23).
Cost of nuts/month		2560	Monthly quantity x cost/kg x No months supply (i.e. 2438 x 1.05 x 1)

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Fixed capital	Amount	$	Notes
Labour			
Daily wage		1.74	
No labourers	5		
Days/month	23		
No months' labour costs	1		
Cost of labour/month		200	Daily wage x No labourers x days/month (i.e. 1.74 x 5 x 23)
Management			
Supervisor's salary/month		90	
Salesperson's salary/month		60	Assuming income will pay salaries after one month
Manager's salary/month		130	
No months' management costs	1		Sum of salaries x No months' cost (i.e. (90 + 60 + 130) x 1)
Total management costs		280	
Fuel			Assuming income will pay for fuel after one month. Cost of fuel/month x No months (i.e. 50 x1)
Cost/month		50	
No month's supply	1		
Total fuel cost		50	
Debtors			This covers the cost of giving credit to customers and should be kept to a minimum. Assuming payments are made within one day. Monthly revenue x No months (i.e. 3714 x 0.04)
Monthly revenue		3714	
No months	0.04		
Total debtors		149	
Total working capital		3239	Cost of nuts + labour + management + fuel + debtors (i.e. 2560 + 200 + 280 + 50 + 149)

Table 7.2. Indicative start up costs for groundnut oil production (Adapted from Potts and Machell (1993) in Annex B)

At a micro-scale of production, an oil processor can begin production at home using domestic equipment, although it is preferable to start work in a separate room that is set aside for processing. At this scale of operation, oil extraction by hand or using simple manual machines (Chapter 4, Section 4.3) does not involve a large capital expenditure. Oil can be sold from bulk containers or packed into plastic bags or reused bottles, so packaging costs are also lower. The fixed and working capital (i.e. the investment needed to get started) are therefore relatively low. However, this type of operation is very time-consuming, inefficient, and produces low yields of oil compared to mechanised extraction. Processors are therefore likely to aim for mechanical extraction when funds are sufficient to buy equipment and upgrade production.

The cost of equipment for oil processing is higher than many other types of food processing. The move to small-scale production using manual or motorised oil presses, or to an expeller for higher rates of production, involves significant expenditure. Additionally, working capital is needed to cover the cost of new packaging and several months' supply of crops. There are also other start-up costs such as conducting a feasibility study and preparing a business plan, obtaining licences and health certificates. This usually requires additional finance in the form of a loan.

Getting finance

The fixed and working capital should be calculated to find out whether the entrepreneur's savings (known as the *owner's equity*) are sufficient to start the business without a loan. Where a loan is needed, it is likely that the funds will be required at intervals as the business develops, and these 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 7.4).

Case Study 7.4: Getting finance

The following examples were provided by oil processors in different countries:

- The enterprise is profitable, although often there are constraints in obtaining operating finance (loan). Banks are the only probable source, but the high interest rates limit the owners' desire to take on loans. First you have to work out the capital cost to set up the enterprise, then the running costs and monthly income. This will enable you to establish if you need a loan, and if so how much and when. A secure building that is rodent-proof and completely screened is required. A cost of US$ 1360 was estimated for a new building in Malawi and, for smallholder farmers

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or women's groups, a loan may be needed for this level of investment. It is essential to make these estimates before deciding whether to set up an enterprise, whatever the size. While it is only a theoretical calculation at the beginning, it can give a useful indication of whether it will be profitable and to what extent the enterprise can cope with unfavourable changes in conditions, such as increased raw material costs. (From Potts and Machell (1993) in Annex B)

- Due to the good financial history of the company they were able to obtain a half a million dollar loan from the African Development Bank guaranteed by the Ghana Government at 30% interest. This loan was used to recapitalise the factory and buy more stock.
- The operational funds are provided by the owner. He has not sought bank credits.
- The owner has financed the business mainly through his own funds. However, he has also obtained credit from a savings and credit co-operative, which he has managed well. He has not accessed bank loans, but does not see any obstacle if they were needed; only the high interest rates are scaring him.
- The company's aggressive expansion policy to increase production capacity as well as add value to its products resulted in the establishment of a 10 metric tonne per day capacity oil refinery plant in 2007 with loan facility from Ghana/Italian Government Assistance for Small and Medium Scale Enterprises.
- The enterprise was equipped with its own processing unit funded from the sale of its products.
- In 2004 they acquired a loan of US $400,000 from the African Development Bank guaranteed by the Ministry of Agriculture for expansion and technology upgrading.
- In order to increase production, the entrepreneur has received loans from financial institutions. These funds allowed him to acquire processing equipment and land to set up palm plantations. He will ensure gradual payment of these loans with interest.
- Members of the board are all professionals - accountants, solicitor, business administrator, financial consultant, etc. The company keeps all the necessary financial records and receives financial advice from its financial consultant on a regular basis. Due to their good financial record

they were able to access a large loan in 2007 at 15% interest with a two-year grace period. This loan was used to establish the new production facility to increase production and to improve the packaging to compete favourably with imported products.

- Individual entrepreneurs have taken loans ranging from US$20 - 2,000 to increase production and buy raw materials.
- When the cooperative company has a debt, the individual workers who have money lend to the company, after which the company compensates them by not charging a processing fee until the amount lent is repaid.

Operating costs

Once an oil processing business has been set up and is in production, there are two types of operating (or running) costs: those that have to be paid even if no production takes place, known as *fixed costs,* and those that vary with the amount of oil produced, known as v*ariable costs*. These costs are described in more detail in *Opportunities in Food Processing,* Volume 1, Section 7.1 and examples of each are shown in Table 7.3. It is advisable to keep fixed costs as low as possible to increase profitability. In the example in Table 7.3, the fixed costs are 15% of total costs.

Fixed costs		$	Notes
Management			
Supervisor's salary/month		90	
Salesperson's salary/month		60	
Manager's salary/month		130	
Total management costs		280	
Depreciation			
Equipment cost		5600	
Years until replacement	5		
Annual rate of depreciation (%)	20		100/years until replacement
Monthly cost of depreciation		93	Equipment cost x annual rate of depreciation/(100 x 12) (i.e. (5600 x 20)/(100 x 12))

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Fixed costs		**$**	**Notes**
Maintenance Equipment & building costs Maintenance per annum (%) Monthly cost of maintenance			
Interest Total fixed capital Total working capital % borrowed Amount borrowed Interest rate (%) Period of loan (years) Monthly repayment Total interest repayable Monthly interest repayments	80 18 3	9600 3239 10270 370 3054 85	 Total fixed and working capital x (% borrowed/100) (i.e. 9600 + 3239 x (80/100) Depending on how credit agency calculates interest payments Monthly payments x 36 - amount borrowed (i.e. 370 x 36 - 10270) Total interest / period of loan (i.e. 3054/36)
Total fixed costs		498	Management + depreciation + maintenance + interest (i.e. 280 + 93 + 40 + 85)

Table 7.3 a) Indicative fixed costs

Variable costs			
Groundnuts Batch quantity (kg) Losses (%) No batches/day Days worked /month No months' supply of nuts Cost of nuts ($/kg) Cost of nuts/month	 10 6 10 23 1	 1.05 2560	 From grading and milling Assuming that income after one month will pay for nuts Delivered to site Batch quantity x (100 + losses)/100 x batches/day x days/month x cost/kg (i.e. 10 x (6 + 100)/100 x 10 x 23 x 1.05)
Labour Daily wage No labourers Days/month Cost of labour/month	 5 23	 1.74 200	 Assuming daily labour, not on contract Daily wage x No labourers x days/month (i.e. 1.74 x 5 x 23)

Variable costs			
Fuel Cost/month		50	
Selling costs Selling cost/litre oil Litre oil/batch Batches/day Days/month Losses (%) Litres sold/month Selling costs	 3 10 23 10 621	 0.05 31	 Cost of promotion During filtering, boiling and filling Litre/batch x batches/day x days/month x (100 - losses)/100 (i.e. 3 x 10 x 23 x (100 - 10)/100) Litres sold/month x selling cost (i.e. 621 x 0.05)
Total variable costs		2841	Cost of nuts + labour + fuel + selling costs (i.e. 2560 + 200 + 50 + 31)

Table 7.3b) Variable costs

Loan repayment		$	Notes
Owners' equity		2568	20% of total required
% borrowed	80		
Amount borrowed		10271	Total fixed capital + total working capital x % borrowed (i.e. 9600 + 3239 x 80/100)
Interest rate (%)	18		
Period of loan (years)	3		
Monthly loan repayments		370	
Annual loan repayments		4442	

Table 7.3c) Loan repayments

Annual costs	$	Notes
Annual variable costs	34093	2841 x 12
Annual fixed costs	5978	498 x 12
Annual fixed costs including interest in year 1-3	5978	
Annual fixed costs including total loan repayments in year 1-3	9402	
Annual fixed costs in year 4 onwards	4960	
Annual costs year 1-3 including interest only	40,071	34093 + 5978
Annual costs year 1-3 including total loan repayments	43,494	34093 + 9402
Annual costs year 4 onwards	39,053	34093 + 4960

Table 7.3d) Summary of annual costs

Table 7.3a-d: Running costs for a small-scale oil mill (Adapted from Potts and Machell (1993) in Annex B)

Case Study 7.5: Production costs

The following production costs were reported by oil processors in different ACP countries:

- Due to low throughput, the costs of production are high and the business is therefore challenged by competition from cheap imported oils.
- The major cost was raw materials (over 50% of total costs). Energy cost is also substantial.
- They also grow their own sunflower seed to reduce the costs of raw materials, but need to investigate whether this production is more cost-effective than buying seed to arrive at a decision on which alternative is best.
- Raw materials and packaging materials constitute the major production costs; with seeds being 70% of the total cost of inputs and both would account for about 80-90% of costs. Reducing costs is a challenge as limited capital makes it impossible to buy bulk raw materials when in season and prices are low.
- Groundnuts are bought from wholesalers and represent 79% of the total cost of processing. The price varies throughout the year depending on the availability of the nuts. Other costs for transport and processing materials are 21% of total costs because members of the group donate their time for processing.
- Overall, the cost of soybean raw materials in relation to production is about 10-15% depending on availability.
- Raw material costs for palm fruit are 69% of total production costs, transport is 19% and labour is 12%.
- To overcome the problems of high crop costs during the lean season, the company stocks up during the bumper season in October to December, but the amount of money needed to purchase large volumes limits the amount that can be stocked.
- Palm fruit bunches triple in price outside the period of abundance in the harvest season from December to March.
- Palm fruit is 54.5% of total production costs, although it varies over time depending on the availability of the bunches.

- The packing materials for refined oil are more expensive and depending on the size of bottle, up to 10% of the production cost is in packaging. Overall, the cost of raw materials is about 15-30% of production costs depending on their availability. The months of April to July are particularly difficult because of increased prices.
- Transport of crops represents 27% of total production costs and labour is 19%.
- The most commonly used packaging for the crude oil is tanks or drums that are transported to the refinery for further processing, and the oilcake is stored in 50 kg bags that are sold to poultry farmers. So little is spent on packaging at this stage and it is estimated to be 5% of total production costs.
- Most of the family members are skilled/professionals. The salary budget is over 30% of the cost of production.
- Remuneration for workers constitutes 20% of the total cost of production.
- Labour contributes to about 2% of total production cost.
- Utilities and transport together account for less than 10% of total costs, with transport accounting for over half of this. To reduce transport costs, plans are underway to acquire their own vehicle.
- The cost of electricity went up by over 100% in the last year, and coupled with continuous power-outages, this has increased the cost of production by more than 30%.
- The company has access to utilities such as safe drinking water, liquid petroleum gas and electricity, but recently these are sometimes not very reliable and have become very expensive. They take a sizeable amount of the production cost (approximately 15%).
- Fuel is about 9% of production cost and the group believes that by replacing the diesel engine with an electric motor to drive the combined digester and hydraulic press, the fuel cost would be reduced. To save on the cost of fuel, biomass in the form of fibre and kernel by-product, are used for fuel. A long-term strategy is to invest further in the use of biomass fuel.

7.2 Income and profit

Income from the sales of oil and by-products should exceed the total costs of production in order for a business to make a profit. Details of income are shown in Table 7.4. Details of methods for calculating income and profit are given in *Opportunities in Food Processing,* Volume 1, Section 7.3.

Product costing for a small oil processing enterprise with a single main product and a by-product is relatively straightforward. There are a limited number of raw materials and only one production method is used. Also there are relatively few items of equipment compared to other types of food processing, which makes equipment depreciation costs easy to calculate. The cost of making a litre of oil and a kilogram of by-product can be found by adding together the total annual costs (Table 7.3d) and dividing this figure by the amount of oil and by-product produced per year. This method of calculating the cost of a product (i.e. based on production costs) is straightforward and suitable for most small-scale oil processors.

Monthly income	$	Notes
Oil		
Oil/batch (litres)	3	
Batches/day	10	
Days/month	23	
Losses (%)	10	
Selling price/litre	4.47	
Total income	2776	Litre/batch x batches/day x days/month x (100 - % losses)/100 x selling price (i.e. 3 x 10 x 23 x (100 - 10)/100 x 4.47
Oilcake		
Oilcake/batch (%)	68	
Batch quantity (kg)	10	
Batches/day	10	
Days/month	23	
Selling price/kg	0.6	For human consumption (lower price for animal feed)
Total income	938	Oilcake/batch x batch quantity x batches/day x days/month x selling price/100 (i.e. 68 x 10 x10 x 23 x 0.6/100)
Total income	3714	Oil + oilcake (i.e. 2776 + 938)

Table 7.4a) Indicative monthly income

Annual income	$	Notes
Annual income from oil	33310	2776 x 12
Annual income from oilcake		
Total annual income	11261	938 x 12
	44571	33310 + 11261

Table 7.4 b) Annual income

Table 7.4a-b, Income from a small-scale oil mill (Adapted from Potts and Machell (1993) in Annex B)

Case Study 7.6: Profitability

- They view the business as being very profitable, and it would be even more lucrative if they were able obtain raw materials more cheaply and if power supplies were stable. They are able to sell all their production on a cash basis at the moment.
- Initially, profits from the sale of products were shared between group members. In 2006, the group president suggested that profits should be reinvested to ensure the maintenance of facilities, payment of debts and strengthening the purchasing power to buy raw materials. This led to misunderstandings within the group and it ceased activity.
- The entrepreneur makes periodic financial analyses of his production to ensure the profitability of his business.
- Using profits from the sale of its products, the enterprise grew from using a manual press to a motorised press and the owner could increase its working capital, which permits him to store the oil for periods of scarcity before selling, so increasing his profit.
- This company like many local industries has had their profit margins reduced considerably in the last two years. In spite of these financial obligations, creditors do not pay on time while others do not pay at all. These do not help but they hope conditions will change for the better in 2010.
- The cost of production rises when palm fruit is out of season in December and January. This affects their profit margins since they have no control over the price of the products. Processing is profitable in March when fruit is in season.

Pricing products

The simplest way to set a price for oil and by-products is to add on a percentage for the owner's profit (the *profit margin*) to the total production costs. However, the size of the profit margin (and hence the price of a product) can be a difficult decision. The price should allow the producer, the distributors and the retailers to each make an adequate profit. It is also essential to take account of the prices of competing products. Setting a price is therefore influenced by the amount of competition, the type of market, and the demand for the product. It is particularly important to know whether an enterprise is critically dependent on one buyer and whether it is able to influence the price for the oil. Examples of pricing decisions in different types of markets (Chapter 2, Section 2.2) are as follows:

Enterprises that sell to less wealthy retail markets or supply ingredients to commercial or institutional buyers may have little flexibility in setting the price for products. This is because these customers look for a low price as the main factor in their decision to buy from a supplier. Selling oils to consumers in more wealthy retail markets allows greater pricing flexibility because sales are influenced by factors other than price (e.g. presentation and packaging). If there are few competitors and a strong demand, a processor has more flexibility in setting the price, and can decide the price that the market will bear. More commonly, there is strong competition either from other producers or imported oils, and competing products determine the price that can be set. In countries where the price of cooking oil is controlled or where there are significant imports of cheap oil, the processor has little control over the price of oil. In this situation, it is likely that the sales of oilcake will be the deciding factor in determining the overall profitability of an oil processing business.

Accurate costing of the products is therefore a key factor to make sure that the income is sufficient. This should not be regarded as an academic paper exercise, but should be done carefully to find out:

- Whether the income will be sufficient to cover all business costs and produce a profit.
- If the product can match the prices of the competitors.
- If, where, and how, savings can be made to reduce costs.

Details of different methods for costing a product to determine its price are described in *Opportunities in Food Processing,* Volume 1, Section 7.3.

When the price of the oil has been set, the income is calculated as follows:
Income = Selling price per unit x number of units sold.

The *gross profit* is the difference between the income and operating costs, and *net profit* is the amount remaining after tax. A *profit and loss statement* (Table 7.5) summarises the income, expenditure and gross profits or losses. It is used to plan the finances of a business over several years. This is useful to find out whether a loan should be taken out in stages as a business develops.

	Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**
Annual Costs Fixed costs Variable costs	 5978 34093	 5978 34093	 5978 34093	 4960 34093	 4960 34093
Total costs	40071	40071	40071	39053	39053
Annual income From oil From oilcake	 33310 11261	 33310 11261	 33310 11261	 33310 11261	 33310 11261
Total income	44571	44571	44571	44571	44571
Profit/loss (before tax)	4501	4501	4501	4501	4501
Profit/loss as % of income	10	10	10	12	12
Profit/loss as % of costs	11	11	11	14	14

Table 7.5. Indicative profit and loss statement (From Potts and Machell (1993) in Annex B)

Note: In the first 3 years the profit = 10% of income and 11% of costs, which is low for a viable production unit, and an increase in production is advisable. This level of profit is vulnerable to problems in raw material supply, decreased sales, or equipment breakdowns. The situation improves once the loan has been repaid after year 3.

> Processors should not consider the net profit as their own income - it belongs to the business.

Profits belong to the business and owners should take a salary that is recorded as a business expense. A common cause of business failure is when an owner takes large amounts of cash from the business (e.g. to pay for a wedding or other family occasion) because this disrupts the cashflow of the business. Profits should 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 reasonable for owners to increase their salaries if the business is doing well, this should be a carefully considered decision that does not affect the performance of the business.

7.3 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 also 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 6.1).

Controlling costs

The main costs for oil processors are raw materials, labour and power charges (Case Study 7.7). 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.
- Owning own farm or plantation.

Other methods of cost control include:

- Minimising debts and maximising credit.
- 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.
- Keeping records of each type of expenditure and relating these to the amounts of products that are sold. This allows processors to identify cost reductions that result from any changes in the efficiency of material usage that are introduced.
- Monitoring oil yields (Chapter 6, Section 6.4) by direct measurements to identify actual losses and opportunities for improvement.

Case Study 7.7: Managing costs

- In Tanzania, packaging contributes 30% to costs of production; the rest (70%) is contributed by raw materials. A reason for growing their own sunflower was to reduce the cost of raw materials, which varied from season to season depending on the level of production in the country.
- The company has generally been efficient in managing its debtors and suppliers. There have not been any delayed payments so far and they have paid income tax regularly.
- To reduce costs of raw materials and transportation, the enterprise owner has a palm plantation of 20 Ha of improved and local varieties of Tenera palms.

The profitability of an enterprise also depends on the productivity of the workers and equipment. Motivated workers with a loyalty to the business have the potential to greatly increase productivity (see Chapter 6, Section 6.6).

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 6.4) because reductions in yield due to careless workers negatively affect profitability. Finally, some types of oil processing use a lot of energy for heating. This energy must be used efficiently to minimise costs.

Power consumption can be controlled by ensuring that equipment is correctly set up and regularly maintained (Chapter 6, Section 6.7).

Breakeven point and margin of safety

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 that can enable the enterprise to make a profit. Breakeven point can be expressed as either the volume of production or the value of products.

Breakeven point expressed as the volume of production can be calculated as follows:

1. Calculate the variable costs per pack.
2. Subtract this 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 (see Case Study 7.8).

Case Study 7.8: Calculation of breakeven point by volume of production

The annual production of groundnut oil is 7200 litres and it sells in litre bottles at $4.2 per litre. The total variable costs are $3800 per annum and the total annual fixed costs are $1280. The breakeven volume of production is calculated as follows:

$$\text{Variable costs per pack} = \frac{\text{Total variable costs}}{\text{Number of packs}} = \frac{3800}{7200} = 0.53$$

Unit contribution = 4.2 - 0.53 = 3.67

Total fixed costs = $1280

$$\text{Breakeven volume} = \frac{\text{Fixed costs}}{\text{Unit contribution}} = 1280/3.67 = 348 \text{ litres/year}$$

A formula to calculate breakeven point by value of products is:

$$\text{Breakeven} = \frac{\text{Annual fixed costs}}{1 - (\text{Annual variable costs/Annual net sales})}$$

Margin of safety

The *margin of safety* is an indicator of how much the income to the enterprise exceeds the breakeven income. The smaller the figure, the more the business is at risk.

$$\text{Margin of safety} = \frac{\text{Budgeted income - Breakeven income}}{\text{Budgeted income}} \times 100$$

Using the data from Table 7.3:

$$\text{Margin of safety} = \frac{44571 - 39990}{44571} \times 100$$

$$= 10\%$$

This value is acceptable, but quite low. A figure of 12 - 15% would be better.

7

Case Study 7.9: Product pricing, income and profitability

- The quantity and quality of the crop will vary each year depending on the climate and pricing of the oil and oilcake should be regularly reviewed to ensure that changing circumstances and costs are taken into account. (From Potts and Machell (1993) in Annex B)
- Information was given that the enterprise is lucrative and is making a profit. This was attributed to the recent increased consumer demand for sunflower oil, which is regarded as good for health.
- Income from the sale of palm oil is 65% of total income and sales of palm kernels are 25%. The balance is from sales of wastes as fuel.
- The owner installed oil storage tanks that allowed him to keep the oil for periods of scarcity in order to increase his profits from a higher sale price.
- Oil processing is a lucrative business in Ghana but to be competitive the company has to carve a niche in the market by producing good quality products and constantly being innovative.
- The way the money is managed - the loan, the income and profit (or loss) - needs to be agreed, and also how this will be checked. (From Potts and Machell (1993) in Annex B)

Cashflow forecast

A *cashflow forecast* shows whether there is sufficient cash available to operate the business and an example is given in Table 7.6. Further details are given in *Opportunities in Food Processing*, Volume 1, Section 7.4)

	Year 0	Year 1 (months)												Year 1 total	Year 2	Year 3	Year 4	Year 5
		1	2	3	4	5	6	7	8	9	10	11	12					
BBF		3339	100	105	110	115	120	125	130	134	139	144	149	3339	154	1231	2308	7827
Income																		
Oil			2776	2776	2776	2776	2776	2776	2776	2776	2776	2776	2776	30535	33310	33310	33310	33310
Oilcake			938	938	938	938	938	938	938	938	938	938	938	10322	11261	11261	11261	11261
Equity	2668													0				
Loan	10271													0				
Total income	12939	3339	3814	3819	3824	3829	3834	3839	3844	3849	3854	3859	3864	44196	44725	45803	46880	52398
Expenditure																		
Fixed capital	9600													0				
Working capital		3239												3239				
Fixed costs (excluding interest)			498	498	498	498	498	498	498	498	498	498	498	5480	4960	4960	4960	4960
Variable costs			2841	2841	2841	2841	2841	2841	2841	2841	2841	2841	2841	31252	34093	34093	34093	34093
Loan repayments			370	370	370	370	370	370	370	370	370	370	370	4071	4442	4442		
Total expenditure	9600	3239	3709	3709	3709	3709	3709	3709	3709	3709	3709	3709	3709	44041	43494	43494	39053	39053
Balance	3339	100	105	110	115	120	125	130	134	139	144	149	154	154	1231	2308	7827	13346

Table 7.6. Example of cashflow forecast for oil manufacture (From Potts and Machell (1993) in Annex B)

BBF = Balance Brought Forward

The data in Table 7.6 shows that production costs are just below the income received, thus allowing a small increase in the balance carried forward month on month. This assumes that costs do not rise, and that all products and by-products are sold at the anticipated prices each month. The financial situation improves considerably once the loan has been repaid in Year 3.

Common financial mistakes

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

- Treating profits as their income, instead of paying themselves a salary.
- Failing to calculate the cost of products or 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 not enough creditors. *Debtors* are people or other businesses who owe money to a processor. This usually happens where the processor sells oil with a period of credit before the customer pays. During this time the purchaser owes the processor the money and is therefore a debtor. *Creditors* are the businesses or people who provide goods on credit. That is, they allow the processor time to pay rather than paying immediately the goods are received.

Case Study 7.10: Financial records

Analysis of accounts is done regularly, but the major interest is in the profit and loss statements.

The enterprise makes a periodic financial analysis of its production to ensure the profitability of its business.

This is a public company limited by shares and it has a comprehensive business action plan which was used to source a €1.0M loan/grant facility from the European Union through the Italy/Ghana partnership. The company also has a clear strategic plan, which is described in annual reports, and the accounts are prepared to inform shareholders. These reports clearly state the company's vision for the subsequent years, the business scene in the country, the operating results and share value and dividend.

Bookkeeping

Bookkeeping should be regarded as an integral part of each working day and not as an 'extra chore'. All enterprises should keep financial records that allow easy analysis either by the owner or an accountant. 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* (see *Opportunities in Food Processing*, Volume 1, Section 8.2).

> Remember: the better the records, the easier the accountant's job is and the lower their bill.

Summary of the chapter

✔ Calculate the start-up costs and ensure that adequate finance is available before you start the business.

✔ Know what the risks are and calculate the rate of return on an investment before approaching investors.

✔ Find out where the cheapest finance is - bank loans, investors, suppliers' credit etc.

✔ Records of start-up costs should be kept, as it may be possible to offset them against tax.

✔ Assess all production costs (fixed and variable costs) to calculate prices for your products.

✔ Manage your finances to make sure you always have a positive cash flow and that you are making a profit.

✔ 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.

✔ Get prompt payment from customers and negotiate delayed payments to suppliers.

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 business?

....

❑ 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?

....

....

Reader's notes

Please use this space to write your own notes on Chapter 6.

Annex A
A summary of the science of cooking oils

What are cooking oils?

'Fats' and 'oils' are chemically the same and the only difference is whether they are solid or liquid at room temperature. Important fats in food processing include animal sources such as lard, and the fats in dairy products (butter, cheese, ghee, cream). These are not considered in this book and further information can be found in *Opportunities in Food Processing - Setting up and running a small scale dairy processing business*. Similarly, cocoa butter is mainly used for the manufacture of chocolate and is not considered here because it is not used as a cooking fat. The main fats from vegetable sources are shea butter and to a lesser extent argan, and common oils are from coconut, maize, mustard, olive, palm and palm kernel, groundnut (peanut), sesame, sunflower and soybean (Chapter 4, Table 4.1).

Some properties of selected oils and fats are shown in Table A1. It can be seen that the fats have a higher melting point, which makes them solid at the usual range of room temperatures. Butter and cocoa butter have melting points that are close to body temperature, so they melt in the mouth. Conversely, oils melt at a lower temperature, which makes them liquid at normal room temperatures.

Type of fat or oil	Quality	Approx. melting point (°C)	Smoke point (°C)	Density (or specific gravity)
Animal				
Butterfat		32	177	0.911
Lard		30	182	0.919
Tallow		42	-	0.945
Plant				
Avocado		-	271	
Canola/rapeseed	Unrefined	-10	240	
	High Oleic		246	
	Refined		240	
Cocoa butter		34		0.964
Coconut oil	Unrefined	25	177	0.924
	Refined		232	
Maize(Corn) oil	Unrefined	-20	160	0.922
	Refined		232	
Olive oil	Virgin	-6	216	0.918
	Pomace		238	
	Extra light		242	
	Extra virgin		207	
Palm oil	Fractionated	35	235	0.915
Palm kernel oil	Unrefined	24		0.923
Peanut (groundnut) oil	Unrefined	3	160	0.914
	Refined		232	
Safflower oil	Unrefined	-18	107	0.90
	Semi-refined		160	
	Refined		266	
Sesame oil	Unrefined	-6	177	0.919
	Refined		232	
Soybean oil	Unrefined	-16	160	0.927
	Semi-refined		177	
	Refined		232	
Sunflower oil	Unrefined	-17	160	0.923
	Semi-refined		232	
	Refined		232	

Table A1. Properties of fats and oils (Adapted from Chu and Snowdrift Farm in Annex B) www.snowdriftfarm.com/fatproperties.html and M. Chu, Smoke Points of Various Fats, available at www.cookingforengineers.com/article/50/Smoke-Points-of-Various-Fats)

Chemically, fats and oils are made up of a glyceride 'backbone' that has a long chain of *glycerol* units linked together. Each glycerol unit has one, two or three 'arms' made from chemicals known as *fatty acids* (Fig. A1). Technically, these are known as 'monoacylglycerols' 'diacylglycerols' and 'triacylglycerols' respectively. The ones that have three fatty acids (the triacylglycerols) are the main constituents of cooking oils and fats. It is these fatty acids that give oils their different properties.

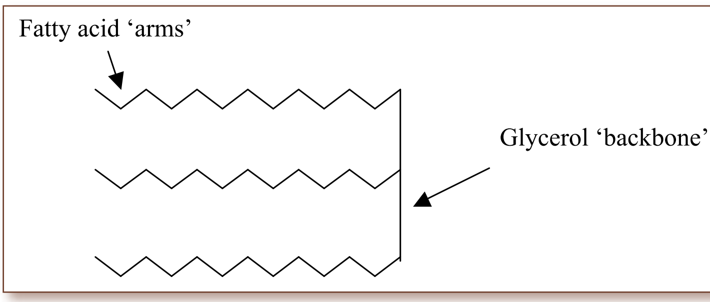

Fig. A1. Chemical structure of a unit of cooking oil (there are many thousands of these units joined together in an oil molecule)

The backbone and arms of oils can be split into fatty acids by enzymes named *lipases*, which are naturally occurring in the crop that contains the oil, and are present in digestive juices. Glycerides can also be split by an alkali, and this reaction is the basis for the production of soap.

The fatty acids in oils can also be 'saturated' (known as SFAs or Sats), 'mono-unsaturated' (known as MUFAs or Monos) and 'poly-unsaturated' (known as PUFAs or Polys). The types of fatty acids that are found in an oil or fat depend on the type of crop (Fig. A2) and whether it has been selectively bred to achieve a particular ratio of fatty acids. Some crops are bred to contain high levels of MUFAs or PUFAs (e.g. some types of safflower oil have up to 78% MUFAs). These oils are therefore commonly called 'unsaturated' oils. Others, such as coconut oil, contain higher levels of saturated fatty acids and these are commonly called 'saturated' oils. It is the difference in the amounts of these different fatty acids that give cooking oils their different qualities. These include their suitability for frying, their shelf life and susceptibility to rancidity, and their nutritional value (Note: In deep fat frying applications, oils such as coconut and palm kernel oil should not be blended with other oils such as palm, soya, rapeseed due to foaming).

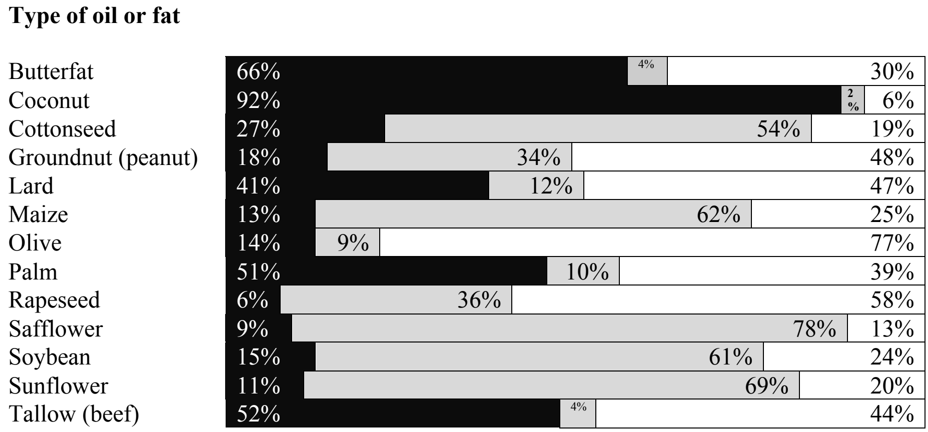

Fig. A2. Comparison of degree of saturation of fats and oils
(Adapted from Sunora Foods in Annex B)

Key:
= Saturated
= Polyunsaturated
= Monounsaturated

Fig. A2. Comparison of degree of saturation of fats and oils (Adapted from Sunora Foods)

Properties of fats and oils

Crystallisation

When the temperature of oils is lowered below their melting point, they form crystals as they become solid fats. The size and shape of the crystals depend on how quickly the temperature is lowered, the purity of the oil, and any stirring while the oil is cooled. These crystals give the different textures to solid fats. Fats can also change between different crystal shapes, from one to another, without melting (known as *polymorphism*). These changes produce more stable fat crystals and are important for solid fats, such as shea butter and cocoa butter, where the crystals contribute to the texture. It is changes to crystals of cocoa butter that sometimes produce the white ‘bloom’ on the surface of chocolate.

Smoke point

The *smoke point* is the temperature at which cooking oil begins to break down to form glycerol and fatty acids. On further heating, the fatty acids are driven off and the glycerol is broken down to 'acrolein' to form a bluish smoke above the oil, and is extremely irritating to the eyes and throat. The smoke point is also the temperature at which the flavour of the oil changes and the nutritional value begins to be lost. The smoke point is very important because it is the highest temperature that a particular oil may be used. It therefore determines what the oil can be used for (e.g. the oil should have a high smoke point for deep-frying in which a very high temperature (around 180°C) is needed).

Rancidity

When fats and oils spoil they produce unpleasant tastes and odours, in chemical reactions known as *rancidity*. This is very important in all types of food processing, where very small amounts of rancid fat can make a food inedible. It is particularly important in cooking oils, because the product becomes unsaleable. Different types of cooking oils go rancid at different rates, with the ones that contain more unsaturated fatty acids spoiling faster than those that contain more saturated fatty acids. For all oils, the factors that cause rancidity are as follows:

- Air.
- Heat and light.
- Metals (especially copper, brass and iron).
- Moisture in the oil.

There are two types of rancidity: one type is caused by chemical reactions that are accelerated by air, heat and light and metals (known as *oxidative rancidity*) and the other (known as *hydrolytic rancidity*) is caused by moisture, plant material or dust in the oil. The plant material contains enzymes that can break down the oil and both dust and plant material can be contaminated with bacteria or moulds that produce similar enzymes. Moisture in the oil allows the enzymes to act and break down the oil to increase the levels of fatty acids and cause rancidity. Generally, oxidative rancidity is a slower process that can take place when the crop or the extracted oil is stored under incorrect conditions. Hydrolytic rancidity can occur much faster if the oil is not filtered to remove plant material, or heated to destroy micro-organisms and enzymes and to remove moisture.

To prevent rancidity, processing and storing oils and fats should therefore take place as follows:

1. Ensure that crops are properly dried and stored in a dark place at a constant temperature.
2. Process the raw materials quickly to reduce the time available for rancidity to take place.
3. Ensure that none of the processing machinery that can come into contact with the oil is made of iron, copper, or any alloys made from these metals (e.g. bronze, brass). Ensure any repairs or brazing do not contain copper or brass. Use only steel (preferably stainless steel), aluminium or plastic.
4. Filter the oil after extraction.
5. Heat the oil to remove moisture and destroy enzymes and bacteria before packaging it.
6. Package the oil in airtight, lightproof and moistureproof containers, and ensure that the packs are properly dried before filling them. Do not use packs or containers that have iron or copper in them. Reused oil containers should be thoroughly cleaned because a film of old oil inside a container will rapidly cause fresh oil to go rancid.
7. Store the packaged oil in a dark place at a constant temperature, which should be as low as can be achieved without refrigeration.

By following these guidelines, a processor can make cooking oils in which rancidity is slowed (but not stopped altogether) to give a shelf life of many months before the unpleasant rancid tastes develops.

The oilcake should be dry to prevent mould growth and stored in a cool dark place to prevent the oil remaining in the cake from going rancid. It should be protected against insects and rodents using the same methods as are used for the raw material.

A note on hydrogenation

Hydrogenation is a process used to make liquid oils into solid fats (i.e. to make unsaturated fats more saturated). The solid fat, known as 'shortening', is used in many processes, especially baking. Also, more saturated fats have, because of their structure, a greater resistance to development of rancidity and hence a longer shelf life or fry life. However, the conversion of oils to shortenings is not a suitable business for small-scale oil processors in ACP countries. Oil processors should however be aware of these products because they may be competing products in sales to bakeries and other food manufacturers (see also nutritional and health importance below).

Antioxidants

Oxidative rancidity can be slowed by the use of chemicals known as 'antioxidants'. There are several types used by the food industry, including BHT[5], BHA[6], Vitamin E, Vitamin C and TBHQ[7]. However, it is not necessary for small-scale cooking oil producers to have the additional expense of using antioxidants because:

- Well-made cooking oils have the required shelf life without any additives.

Some herbs and spices, such as cloves, rosemary, oregano, sage and vanilla also have antioxidant properties. But because these are strongly flavoured, they are not suitable for use in general-purpose cooking oils, but there may be small specialist markets for flavoured oils in some ACP countries. These herbs also protect oils against rancidity in any recipes that use them.

5 Butylated HydroxyToluene
6 Butylated HydroxyAnisole
7 Tertiary-ButylHydroQuinone

Nutritional and health importance of cooking oils

Oils and fats contain more than twice the calories of carbohydrate or protein (nine calories per gram compared to four calories per gram). This makes cooking oil a valuable source of concentrated energy, which is important in many ACP countries where the diet consists mainly of grains and legumes. Without oil, infants and the elderly on these diets may not be able to eat enough food to get all of the calories they need to avoid weight loss or malnutrition.

Fats and oils also have an important role in the taste and texture of foods, and without them many foods are more difficult to eat and are less enjoyable. A small amount of fat in the diet is also necessary for our bodies to properly absorb fat-soluble vitamins such as Vitamins A, D, E and K. Some types of fatty acids, known as *Omega-3* and *Omega-6* fatty acids, cannot be created by the body and must therefore be eaten in fats and oils in foods. These are therefore known as *essential fatty acids*.

However, too much fat in the diet also has important nutritional consequences: eating too much fat contributes to obesity, which can result in diabetes and heart disease. The risk from cancers of the colon, prostate and breast may also be increased by eating too much fat. The degree of saturation of oils is also a factor and highly saturated oils can cause artery hardening and heart disease. These health concerns over eating high levels of saturated oils have encouraged the use of alternative, more unsaturated oils.

Rancid fats contain peroxides and other chemicals that may promote the formation of cancers but this has not been studied extensively, and they may also cause hardening of the arteries and heart disease. Hydrogenated oils contain *trans-fatty acids*, which have also caused health concerns: specifically, trans fatty acids raise the level of 'bad' cholesterol, reduce the level of 'good' cholesterol in the blood, which increases the risk of heart disease.

At high temperatures (e.g. during frying) oils break down to form a chemical known as *acrylamide*, which is potentially carcinogenic. Acrylamide has been shown to produce various types of cancer in mice and rats, but studies with humans have so far failed to produce consistent results. Lower temperature frying at a maximum of 180°C rather than at 190°C has been shown to reduce the formation of acrylamide. To fry effectively, the oil to food ratio has to be increased from 6 parts oil to 1 part food to 10 parts oil to 1 part food. If this is not done, the oil cools too much to ensure good frying results.

Uses for cooking oils

The markets for cooking oils are described in Chapter 2, Section 2.2. In ACP countries, the main use is as an ingredient in many different types of meals prepared in the home or in institutions. However, increasingly in some countries, cooking oils are also used for frying foods either by the growing number of 'fast-food' outlets in urban areas, by roadside snackfood producers (e.g. fried banana or plantain chips) or in restaurants and hotels. Frying oils are therefore a potentially large market for small-scale oil processors.

The selection of the types of oils used for frying depends on a number of factors, but the main one is stability against rancidity, both during storage (to give the required shelf life) and for frying for long periods (to give a long 'fry life'). Good quality frying oil should:

- Have a low melting point and a high smoke point.
- Have a low viscosity.
- Not foam or produce gums in the fryer.
- Have a bland flavour.
- Be low in saturated and *trans*-fatty acids.
- Have a long frying life.
- Be low cost.

The type of fried product also affects the oil: products that are coated with batters or breading accelerate the breakdown of the oil. Blended vegetable oils (e.g. maize, sunflower and groundnut oils, with or without animal fats), were used previously, but the link between saturated fats and heart disease has resulted in them being replaced with hydrogenated oils. However, health concerns about both saturated and *trans*-fatty acids in partly hydrogenated oils have more recently prompted food manufacturers and fast-food operators to use more unsaturated oils, such as rapeseed and sunflower oil that have the required frying properties. A blend of refined sesame and rice bran oils is also used, but large scale frying operations still use palm olein for frying because it is cheaper and longer lasting.

Refined oils

Competition for ACP oil processors who wish to supply commercial fryers also comes from imported oils that are made from refined oil. There are three basic steps that are used for refining cooking oil, but this type of refining is not suitable for small-scale oil processors: first degumming with phosphoric or citric acid is a pre-treatment prior to neutralisation for many oils; the oil is neutralised to remove free fatty acids by mixing it with caustic soda. The neutralised oil is then bleached to remove the colour using chemicals such as Fullers earth and activated carbon. Finally, the bleached oil is filtered and deodourised using steam under a high vacuum. The resulting refined oil is transparent, odourless and colourless.

A wide range of refined oils is made from palm oil and these are likely to be the main imported oils that compete with locally produced cooking oils. These oils are resistant to rancidity and have good flavour stability, which produce a long frying life and product shelf life. Most of these oils have citric acid added as a processing aid, which becomes depleted over time as it scavenges trace metals and reduces the development of rancidity.

Mycotoxins

Some types of moulds produce a variety of toxins (poisons) when they grow on cereals, groundnuts, nuts and oilseeds. Mould growth usually takes place because of inadequate drying of the harvested crop and/or humid storage conditions. Groundnuts are particularly susceptible if they are stored in their shells because inadequately dried nuts can easily become mouldy, but they remain unseen. Methods to correctly harvest and store crops are described in Chapter 4, Section 4.2. In general, the toxins produced by these moulds cause chronic illnesses that may result in cancer or liver damage. The most important types are named *aflatoxins*, and the optimum temperature for their production is 30°C; so they are most commonly found in tropical and sub-tropical regions. The most toxic is aflatoxin B_1, which is often fatal. Once aflatoxins are in the crop, they cannot be destroyed by processing and they pass into both the oil and the oilseed by-product. It is therefore essential that processors use proper quality assurance methods to control the risks of aflatoxins in their raw materials (see Chapter 5, Section 5.4).

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Annex C
Equipment manufacturers

The following list of manufacturers of oil extraction equipment is not exhaustive as there are a very large number of manufacturers of oil processing machinery, especially in India and China. Oil processors should identify manufacturers who may supply the type of equipment they are looking for in trade catalogues, websites of machinery suppliers (e.g. www.tradekey.com/ks-oil-extraction-machine, http://trade.indiamart.com/offer/plant-machinery/oil-extraction-machinery/buy.html or http://www.alibaba.com/product-gs/248454521/1_50T_D_small_scale_edible.html). It is emphasised that inclusion of the equipment suppliers in this Annex does not imply endorsement by the authors or CTA and any failure to mention a particular supplier is not a sign of disapproval.

Africa

- Agrico Agricultural Engineers Limited Kaneshie Industrial Area, P.O.Box 12127 Accra-North, Ghana, Tel: 233 21 228 260/236 240/228 292, Fax: 233 21 230 481, e-mail: agrico@ncs.com.gh. Shea butter equipment, presses and expellers, mills, grinders.
- Agrimal (Malawi) Ltd., P.O. Box 143, Heavy Industrial Area, Blantyre, Malawi, Tel: 265 670 933, Fax: 265 670 651. E-mail/website not known. Groundnut shellers.
- Amdale Sari, BP 2921, Douala, Cameroon, Tel: 237 425354. Palm kernel processing equipment
- Camemec, BP 8202, Cotonou, Benin, Palm oil processing equipment, Tel/e-mail/website not known
- CGC Agricultural Service Ltd., No.1 Clarkson Street, SK 2591, Banjul, Gambia, Tel: 220 222 254 /Fax: 220 222 254, Presses and expellers, mills, grinders

- Coopérative des Ouvriers Metallurgiques de Faranah (COMFAR) Quartier Aviation en face de l'Aéroport de Faranah, B.P. 11 Faranah / B.P. 2399 Conakry Faranah, Guinea, Tel: 224 41 20 88 /41 20 98, Fax: 224 41 20 88, Decorticators
- Farm Implements Limited, Ubungo Industrial Area, P.O. Box 20126, Dar Es Salaam
  Tanzania, Tel: 255 51 43075/43259, Fax: 255 51 43259, Decorticators
- FATECO, Agbogba Village, 3 km. off Madina-Kwabenya Road PO Box 9899, Airport, Accra, Ghana. Tel: 233 21 663114/303029/502547, Palm and palm kernel processing equipment, presses and expellers, mills, grinders
- Gack Engineering, Tantra Hills, New Achimota, Ant / B / 016 Accra, P.O. Box 15883 Accra, Ghana , Tel: +233 21 404109/403744/403801, Shea butter equipment, decorticators
- Hormeku Engineering Works, PO Box 20, Ashaiman, Tema, Ghana
  Tel: 233 22 307811 Palm and palm kernel processing equipment
- Intermech Engineering Ltd, P.O. Box 1278, Morogoro, Tanzania, Web: www.intermech.biz, Oil Expeller for sunflower, sesame, neem, moringa, groundnuts, coconut
- John F Marshall (A Division of Vera Cruz), 6 Jonas Road, Driehoek, Germiston, South Africa, Tel: +27 (11) 842 7100, E-mail: jfm@veracruz.co.za,
  Web: www.johnfmarshall.co.za
- Kaddai Engineering Enterprise, No. O.I. 89 Ashanti New Town, P.O. Box 2268, Kumasi, Ghana, Tel: 233 51 20 492, Fax: 233 51 27 528, Presses and expellers, mills, grinders
- Lutanda Ltd., P O Box 20516, Kitwe, Zambia, Presses and expellers, mills, grinders, Tel/e-mail/website not known
- Nigerian Oil Mills Ltd, P.O. Box 264, Atta, Owerri, Imo-State, Nigeria, Milling machine/oil expeller for palm kernels, groundnut and moringa seeds.
  Tel/e-mail/website not known
- Nova Technologies, Ibadan, Nigeria, Palm and palm kernel machinery,
  Tel/e-mail/website not known
- Nova-SOTECMA, Sarl Av. 1o Congresso do MPLA 24-26, C.P. 306, (Caixa postal), Luanda, Angola, Tel: 244 2 330 343, Fax: 244 2 335 378, Presses and expellers, mills, grinders
- OPC, BP 5946, Douala, Cameroon. Tel: 237 370432, Palm and palm kernel processing machinery

- PACESL - Professional Agricultural Consultancy and Expertise Services of Liberia,
  Vai Ioron, Bushwel Island, P.O. Box 148, 1000 Monrovia, Liberia, Presses and expellers, mills, grinders, Tel/e-mail/website not known
- SERMI, BP 17123, Sis Rue 4, 509 Bonaberi, Douala, Cameroon.
  Tel: 237 391422, Palm and palm kernel machinery
- Sismar, BP 3214, 20 Rue Dr. Theze, Dakar, Senegal, Presses and expellers, mills, grinders. Tel/e-mail/website not known
- Smallholder Agricultural Mechanisation Services (SAMS), Woodlands, P/Bag W47 Lusaka, Zambia, Tel: 260 1 233 229, Fax: 260 1 233 229, Presses and expellers, mills, grinders.
- SOPCI, BP 0247, Cotonou, Benin, Palm oil processing equipment.
- TAMSA Trading, 152 Sidwell Avenue, P.O. Box 14305, 6061 Port Elisabeth, South Africa Tel: 27 41 43 339, Fax: 27 41 411 731, Presses and expellers, mills, grinders
- Tanroy Engineering (Pvt.) Ltd. 179 Loreley Crescent, off Mutare Road, P.O. Box AY 382, 4 Amby, Msasa Harare Zimbabwe, Tel: 263 4 487791/3, Fax: 263 4 487794. Presses and expellers, mills, grinders
- TROPIC BP 706, Douala, Cameroon, Presses and expellers, mills, grinders. Tel/e-mail/website not known
- Ubongo Farm Implements, P.O. Box 2669/20126, Dar es Salaam, Tanzania. Tel/e-mail/website not known. Groundnut decorticators, presses and expellers, mills, grinders

Asia

- ABC Agro & Food Machine (India) Private Limited, 284, Dr. Ambedkar Road, Velandipalayam, Coimbatore, Tamil Nadu 641 025, India,
  Tel: 91 422 2442380/438238 Fax: 91 422 2444429, Mobile: 91 9842244429, Web: www.abcmachines.net, Oil expellers
- Agro Industrial Agency, Near Malaviya Vadi, Gondal Road, Rajkot 360 002, India Tel: 91 281 461134/462079/451214, Fax: 91 281 461770, Oilseed press manufacturers

- Allied Expeller Industries, 11811, S. A. S. Nagar, Ludhiana, Punjab 141 003, India, Tel: 91 161 2532414/2440085, Fax: 91 161 2532414, Mobile: 91 9779912414, Web: www.indiamart.com/alliedexpeller/oil-expeller-machines.html. Oil expellers, spare parts, filter presses and industrial conveyors.
- Amrut Engineering Works, Shakti Campus B/h Vihar Theater Pratapnagar, Vadodara 390004, India, Tel: 91-265-2439348, Fax: 91-265-2438865, Web:www.eindiabusiness.com/company/133781/amrut-engineering-works.html small to large scale oil mill machinery
- Anyang City Longtai Cereals and Oil Machinery Co., Ltd., Huaxiang, Anyang, Henan 455001, China, Tel: 86 372 3932415 Mobile: 86 151 36503906 Fax: 86 372 3919125 Web: http://www.aysat.com.cn/english. Oilseed press manufacturers
- Ashoka Industries Kirama Walgammulla, Sri Lanka, Tel: 94 71 764725, Oil Expeller for oilseeds, capacity: 5 litres/hour.
- B.H. Smith & Sons Company, Gandevi Road, Devsar, 396380 India, Tel: 91 263 4281881, Web: www.eindiabusiness.com/company/140969/b.h.-smith-sons-company.html oil extraction machinery & equipment,
- Brimco Engineering Works, M - 27/1, Street No. 8, Anand Parbat Industrial Area, New Delhi 110 005, India, Tel: 91 257 61786/22145040, Fax: 91 257 61786/22145040, Web: www.eindiabusiness.com/company/58748/brimco-engineering-works.html Manufacturing, erection, commissioning of oil mill machinery.
- Canflex Engineering Private Limited, PB. 1919, D. No. 7-2-c8/a and C33/a, Industrial Estate, S. Hyderabad 500 018, India, Tel: 91 237 12233/23716699, Fax: 91 23813884,
  Web: www.eindiabusiness.com/company/59129/canflex-engineering-private-limited-hyderabad.html Oil filling machines Chetan Agro industries, 108, Atul Complex, Gondal Road, Opp: Bombay Hotel, Rajkot 360 002, India, Tel: 91 281 2461781 Fax: 91 281 2461782 Web: www.chetantent.com. Oilseed press manufacturers.
- Chetan Agro Industries, 108, Atul Complex, Gondal Road, Opposite Bombay Hotel, Rajkot, Gujarat 360 002, India, Tel: 91 281 2461781, Fax: 91 281 2461781, Mobile: 91 9825216014, Web: www.indiamart.com/chetanagro/food-processing-machines.html Small oil expellers, oil extraction machines, filter press, decorticator.

- China National Machinery Import and Export Corporation, Shandong Branch, 82 Fan Hsiu Road, Tsingtao, China. or No.1 (W) Fuchengmenwai Avenue, Beijing 100037, China, Tel: 86 10 68991008, Fax: 86 10 68991000, e-mail:cmc@cmc.genertec.com.cn, Small-scale oil expellers.
- Chuo Baeki Goshi Kaiska (CECOCO), P 0 Box 8, Ibaraki City, Osaka 567, Japan, Small-scale oil extraction plants, groundnut decorticators, presses and expellers, mills, grinders Tel/e-mail/website not known.
- Dandekar Brothers Engineers & Founders, Sangli-Shivaji Nagar, 416416, Maharashtra, India, Presses and expellers, mills, grinders. Tel/e-mail/website not known.
- Flower Food Company, 91/38 Ram Indra Road, Soi 10, Km 4, Bangkok, Thailand. Tel: 66 2 5212203/5523420. Seed Decorticator for oilseeds, Capacity: 500 kg/hour.
- Forsberg Agritech India PVT Ltd 123, GIDC Estate, Makarpura, Baroda 390 010, India. Tel: 91 265 645752, Fax: 91 265 641683. Winnower to remove dust, and impurities
- Goldin India Equipment PVT Limited, F-29, B.I.D.C. Industrial, Estate, Gorwa, Vadodara 390 016, Gujarat, India. Tel: 91 265 3801168/380461, Fax: 91 265 3801168/380461. Grain Cleaners capacity: 100 - 2000 kg/hour.
- Goyum Screw Press (Oil Expeller Division), Plot No. 324/2, Industrial Area A, Ludhiana, Punjab 141003, India, Tel: 91 161 4633180, Fax: 91 161 2230380, Mobile: 91 9915065000, Web: www.oilmillmachinery.com Oil expellers, spares and parts, plate filter press, seed cleaners, decorticator and oil extraction machines.
- Haripriya Enterprises, 151/21 Sector-1 Charkop Kandivli West, Mumbai 400 067, India
  Tel: 91 39407451, Fax : 91 28690241, Web: www.eindiabusiness.com/company/66556/haripriya-enterprises.html Oil filling machines
- Hebei Nanpi Machinery Manufacture Co., Ltd. 72 Guang Ming Xi Road, Nanpi, Hebei 061500, China Tel: 86 317 8864245 Fax: 86 317 8855307, Web: www.cnnpm.com. Oilseed press manufacturers
- Himalaya Expeller Industries, C- 110, Naraina Industrial Area, Phase 1, New Delhi, Delhi 110 028, India, Tel: 91 11 25794583/25791161/25797757,
  Fax: 91 11 25790021, Mobile: 91 9810036970/9999913737, Web: www.indiamart.com/himalayaexpeller/oil-expellers-machines-spares.html Oil expellers for palm kernel, low power and less maintenance palm kernel oil expellers.

- Hindsons Pvt Ltd., The Lower Mall, Patiala 147001, Punjab, India, Presses and expellers, mills, grinders.Tel/e-mail/website not known. Pedal-operated groundnut shellers.
- Hitech Marketing Concepts, Near Century Hotel, Ghat Road, Nagpur, Maharashtra 440 018, India, Tel: 91 712 2772570, Fax: 91 712 2773746, Mobile: 91 9371188264, Web: www.indiamart.com/hitechmarketing/ Manual and hand operated oil expellers.
- Jagdish Exports, Near Malviya Wadi, Gondal Road, Rajkot 360 002,India, Tel: 91 1134/2462079/2451214, Fax : 91 1770/2450628, Web: www.eindiabusiness.com/company/69409/jagdish-exports.html Oil extraction machinery.
- Jayesh Engineering Corporation, B/19, Devda Bldg., Rani Sati Marg, Malad-e, Mumbai 400097 India, Tel: 91 228770338, Fax : 9122 28770338, Web: www.eindiabusiness.com/company/139959/jayesh-engineering-corporation.html oil mill machinery
- Jindal Expeller Industries, 58-B, Industrial Estate, Miller Ganj, Ludhiana, Punjab 141 003, India, Tel: 91 161 2534022 Fax: 91 161 4610468, Mobile: 91 9815970449/9815199974, Web: www.indiamart.com/jindalexpellers/oil-expellers-spare-parts.html Oil expellers for coconut oil, mustard oil, soybean oil and castor oil.
- Kanika Exports, 10 A, Model House, Ludhiana, Punjab 141 003, India, Mobile: 91 9872100027, Fax: 91 161 5019220, Web: www.kanikaexports.com/industrial-expeller.html oil expellers, palm kernel expellers, screw press expellers, hydraulic expellers, geared oil expellers.
- Kirloskar Brothers Ltd., Udyog Bhavan, Tilak Road, Pune 411002, India, Presses and expellers, mills, grinders
- Kumar Industrial Works, 43-45, Sidco Industrial Estate, Five Roads, Salem, Tamil Nadu 636 004, India, Tel: 91 427 2448443, Mobile: 91 9443248443, Web: www.indiamart.com/kumarindustrialworks/mechanical-expellers.html Mechanical oil expellers, oil extract machines, groundnut decorticators and cotton seed cleaners.
- Lipid Systems Engineers Pvt. Ltd. A-6/15, Kunal Estate, Keshav Nagar, Chinchwad, Pune 411033 India, Tel: 91 212 7486606, Fax : 91 212 7450936, Web: www.eindiabusiness.com/company/139960/lipid-systems-engineers-pvt.-ltd..html, oil mill machinery
- M/s.Best Engineering Technologies, Plot No.69/A, 5-9-285/13, Rajiv Gandhi Nagar, Industrial Estate, Kukatpally, Hyderabad, Andhra Pradesh 500 037,

India, Tel: 91 40 65908498, Fax: 91 40 23074198, Mobile: 91 9391057812, Web: www.bestengineeringtechnologies.com/bio-diesel-equipment.html. Oil expellers, dehullers, decorticators, filter press, settling tanks and seed cleaners.

- Mitsun Engineering, FF-107, Silver Coin, Shrenikpark Char Rasta, Akota, Vadodara, Gujarat 390 020, India, Tel: 91 265 2352802, Fax: 91 265 2354371, Mobile: 91 9824083532/9824097599, Web: www.mitsunengg.com/oil-mill-machinery.html. Oil expellers, jacketed cooker mounted expellers, baby oil expellers, filter press, mini filter, hammer mill and screw press.
- Nandys Engineering Works, 139, Benaras Road, Kolkata 711106 India, Tel: 91 33 26656485/4035, Fax: 91 33 26752302, Web: www.eindiabusiness.com/company/140198/nandys-engineering-works.html Retailers of oil mill machinery
- Om Sons International, 77-A, Industrial Estate, Ludhiana, Punjab 141 003, India, Tel: 91 161 4640008, Fax: 91 161 2530507, Mobile: 91 9463009508/9463335027, Web: www.omoilexpeller.com/oil-expeller.html Oil expellers, filter presses, mini boilers, copra cutters, seed cleaners, seed crackers, decorticators, elevators and conveyors.
- Rama Expeller Industries Private Limited, 155- B, Industrial Estate, Ludhiana, Punjab 141 003, India, Tel: 91 161 2532310, Fax: 91 161 2532310, Mobile: 91 9814561310, Web: www.indiamart.com/ramaexpeller/mill-accessories.html Oil expellers, screw press oil expeller.
- Shaoxing Liangfeng Machinery Manufacture Co., Ltd., Inside Dayu Silkworm Egg Area Jiuli Shaoxing, shaoxing, Zhejiang 312000, China, Tel: 86 575 88361633, Fax: 86 575 88317447 Web: www.sxlfjx.com.cn, Oilseed press manufacturers
- Sharma Expeller Company, 6772, Street No. 6, Daba Road, New Janta Nagar, Ludhiana, Punjab 141 003, India, Tel: 91 161 2496237/2500809, Fax: 91 161 2500809, Mobile: 91 9815234236, Web: www.indiamart.com/sharmaexpellers/oil-mill-machinery.html Oil expellers for sunflower, cotton seed, linseed, jatropha and mustard.
- Sichuan Qingjiang Machinery Co., Ltd. 104, Qingjiang Road, Ya'an, Sichuan 625000, China, Tel: 86 835 2823600, Fax: 86 835 2820747, Web: www.qingjiang.com.cn/yw/first.htm. Oilseed press manufacturers

- Simplex Expeller Works, Nirankari St.no.3, G.T. Road, Miller Ganj, Ludhiana 141003 India, Tel: 91 161 2532134, Fax: 91 161 2543442, Web: www.eindiabusiness.com/company/136064/simplex-expeller-works.html Manufacturers & exporters of oil mill machinery.
- Tiny Tech Plants (pvt) Ltd., Tagore Road, Rajkot 360 002, India, Tel: 91 281 2480166, 2468485, 2431086, Fax: 91 281 2467552, Mobile: 91 9227606264/9227606570, E-mail : tinytech@tinytechindia.com, Web: www.tinytechindia.com, Oil expellers: capacity: 125 kg/hour Filter Press capacity: 100-200 litres/hour.
- Wuxi Honggang Imp. & Exp. Co., Ltd., 9 Dongliangxi Road, Chong'an, Wuxi, Jiangsu, 214062, China Website: www.hgsourcing.com, Oil Presses.
- Yuzhou Xingyun Fire Controlling Facility Co., Ltd., 12 Garden Road West Industrial Zone, Yuzhou, Henan 461670, China, Tel: 86 0374 8276119 Mobile: 86 13937472310, Fax: 86 0374 8276119, Web: www.xyxfqc.cn, Oilseed press manufacturers.

Europe

- Alvan Blanch Ltd., Chelworth Malmesbury, Wiltshire, SN16 9SG, UK. Tel: 44 1666 577333, Fax: 44 1666 577339, E-mail: info@alvanblanch.co.uk, Web: www.alvanblanch.co.uk, Expellers, mills, grinders, oil screw press to suit village communities or small industries. Capacity: 50 kg/hour input.
- Buhler-Miag Ltd., Uzwil, Switzerland. Tel: 41 71 9551111, Fax: 41 71 9553379, E-mail: buhler.uzwil@buhlergroup.com. Decorticators, seed cleaners.
- De Smet Rosedowns, Cannon St, Hull East Yorkshire HU2 0AD, UK, Tel: 44 1482 329864, 441482, 325887, E-mail: info@ Rosedowns.co.uk www. rosedowns.co.uk, mini oilseed press. Capacity: 1 - 10 ton per day.
- Harburg-Freudenberger Maschinenbau GmbH, Kautschuktechnik, Speiseöltechnik Seevestr. 1 21079, 21045 Hamburg, Germany, Tel: 49 40 771790, Fax: 49 40 77179325, Web: www.hf-group.com/en/kontakt/index.html, Large expellers, pre-press expellers, oilseed preparation equipment.
- IBG Monforts Oekotec GmbH & Co, KG Schwalmstr 301, D-41238 Mönchengladbach, Germany, Tel: 49 2161 4015-80, Fax: 49 21614015-79 , E-mail: oekotec@ibg-monforts de, Web: www.oekotec.ibg-monforts.de/ en/11.html, Oilseed press, decorticators, seed cleaners, Komet expellers.

- Mathias Reinartz, Neuss, Maschinewfabril, P.O. Box 137, Industriestrasse 14 404, Neuss, Germany. Oilseed equipment. Tel/e-mail/website not known
- Skeppsta Maskin ABB engt Jonsson Täby Skeppsta S-705 94 Örebro, Sweden, Tel: 46 19 228005, e-mail: sales@oilpress.com, Oilseed Press manufacturers
- Ste Les Fils De Louis Samat, 10 Boulevard De Freres-Godchot 13392, Marseilles Cedex 4, France, Presses and expellers, mills, grinders. Tel/e-mail/ website not known
- VIVAS Co. #2, Nejinskaya str. 69 Odessa 65045, Ukraine, Tel: 380 482355591, 487155331, Fax 380 482267284, e-mail: manager@vivas.com.ua Web: www.vivas.com.ua, Oilseed press manufacturers

North America

- C S Bell Co, 170 West Davis Street, PO Box 291, Tiffin, Ohio 44883, USA, Tel: 1 419 4480791, Fax: +1 419 4481203 - mill for cereals/Oilseeds/Herbs/ spices, Capacity: 150 kg/hour
- Cropland Biodiesel, 2003 Pangborn Rd. Lynden, WA, 98264, USA. Tel: 1 360 8157061, E-mail: hunter@croplandbiodiesel.com, Web: www.croplandbiodiesel.com. Oil press - capacity: 1 - 3 tons per 24 hours
- Hybren, distributors: Sustainable Village, 1080 Oakdale Place Boulder, CO 80304, Tel: 303 998-1323 or 888 317-1600, 303 449-1348, E-mail: info@sustainablevillage.com, Web: www.hybren.dk, www.sustainablevillage.com, Hybren oilseed press capacity: 1/2 ton per day.
- Kern Kraft, 1531A Owl Creek Road, Thermopolis, WY 82443, USA. Tel: 1 307 8672233, Web: www.circle-energy.com Oilseed press, ¼ ton to 4 ton per day capacity (see also www.ncat.org/special/oilseed_crushers_list.pdf).
- Seedburo Equipment Company, 1022 W. Jackson Blvd. Chicago, IL 60607, USA, Tel: 1 312 7383700, 7385329, e-mail: sales@seedburo.com, Web: www.seedburo.com, Mills, hullers
- The French Oil Mill Machinery Co., 1035 West Greene St., P.O. Box 920, Piqua, Ohio, USA. 45356-0920, Tel: 1 937 7733420, Fax: 1 937 7733424, E-mail: sales@frenchoil.com, Web: www.frenchoil.com. Mills, seed conditioners, presses, expellers, oil filters.

- Trimline Design Centre Inc., 6772-99 Street, Edmonton, Alberta T6E 5B8, Canada, Tel: 1 780 4669034, 4669031, e-mail: info@trimlinedesigncentre.com, Mammoth oilseed press capacity: 2 -10 ton per 24 hours.
- V.D. Anderson Company, Harvar Ave., Cleveland, Ohio 44105-4896, USA, Tel: 1 216 6411112, Fax: 1 216 6411571, Web: www.feedscrews.com/supplier/1017, oil extraction equipment and expeller plants.

Pacific/Australia

- Billabong Logistics International, Box 805, Croydon, Victoria 3136, Australia, Tel: 61 97229440, Web: www.eindiabusiness.com/company/58274/billabong-logistics-international.html, Wholesale supplier and distributor seller of oil extraction plant and machinery.

The Food Processing Machinery & Supplies Association is a nonprofit trade association that provides link between food and beverage processors and suppliers. It can provide information about sources of equipment and supplies. Processfood.com is the association's electronic marketplace and the contact details are: 1451, Dolley Madison Drive, Suite 200, McLean, VA 2210, USA., Tel: 1 703 7612600, 6841080, E-mail: info@fpsa.org.

South America

- Masiero Industrial S.A., P.O. Box 218-219, Jan Sao Paulo, Brazil. Pre-press expellers.

Oil test kits

- All QA Products, P.O. Box 369 • Mount Holly, NC 28120, USA, Tel: +1 800 8458818, Fax: +1 704 829660, E-mail: sales@allqa.com, Website: www.allqa.com/Oil_Testers.htm
- Global Complex Co., Ltd., 712 HappyLand Sai 1 Rd., Klongchan, Bangkapi, Bkk 10240, Thailand, Tel: +662 375245558 Fax: +662 3752499, E-mail: foodsafetykit@gmail.com, Website: www.asianmedic.com www.gccthai.com

Suppliers of speciality oils:

- Chalice at www.aakuk.com/news-press/news/chalice-launches-fairtrade-brazil-nut-oil
- Fair Trade Foundation at www.fairtrade.org.uk/products/retail_products/default.aspx
- Olivado at www.tradekey.com/product_view/id/1073690.htm

Annex D
Institutions involved in oil extraction

The following institutions in ACP countries are able to provide advice and assistance to oil processing entrepreneurs. These are in addition to institutions listed in Volume 1 *Opportunities in Food Processing.*

Africa

- African Groundnut Council, P.O. Box 3025, Lagos, Nigeria. Member countries: Nigeria, Senegal, The Gambia, Mali, Niger, and Sudan. The association advises on marketing policies and ensures remunerative prices for groundnut and its by-products; organises exchange of technical and scientific information on production, marketing and uses of groundnuts.
- Angola Minieteno da industria, Rua Chequered Lukoki No. 25, 7 ander C.P. 594 , Luanda-Angola. Tel: 244 2337294, Fax: 244 2392400, Email:inanorq@ metangola.com
- Appropriate Technology Unit (ATU), Dept. of Community Development, Ministry of Local Government and Lands, 13 Marina Parade, Banjul, Gambia, Tel: 220 228178, Fax: 220 228178. Has expertise in shea butter and coconut oil extraction and supplies equipment for both products.
- Botswana Bureau of Standards, Plot no. 14391, Private Bag B 048, Gaborone, Botswana. Tel: 267 3164044, Fax: 267 31641042, Email.infoc@ hq.bobstandards.bw
- Botswana Technology Centre, PO Box 0082, Gabarone, Botswana. www. botec.bw
- Centre de Formation Technique Mgr. Steinmetz (CFTS), Quartier Gbena, Route de Lomé, sur la droite venant de Cotonou, B.P. Quidah, Altantique Quidah, Benin, Tel: 229 341335. E-mail: cfts@intnet.bj. Has expertise in palm/ palm kernel oil and supplies presses/expellers, palm/palm kernel equipment.
- Centre Pilote de Technologie Industrielle (CPTI), s/c Ministère de la Promotion du Secteur Privé, de l'Industrie et du Commerce, B.P. 468 Conakry, Guinea,

Tel: 224 60214069, E-mail: satoure@mirinet.net.qn. Has expertise in shea butter and palm/palm kernel oil extraction and supplies equipment for both products.

- Confederation of Tanzania Industries, 10th Floor, NIC Investment House, Samora Avenue, PO Box 71783, Dar es Salaam, Tanzania. Tel: 255 222 114954/123802. Fax: 255 222 115414. E-mail: cti@cats-net.com
- Coopérative des Ouvriers Metallurgiques de Faranah (COMFAR), Quartier Aviation en face de l'Aeroport de Faranah, B.P. 11 Faranah / B.P. 2399 Conakry Faranah, Guinea, Tel: 224 41 20 88 / 41 20 98, Fax: 224 41 20 88. Has expertise in palm/palm kernel oil extraction and supplies equipment.
- Council for Scientific and Industrial Research, PO Box M20, Accra, Ghana. Tel: 233 21 777330/ 761209/ 777647. E-mail: fri@ghana.com
- Council for Scientific and Industrial Research/FOODTEK, PO Box 395, Pretoria 0001, South Africa, Tel: 00 27 12 841 2911, 2663, 3661, Fax: 00 27 12 841 2185, 4790, 3865, E-mail: info@csir.co.za
- D.T.E - C.I. Matériel Agro-Industriel, 37, Rue de l'Industrie, Boulevard de Marseille, Zone 3, B.P. 18-629 Abidjan, Côte d'Ivoire, Tel: 225 242666, Fax: 225 242688. E-mail: dte@afnet.net, Web: http://www.dtematagri.com. Has expertise in shea butter extraction and supplies presses/expellers and shea butter equipment.
- Department of Agricultural Engineering. Egerton University, PO Box 536, Njoro, Kenya, Tel: 254 3761620, Fax: 254 3761442, Web: www.egerton.ac.ke. Has expertise in oil extraction.
- Department of Food Science & Technology, Sokoine University of Agriculture, PO Box 3006, Morogoro, Tanzania. Tel: 255 23 4402. Fax: 255 23 4562/3259.
- Department of Food Science and Technology, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana: Email foodtech@knust.edu.gh
- Department of Food Science and Technology, Makerere University, PO Box 7062, Kampala, Uganda. Tel: 256 41 533676, Fax: 256 41 533676, E-mail: foodtech@infocom.co.ug
- DRC National Programme of Nutrition, Kinshasa, Democratic Republic of Congo. Tel: 24381 5257861, Email: fmekob@yahoo.fr
- Ghana Appropriate Technology Industrial Services (GRATIS), PO Box 151, Tema, or PO Box M 39, Accra Ghana, Tel: 233 22 204243/207610, Fax: 233 22 204374, E-mail: executivedirector@gratisghana.com, gratis@ighmail.com,

info@gratisghana.com. Has expertise and information on palm oil, coconut oil and shea butter processing and supplies equipment.

- Ghana Export Promotion Council, PO Box M146, Accra, Ghana.
  Tel: 233 21 228813/228830. E-mail: gepc@ghana.com
- Ghana Standards Board, PO Box MB245, Accra, Ghana.
  Tel: 233 21 500065/500066. E-mail: gsbdir@ghana.com
- Government Chemist Laboratory, PO Box 164, Dar es Salaam, Tanzania.
  Tel: 255 222 113383/4. Fax: 255 222 113320.
- International Development Research Centre (IDRC), Regional Office for Eastern and Southern Africa, PO Box 62084 00200, Liaison House, 2nd and 3rd floors, State House Avenue, Nairobi, Kenya, Tel: 254 20 2713160/61, Fax: 254 20 2711063, Email: vngugi@idrc.or.ke, Web: www.idrc.ca/esaro, Has information and project activities in all types of oil processing.
- International Development Research Centre (IDRC), Regional Office for West and Central Africa, BP 11007 PEYTAVIN, Rue de Saint-Louis, angle de l'avenue Cheikh Anta Diop, Point E, Dakar, Sénégal, Tel: 221 33 8640000, Fax: 221 33 8253255, Email: jgerard@idrc.org.sn, Web: www.idrc.ca/waro
- International Institute for Tropical Agriculture (IITA), Post-Harvest Engineering Unit, Resource and Crop Management Division, PMB 5320, Oyo Road, Ibadan, Nigeria, Tel: 234 2 2412626, 234 2 2400300/319, Fax: 234 2 241222, 234 2 2874177/2276, Email: iita@cgnet.com, Web: www.iita.org. Has information and expertise in all types of oil extraction, information on equipment suppliers and reports on oil extraction projects.
- Kakute, P.O. Box 13954, Arusha, Tanzania, E-mail: kakute@tz2000.com, Website:www.jatropha.de/tanzania/Kakute/kakute.htm
- Kenya Bureau of Standards, P.O. Box 30016, Nairobi, Kenya.
  Tel: 254 20 502211-19/ 722 751666, Fax: 254 20 609660/503293,
  Email: tomc@kebs.org
- Lesotho Standards and Quality Assurance Section, P.O. Box 747, Maseru, Lesotho.
  Tel: 266 22317454/320659, Fax: 266 22311075/310326, Email:lessqo@leo.co.ls
- Malawi Bureau of Standards, P.O. Box 964, Blantyre, Malawi.
  Tel: 265 1 670 488, Fax: 265 1 670 756, Email: mbs@malawi.net
- Malawi National Laboratory, Biochemistry Lab, Lilongwe, Malawi.
  Fax: 265 1 789431/ 789536/788232,
- Mauritius Standards Bureau, Villa Road, Moka, Mauritius.
  Tel: 230 4335051/4335150 Fax: 230 4333648, Email: msb@intret.mu

- Ministry of Industry and Trade, PO Box 9503, Dar es Salaam, Tanzania. Tel: 255 222 180075.
- Mozambique National Laboratory for food and water hygiene, Av 25 De Serembno, No 1179, 2 andar. Tel: 258 1 325178, Email: parruque@hotmail.com
- Namibia Standards In Information And Quality Office, Ministry Of Trade And Industry,
  Goethe Street, Private bag 13340, Windhoek, Namibia. Tel: 264 612837111, Fax: 264 61220227, Email:ndishishi@mti.gov.na
- National Agricultural Research Organisation (NARO), PO Box 7852, Plot M217, Nakawa Industrial Area, Kampala, Uganda. Tel: 256 41 222657/285248/222627, Fax: 256 41 222657 E-mail: fosri-@imul.com
- National Food Control Commission, Ministry of Health, PO Box 7601, Dar es Salaam, Tanzania. Tel: 255 222 114039/114060.
- National Institute for Scientific and Industrial Research (NISIR), Food Technology Research Unit, Old Airport Road, PO Box 310258, Lusaka, Zambia. Tel: 260 1 2824888 or 260 1 282081-4. E-mail: nisiris@zamnet.zm
- Nigerian Institute for Palm Oil Research, 206 Benin-Lagos Road, Ugbowo, Benin City, Nigeria. Tel: 052 602485. E-mail nifor@infoweb.abs.net
- Nova-SOTECMA SARL, Av. 1o Congresso do MPLA 24-26, C.P. 306 (Caixa postal), Luanda, Angola, Tel: 244 222 330343/5, Fax: 244 222 335378, E-mail: mjferrao@novasotecma.com. Has expertise in palm/palm kernel oil extraction
- Oil Palm Research Institute, P.O. Box 74, Kusi, Kade, Ghana.
  Tel: 233 0803 610257/8,
  Fax: 233 0803 610235, E-mail: csir@ghana.com, Web: www.csir.org.gh. The institute works for improvement of small-scale semi-mechanized methods of processing palm, kernel and coconut oils and to commercialise research findings through consultancy and training.
- Practical Action Southern Africa, 4 Ludlow Road (off Enterprise Road), Newlands, Harare, Zimbabwe, Tel: 263 4 776631-3/776107/2936857-60, Fax: 263 4 788157, E-mail: practicalaction@practicalactionzw.org, Web: http://practicalaction.org/pauk/southern-africa/region_southern_africa. Has information and expertise in establishing small-scale sunflower and groundnut oil extraction enterprises.
- Seychelles Bureau of Standards, P.O. box 953, Victoria, Mahe, Republic of Seychelles Tel: 248 380400, Fax: 248 375151, Email: sbsorg@seychelles.net

- Smallholder Agricultural Mechanization Promotions (SAMeP, umbrella organization: AFRICARE), 87 Provident Street, P.O. Box 36658 Lusaka, Zambia, Tel: 260 1 239 794/233 578, Fax: 260 1 235 665/226 406, Email: samep@zamnet.zm. Has expertise in shea butter extraction.
- South Africa Bureau of Standards, Private bag x 191, Pretoria, 0001. Tel: 27 124286514, Email: rikhotp.ptapo.sabs@sabs.co.za
- Strengthening African Food Processing Project (SAFPP), CSIR Bio/Chemtek-FFD, Building 22, PO Box 395, Pretoria, South Africa. Tel: 27 12 841 3097, Fax: 27 12 841 3726. E-mail: dharcourt@csir.co.za. Web: www.safpp.co.za
- Suame Intermediate Technology Transfer Unit (ITTU), a department of the College of Engineering of the Kwame Nkrumah University of Science and Technology (KNUST) Tel 233 51 21177. Email: www.knust.edu.gh/tcc.
- Swaziland Bureau of Standards, P.O.Box 451, Swaziland. Tel: 268 0 43201/6, Fax: 268 40 44711, Email: bziyane@hotmail.com/ mee@realnet.co.sz
- Tanzania Bureau of Standards, Ubungo Area, Morogoro Road/ Sam Nujoma Road, PO Box 9524, Dar es Salaam, Tanzania. Tel: 255 222 450298. Fax: 255 222 450959. E-mail: standards@twiga.com
- Tanzania Engineering & Manufacturing Design Organisation (TEMDO), P.O. Box 6111 Arusha, Tanzania, Tel: 255 57 8058/6220, Fax: 255 57 8318, E-mail: temdo@habari.co.tz. Has information on oil extraction and supplies presses/ expellers.
- Technology Consultancy Centre, College of Engineering, Kwame Nkrumah University Of Science and Technology, Kumasi, Ghana, Tel: +233 20 815 2824, +233 51 62072, Fax: 233 51 60137, E-Mail: Email: provost.coe@knust.edu.gh, Website: http://coe.knust.edu.gh
- Uganda Industrial Research Institute, Plot M 217 Nakawa, P.O. Box 7086, Kampala, Uganda. Tel: 256 41286245, Email: makhokav@yahoo.com
- Uganda National Bureau of Standards, Plot M 217, Nakawa Industrial Area, P.O. Box 6329, Kampala, Uganda. Tel: 256 41222367, Fax: 256 1286123, Email: david.eboku@unbs.org
- Uganda Oilseed Producers and Processors Association (UOSPA), Kampala, Uganda, P.O. Box 26357, Kampala, Uganda, Tel/Fax: 256 41 342504, E-mail: oilseed@utlonline.co.ug, offers support to growers and oil processors.
- Zambia Food and Drugs Control Lab, P.O. Box 30138, Lusaka, Zambia. Tel: 260 1 252855/73/252875, Fax: 260 1 252875, Email: fdcl@zamtel.zm

- Zimbabwe Department of Health, Government Analyst Laboratory, P.O. Box CY 23, Causeway, Harare. Tel: 263 4 7920267, Fax: 263 4 708527, Email: rzindi@yahoo.com

Asia

- Asian and Pacific Coconut Community, 3rd Floor, Lina Building, Jl. H.R. Rasuna Said Kav. B7, Kuningan, Jakarta 12920, P.O. Box 1343, Jakarta 10013, Indonesia. Tel: 62 21 5221712 - 13, Fax: 62 21 5221714, E-mail: apcc@indo.net.id, Web: www.apccsec.org
- Coconut Research Institute of Sri Lanka, Bandirippura Estate, Lunuwila 61150, Sri Lanka, Tel: 94 31 2257419/94 31 2255300/94 011 2253795, Fax: 94 31 2257391, Email: director@cri.lk, www.cri.lk. Has qualified technical staff, resources and analytical facilities for research and development. It promotes collaborative research with other national institutes and private sector organisations.
- International Development Research Centre (IDRC), Regional Office for South Asia, 208 Jor Bagh, New Delhi 110 003, India, Tel: 91 11 2461-9411/12/13, Fax: 91 11 2462-2707, Email: saro@idrc.org.in, Web: www.idrc.ca/saro, Has information and project activities in all types of oil processing.
- International Development Research Centre (IDRC), Regional Office for Southeast and East Asia, 22 Cross Street #02-55, South Bridge Court, Singapore 048421, Tel: 65 6438 7877, Fax: 65 6438 4844, Email: asro@idrc.org.sg, Web: www.idrc.org.sg.
- Oil Technological Research Institute (OTRI), Jawaharlal Nehru Technological University, Anantapur, Andhra Pradesh, India. The institute conducts research and development in oils, fats, and related subjects. It has laboratory and pilot plant scale facilities for research in the chemistry and technology of oils and fats.
- Philippine Coconut Oil Producers Association, c/o United Coconut Associations of the Phils. (UCAP), 2nd Flr., PCRDF Bldg., Pearl Drive cor Lourdes St., Ortigas Center, Pasig City, Pasig, NCR, Tel: 63 02 6338029, Fax: 63 02 633-8030.

- Philippine Coconut Research & Development Foundation, Inc., 3/F, PCRDF Bldg., Pearl Drive cor. Lourdes St., Ortigas Center, Pasig City, 1605 Metro Manila, Philippines. Tel: 63 2 633-8031/6338488, Fax: 63 2 6338032, E-mail: info@pcrdf.org.ph / cocolab@cl-pcrdf.org.ph, Web: www.pcrdf.org

Caribbean

- Antigua and Barbuda Bureau of Standards (ABBS), PO Box 110, St. John's, Antigua. Tel: 1 (268) 462 1542/2424. Fax: 1 (268) 462 1625. E-mail: abbs@candw.ag
- Barbados National Bureau of Standards (BNSI). Flodden, Calloden Road, St. Michael, Barbados. Tel: 1 (246) 426 3870. Fax: 1 (246) 436 1495. E-mail: dbr@bnsi.com.bb
- Caribbean Export Development Agency, PO Box 34B, Brittons Hill, St. Michael, Barbados. Tel: 1 (246) 436 0578. Fax: 1 (246) 436 9999. E-mail: lseon@carib-export.com
- Caribbean Industrial Research Institute (CARIRI), Tunapuna Post Office, Trinidad. Tel: 1 (868) 662 7161/7163. Fax: 1 (868) 662 7177. E-mail: cariri@tstt.net.tt
- Chemistry and Food Technology Division, Ministry of Agriculture, Fisheries and Lands, Dunbars, Antigua. Tel: 1 (268) 462 4502/1213. Fax: 1 (268) 462 6281/6104. E-mail: moa@candw.ag
- Chemistry, Food and Drugs Division, 92 Frederick Street, Port of Spain, Trinidad. Tel: 1 (868) 623 5242. Fax: 1 (868) 623 2477. E-mail: cfdd@carib-link.net
- Dominica Bureau of Standards, 28 Kennedy Drive, 1st. Floor, Roseau, Dominica. Tel: 1 (767) 448 1685. Fax: 1 (767) 449 9217. E-mail: standards@cwdom.du
- Food Technology Institute, Scientific Research Council, Hope Gardens, PO Box 350, Kingston 6, Jamaica. Tel: 1 (876) 977 9316. Fax: 1 (876) 977 2194. E-mail: ftihead@cwjamaica.com
- Grenada Bureau of Standards (GDBS), Lagoon Road, St Georges, Grenada. Tel: 1 (473) 440 5886/6783. Fax: 1 (473) 440 5554. E-mail: gdbs@caribsurf.com
- Guyana National Bureau of Standards (GNBS), Flat 15, Sophia Exhibition Complex, Sophia, Greater Georgetown, Guyana. Tel: + 592 2 59041. Fax: + 592 2 57455. E-mail: gnbs@sdnp.org.gy

- International Development Research Centre (IDRC), Regional Office for Latin America and the Caribbean, Avenida Brasil 2655, 11300 Montevideo, Uruguay, Tel: 598 2 709 0042, Fax: 598 2 708 6776, Email: lacroinf@idrc.org.uy, Web: www.idrc.ca/lacro
- Jamaica Bureau of Standards (JBS), 86 Winchester Road, PO Box 113, Kingston 10, Jamaica. Tel: 1 (876) 926 3140-6. Fax: 1 (876) 929 4736. E-mail: othomas@jbs.org.jm
- OECS/EDADU, PO Box 961, Roseau, Dominica. Tel: 1 (767) 448 2240. Fax: 1 (767) 448 5554. E-mail: csthilaire_edadu@yahoo.com
- Saint Lucia Bureau of Standards (SLBS), Heraldine Rock Building, Block B, 4th. Floor, Waterfront, Castries, St Lucia. Tel: 1 (758) 453 0049/456 0546. Fax: 1 (758) 452 3561. E-mail: slbs@candw.lc
- St. Kitts-Nevis Multipurpose Laboratory, PO Box 39, Department of Agriculture, St. Kitts. Tel: 1 (869) 465 5279. Fax: 1 (869) 465 3852. E-mail: mplbos@caribsurf.com
- St. Vincent and the Grenadines Bureau of Standards (SVGBS), Ministry of Trade and Industry, Kingstown, St Vincent. Tel: 1 (784) 457 8092/ 456 1223. Fax: 1 (784) 457 8175. E-mail: svgbs@caribsurf.com
- Technological Services, Caribbean Development Bank, PO Box 408, Wildey, St. Michael, Barbados. Tel: 1 (246) 431 1690. Fax: 1 (246) 426 7269. E-mail: harvey@caribank.org

Europe

- Agromisa Foundation. PO Box 41, 6700AA, Wageningen, The Netherlands. Tel/fax 31 317 412217/419178. E-mail agromisa@agromisa.org. Web: www.agromisa.org
- Association for Appropriate Technologies in the Third World (FAKT), Gaensheidestrasse 43, 7000 Stuttgart 1, Germany. Tel: 00 49 711 210950, 2109526, Fax: 0049-711-2109555, E-mail: Fakt_ger@compuserve.com. fakt@fakt-consult.de. Has expertise in oil extraction from a wide variety of materials, information and assistance in project development.
- Campden and Chorleywood Food Research Association, Chipping Campden, Gloucestershire, GL55 6LD, UK. Tel: 44 1386 842000, Fax: 44 1386 842100, E-mail: information@campden.co.uk, Web: www.camden.co.uk

- Centre for the Development of Enterprise (CDE). Avenue Herrmann Debroux 52, B1160, Brussels, Belgium. Tel 32 2 6791811. E-mail info@cdi.be. Web: www. cdi.be. (CDE has a network of associated organisations in ACP countries)
- Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) GambH. Dag-Hammarskjold-Weg 1-5, 65760 Eschborn, Germany. Tel: 49 6196 79 0, Fax 49 6196 79 1115. E-mail: gtz@gtz.org.ge. Web: www.gtz.de
- Food and Agriculture Organisation of the United Nations (FAO), Fats and Oils Section, Commodities and Trade Division, Economic and Social Department, Via delle Terme di Caracalla, 00100 Rome, Italy. Tel: 39 06 5705 1, Fax: 39 06 5705 3152, E-mail fao@fao.org. Web: www.fao.org. Has information on equipment and suppliers, publications and research/project reports of oilseed processing in developing countries. There is a large website, with many links and free information including equipment suppliers at www.fao.org/inpho and publications at www.fao.org/catalog/giphome.htm or www.fao.org/docrep. Secretariat of the Joint FAO/WHO Food Standards Programme, E-mail codex@ fao.org, Web: www.codexalimentarius.net.
- GRET, 211-213 rue La Fayette, 75 010 Paris, France. Tel: 33 1 40 056161. Fax: 33 1 40 056110. E-mail: gret@gret.org, Web: www.gret.org.
- International Institute for Tropical Agriculture (IITA) c/o Lambourn (UK) Limited, Carolyn House, 26 Dingwall Road, Croydon CR9 3EE, UK. Tel: (44) 020 8686 9031, Fax: (44) 020 8681 8583
- Natural Resources Institute (NRI), Medway University Campus, Central Avenue, Chatham Maritime, Kent, ME4 4TB. UK. Tel: 44 (0) 1634 880088, Fax: 44 (0) 1634 880066/77, E-mail: nri@greenwich.ac.uk, Web: www.nri.org
- Oilseeds Development, 13 Upper High St., Thame, Oxon, OX9 3HL, UK. Tel: 44 1844 214153. Oilseeds Processing Program conducts research to add value to oilseeds and a technical resource to the oilseed processing industry. It has experience with soybeans, cottonseed, maize germ, canola, peanut, sunflower seed, safflower seed and flax seed. Specific services include practical short courses and customized training.
- Practical Action (formally ITDG). The Schumacher Centre for Technology and Development, Bourton Hall, Bourton on Dunsmore, Rugby, CV23 9QZ, UK. Tel 44 1926 63400. E-mail practicalaction@practicalaction.org.uk, Web: www.practicalaction.org

- Royal Tropical Institute (KIT) Publishers, PO Box 95001, 1090 HA Amsterdam, The Netherlands. Tel: 31 20 5688 272, Fax: 31 20 5688 286. E-mail: publishers@kit.nl, Web: www.kit.nl
- Secrétariat technique du Réseau (TPA), 211-213 rue La Fayette, 75010 Paris, France. Tel: 33 (0) 1 40 05 61 69, Fax: 33 (0) 1 40 05 61 10, E-mail: tpa@gret.org
- Technical Assistance (Int), P 0 Box 1224, Vosskuhlenweg 2, Bargteheide, Germany. Has information on oil extraction.
- Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA), Postbus 380, 6700 AJ Wageningen, The Netherlands. Tel: +31 317 467 100, Fax: +31 317 460067, E-mail: cta@cta.int, Web: www.cta.int
- United Nations Industrial Development Organisation (UNIDO), Vienna International Centre, PO Box 300, A-1400, Vienna, Austria. Tel 43 1 26026, Fax: 43 1 2692669. E-mail: unido@unido.org. Web: www.unido.org

The following organisation has information on management and health and safety issues:

- International Labour Office (ILO), Communications and Files Section (DOSCOM) 4, route des Morillons, CH-1211 Geneva 22, Switzerland. Tel: 41.22.799.6111, Fax: 41.22.798.8685, E-mail: ilo@ilo.org. Publications (PUBL): Tel: 41.22.799.7866, Fax: 41.22.799.6117, E-mail: publns@ilo.org. Library and Information Services (BIBL): Tel: 41.22.799.8675, Fax: 41.22.799.6516, E-mail: bibl@ilo.org. InFocus Programme on Boosting Employment through Small Enterprise Development (IFP/SEED): Tel: 41.22.799.6862, Fax: 41.22.799.7978, E-mail: ifp-sed@ilo.org.

N America

- Enterprise Works Worldwide/VITA (Formally ATI (Appropriate Technology International)), 1100 H Street NW, Suite 1200, Washington, DC 20005, USA, Tel: 1 202 6398660, Fax: 1 202 6398664, E-mail: info@enterpriseworks.org, Website:http://www.enterpriseworks.org. Has expertise and information on small-scale oil extraction in Africa, particularly using manual Bielenberg Ram Presses.

- Food Protein R & D Center, A&M University College Station, Cater-Mattil Hall, 373 Olsen Blvd., Texas 77843-2476, USA, Tel: 1 979 845-2741, Fax: 1 979 845-2744, E-mail: faxmarwaha@tamu.edu, Web: http://foodprotein.tamu.edu/contactus.php. An engineering process development, innovation, and training centre, focused on adding value to materials, including oilseeds, grains, nuts and natural/botanical oils
- International Development Research Centre (IDRC), PO Box 8500, 150 Kent Street, Ottawa, K1G 3H9, Ontario, Canada, Tel: 1 613 236 6163, Fax: 1 613 238 7230, Email: info@idrc.ca, Web: www.idrc.ca. Has information and project activities in all types of oil processing. See also regional offices in Africa, Asian and Caribbean.

Pacific

- Pacific Economic Development Agency Ltd., PO Box 121462, Henderson, Auckland, Australia, Tel: +61 9 836 6719, E-mail: mose@pacificeda.org, Website: www.pacificeda.org.
- New Zealand International Aid and Development Agency (NZAID), 163-175 Featherston Street, Private Bag 18-901, Wellington 5045, New Zealand, Tel: +64 4 439 8200, Fax: +64 4 439 8515, Email: enquiries@nzaid.govt.nz, Website: http://www.nzaid.govt.nz/programmes/c-pac-countries.html
- ANZDEC Ltd., Level 1, 2 Manukau Road, P O Box 99-608, Newmarket, Auckland, New Zealand, Tel: +64 9 523 2830, Website: www.anzdec.co.nz.

Websites

- Oil processors who can obtain assistance from a small business advisory service or an international development agency can access to the Internet. The following websites have useful information on oil processing and good links to other sites:
- www.fao.org/inpho has details of oil processing equipment and manufacturers around the world.
- www.iita.org has publications and contacts for research and development of oilseeds in developing countries

- www.oilseed.org website of the National Institute of Oilseed Products, has an international membership of companies, including processors, equipment suppliers, importers and exporters.
- www.idrc.ca has publications and contacts for research and development of oilseeds in developing countries
- www.undp.org/fi has details of coconut oil production as part of a Small Enterprise Development programme.
- www.experiencefestival.com/a/Essential_oil/id/472320 has a list of articles on different types of essential oils
  books@pacthg.org PACT Publications 1200 18th Street, NW Washington, DC 20036 202-466-5666 has books on small-scale oil extraction.
- http://practicalaction.org/practicalanswers/ has 'Technical Briefs' on food processing including cooking oil extraction.

Fair trade organisations that may buy oil from small-scale producers

Fair Trade organisations seek greater equity in international trade. They contribute to sustainable development by offering better trading conditions to producers in developing countries, and securing the rights of marginalized producers and workers. Fair Trade organisations support producers, raise awareness and campaign for changes to the rules and practice of conventional international trade.

Austria

EZA Dritte Welt, 8, Plainbachstr. 5101 Bergheim, Tel: +43 662 452 178,
Fax: +43 662 452 586, E-Mail: office@eza3welt.at, Website: www.eza3welt.at

Belgium

Magasins du Monde-OXFAM, Route provinciale, 285, 1301 Wavre,
Tel: +32 10 43 79 50, Fax: +32 10 43 79 69, E-Mail: mdmoxfam@mdmoxfam.be,
Website: www.madeindignity.be

Oxfam Wereldwinkels VZW, 15, Ververijstraat, 9000 Gent, Tel: +32 9 18 88 99, Fax: +32 9 18 88 77, E-Mail: oww@oww.be, Website: www.oww.be.

France

Solidar'Monde, 86, Rue Berthie Albrecht, 94400 Vitry s/Seine, Tel: +33 45 73 65 43, Fax: +33 45 73 65 42, E-Mail: solidarmonde@wanadoo.fr, Website: www.solidarmonde.fr.

Germany

GEPA, Gewerbepark Wagner, Bruch 4, 42279 Wuppertal, Tel: +49 202 26 68 30, Fax: +49 202 266 83 10, E-Mail: marketing@gepa.org, Website: www.gepa3.de.

Italy

Ctm Altromercato, Via Macello, 18, 39100 Bolzano, Tel: 0039 0471 975 333, Fax: 0039 0471 977599, e-mail: ctmbz@altromercato.it, Website: www.altromercato.it.

Netherlands

Fair Trade Organisatie, 5, Beesdseweg, 4104 AW Culemborg, Tel: +31 345 54 51 51, Fax: +31 345 52 14 23, E-Mail: info@fairtrade.nl, Website: www.fairtrade.nl.

Spain

Intermón Oxfam, Calle Louis Pasteur, 6, (Parque Tecnológico), 46980 Paterna, (Valencia), Tel.: + 34 96 136 62 75, Fax.: + 34 96 131 81 77, E-mail: comerciojusto@intermon.org, Website: www.intermonoxfam.org/es

IDEAS, Avenida Amargacena, Parcela 9, Nave 7, 14013 Cordoba, Tel: +34 91 407 10 38, Fax +34 957 429845, E-mail: food@comerciosolidario.com, Website: www.comerciosolidario.com.

Switzerland

Claro, 19, Byfangstr., CH-2552 Orpund, Tel: +41 032 35 60 700,
Fax: +41 032 35 60 701,
E-Mail: mail@claro.ch, Website: www.claro.ch.

United Kingdom

Oxfam Market Access Team, 274, Banbury Road, Oxford OX2 7DZ,
Tel: +44 1865 315 900, Fax: +44 1865 313243, E-Mail: oxfam@oxfam.org.uk,
Website: www.traidcraft.com

Traidcraft Plc, Kingsway, Gateshead NE11 0NE, Tel: +44 191 491 0591,
Fax: +44 191 482 2690, E-mail: comms@traidcraft.co.uk, Website: www.
traidcraft.com.

Glossary and Acronyms

Glossary

Aflatoxins	A particular type of mycotoxin that causes damage to the liver
Antinutritional factors	Chemicals in an oil crop that interfere with proper or complete digestion of the oilcake by people or animals
Antioxidants	Chemicals that slow down the development of rancidity in oils
Brand image	All the information and expectations associated with a product created within the minds of people
Breakeven point	The level of turnover at which all costs are covered
Cashflow	The amount of money coming into and going out of a business in a given period
Codex Alimentarius	An internationally agreed set of food standards
Critical control point	(also **process control point**) A point in a process where lack of control can affect the quality and/or safety of a product
Decorticating	Removing the outer coat from seeds
Enzymes	Natural proteins that cause changes in food colours and flavour
Essential oils	(or essences) oils used to give aromas to foods and cosmetics
Expeller	A machine that continuously extracts oil from a crop
Extraction efficiency	The amount of oil removed compared to the amount present in the crop

Food service outlets	The collective term for restaurants, take-aways etc.
Fixed capital	Money needed to buy equipment and build or rent a building
Fixed costs	Costs of production that do not depend on the quantity of goods produced
Free fatty acids	Chemicals formed by the breakdown of oil that cause rancidity
Gross profit	The difference between income and operating cost
Market research/ market survey	The process of identifying market segments
Market segments	A group of similar consumers
Market size	The weight or volume of food sold per month or year
Market value	The amount of money spent on a food per month or year
Marketing mix	The combination of where a product is sold, its price, its characteristics and its promotion.
Mycotoxins	Poisons produced by some types of moulds
Net profit	Profit after taxes have been paid
Niche market	A small specialised section of the a market
Oilcake	The solid part of the crop remaining after oil extraction
Operating cost	Cost of producing a food
Owner's equity	Money put into a business by the owner
Payback period	The time taken to recover an investment
pH	A scale from 1-14 that is used to measure acidity (below 6), neutrality (7) and alkalinity (8-14).
Polymorphism	Changes in shape of fat crystals without them melting
Rancidity	Development of off-flavours in oil due to the oxidation of oils and fats

Refining	The process of removing flavours, colourings free fatty acids and gums from oil
Smoke point	The temperature at which an oil begins to give off smoke.
Taste panel	A group of people, usually trained, who assess particular quality characteristics under controlled conditions.
Throughput	Production rate
Turnover	Annual sales
Variable costs	Production costs that depend on the amount of goods produced.
Working capital	Money needed to buy crops, packaging materials, pay staff and distribute and promote products
Yield	The amount of oil extracted from a crop compared to the weight of the crop

Acronyms

ACP	African, Caribbean and Pacific
CAC	Codex Alimentarius Commission
CCP	Critical control point
CTA	Technical Centre for Agricultural and Rural Cooperation
FAO	Food and Agricultural Organisation of the United Nations
FFA	Free fatty acid
HACCP	Hazard analysis and critical control point system of quality assurance
ISO	International Organization for Standardization
MUFA	Mono-unsaturated fatty acid
PRP	Prerequisite programme
PUFA	Poly-unsaturated fatty acid
QA	Quality assurance

ROI	Return on investment
ROR	Rate of return
SFA	Saturated fatty acid
SME	Small and medium scale enterprise
SWOT	Strengths, weaknesses, opportunities and threats
TQM	Total quality management
UNCTAD	United Nations Committee on Trade and Development
WHO	World Health Organisation

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This manual concentrates on running a small-scale cooking oil business and covers important aspects such as production, processing, quality control as well as marketing, packaging, branding and customer care. Advice on how to plan and manage finances is also provided. Each chapter contains tips for success and a useful checklist of the important things that every entrepreneur should address.

This book is the result of a collaborative effort by practitioners who support small-scale food processing in developing countries.

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