

Opportunities in food processing

Setting up and running a small-scale dairy processing business

Contributing authors

Barrie Axtell, Peter Fellows, Linus Gedi, Henry Lubin, Rose Musoke,
Peggy Oti-Boateng and Rodah Zulu

Edited by
Peter Fellows and Barrie Axtell
Midway Technology Ltd.

Published by CTA
2008

Technical Centre for Agricultural and Rural Cooperation (ACP-EU)

The Technical Centre for Agricultural and Rural Cooperation (CTA) was established in 1983 under the Lomé Convention between the ACP (African, Caribbean and Pacific) Group of States and the European Union Member States. Since 2000, it has operated within the framework of the ACP-EC Cotonou Agreement.

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

CTA is financed by the European Union.

CTA, Postbus 380, 6700 AJ Wageningen, The Netherlands

Website: www.cta.int



Citation:

Fellows, P.J. and Axtell, B. (Eds)

Setting up and running a small-scale dairy processing business. Opportunities in food processing series. Wageningen: ACP-EU Technical Centre for Agricultural and Rural Cooperation (CTA), 2008. 188 pages, ISBN 978-92-9081-377-4

Copyright © 2008 by CTA, Wageningen, The Netherlands

All rights reserved. No part of this publication may be reproduced or used in any form or by any means – graphic electronic or mechanical, including photocopying, recording, taping or information storage and retrieval systems – without written permission of the publisher.

ISBN 978-92-9081-377-4

Printed in Belgium by FAB S.A. Tel: +32 (0)2-340-14 Fax: +32 (0)2-340-14-24

Preface

This handbook is the result of a collaborative effort by small business owners, and advisers who support small-scale food processors in ACP countries, supported by the Technical Centre for Agricultural and Rural Co-operation ACP-EU (CTA). The information contained in the handbook was gathered by the researchers below, and prepared by Midway Technology consultants. We are grateful to Bassirou Bonfoh and Cécile Broutin who reviewed the draft publication and made valuable contributions to the text from the perspectives of their own countries.

We hope that this handbook will meet a need by small-scale dairy processors for technical and business information that was previously difficult to find, so that entrepreneurs can 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

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

Peter Fellows is a consultant food technologist and a Director of Midway Technology. He is Visiting Fellow in Food Technology at Oxford Brookes University in UK and has held the United Nations Educational, Scientific and Cultural Organization (UNESCO) Chair in Post-Harvest Technology at Makerere University, Uganda. He is an experienced author and has published 12 books and more than 30 articles on small-scale food processing. He has practical experience of working in the food processing industry and the institutions that support it in 20 countries.

Linus Gedi has experience in agro-industry and particularly in post-harvest technology. Before becoming a consultant he was first a tutor and then Head of the Illonga Agriculture Training Institute in Tanzania. For the past 17 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, fish and meat products. Since 1996 he has worked as the United Nations Industrial Development Organization (UNIDO) National Expert in food technology, training women entrepreneurs and trainers and helping to set up enterprises that achieve high-quality production and a cleaner environment.

Henry H. Lubin has been Produce Chemist with the Ministry of Agriculture, Saint Lucia for 20 years, conducting investigations into the uses of agricultural produce. During this time he has assisted and advised agro-processors on product development, quality and food safety and he also conducts chemical analyses of foods and feeds. He has been Director of the Saint Lucia Bureau of Standards for a number of years.

Peggy Oti-Boateng of the Technology Consultancy Centre of Kwame Nkrumah University of Science and Technology (KNUST), Ghana, is a Senior Research Fellow and a member of the United Nations Educational, Scientific and Cultural Organization (UNESCO) Expert Group on Technology and Poverty Reduction. She has over 20 years' experience in research, development and transfer of food technologies for micro-, mini- and large-scale enterprises, with a particular interest in enterprise development for women. She has also developed nutritious and affordable weaning foods for children using locally available foods. She has written several books and journal articles on food processing and storage, nutrition and sustainable bio-energy for rural development.

Rodah Zulu is a food technologist with several years' experience of food enterprise development in Zambia. In addition to research work at the Food Technology Research Unit, National Institute for Scientific and Industrial Research, Lusaka, she has undertaken consultancy work with the Food and Agriculture Organization of the United Nations (FAO) and the private sector. She has published a number of books and articles on the food resources of Zambia, and is currently working on the fortification of maize meal with large- and small-scale milling enterprises.

Acknowledgements

This handbook is a collaborative effort by the researchers and authors listed above, but a large number of other people gave freely of their time to assist in its preparation and publication. We would particularly like to record our thanks to Chantal Giuot at CTA for her support, encouragement and constructive ideas, to Sue Hainsworth of Green Ink for copy-editing and proofreading the text, and to Christel Blank of Green Ink for the layout. We also wish to thank the following small-scale industrialists in Africa and the Caribbean for sharing their experiences of the problems and successes of operating their food processing enterprises, and in doing so, contributing to the success of others:

Alfred Malijani, PO Box 320245, Lusaka, Zambia

Anna J.H. Temu, Power Foods, opposite Kawa Tanganyika Packers,
PO Box 23437, Dar es Salaam, Tanzania

Charlotte Ayayee, Joecarl Enterprise Ltd, PO BT 398, Tema, Ghana

Cheryl Rolle, Chi Chi Bees Yogurt, c/o J Garraway & Co. Ltd, PO Box 3,
19 Old Street, Roseau, Commonwealth of Dominica

Chirstabel Malijani, Provincial Health Inspector, PO Box 37136, Lusaka, Zambia

Claudia Mary Massawe, Clama Quality Product, PO Box 33496, Dar es Salaam,
Tanzania

M.T. Kaputo, Food Technology Research Unit, National Institute for Scientific
and Industrial Research, PO Box 310158, Lusaka, Zambia

Fafali Azaglo, Selasie Farms and Groceries, PO Box AN 7541, Accra, Ghana

Florence Adejoh, Flokan Products, PO Box CT 460, Cantonment, Accra, Ghana

G.M. Chingembu, CPL Kaposhi, PO Box 30060, Lusaka, Zambia

Harrington Barigye, Information Officer, Uganda Manufacturers Association,
PO Box 6966, Kampala, Uganda

J. Chikonde, Proc-Press Enterprise Ltd, PO Box 50805, Lusaka, Zambia

Janet Morio Mkonyi, Shesi Holdings, PO Box 5733, Ukonga, Dar es Salaam,
Tanzania

John Anglin, Paramount Dairies Ltd, PO Box 8414, Kampala, Uganda

John Kyenkungu, New Northern Creameries, Plot 4–13 Block D Industrial Area,
Unga Limited, PO Box 338, Arusha, Tanzania

Laura Gonzalez Peltier, PIWI Enterprises Ltd, 17 Hillsborough Street,
PO Box 1928, Roseau, Commonwealth of Dominica

M. Chingembu, Kaposhi Farms, PO Box 30060, Lusaka, Zambia

Margaret Kabasinguzi Nyanja Etagera Enterprises, Kampala, Uganda

Markus Weltin, Majoru Investments Ltd, PO Box 36518, Lusaka, Zambia

Maryline Simba, Simba Foods, PO Box 79360, Ubungo-Maziwa, Dar es Salaam,
Tanzania

Masoud Rizvi Fidahusseini & Co., Vingunguti Industrial Area, PO Box 816,
Dar es Salaam, Tanzania

Mike Richards, Farm Rich Foods, Vieux Fort, St Lucia

Mmari Devangwa Kivaria, Shekilango Road, PO Box 7911, Dar es Salaam,
Tanzania

Gregory Mongroo, Grew Ltd., PO Box 1050, Castries, Saint Lucia

R. Mendes, Tropical Delights, PO Box GW584, Castries, Saint Lucia

Narendra Jamari, Tabisco Enterprises Ltd., Chang'ombe Industrial Area,
PO Box 570, Dar es Salaam, Tanzania

The Manager, GHERA Ltd, PO Box 296, Vieux Fort, Saint Lucia

Thomas Lyimo, Tommy Dairy Farm Products, Morogoro Road, PO Box 71675,
Dar es Salaam, Tanzania

Wassin Naan Halawi, Halawi Holding Farm, c/o Dr Rodah Zulu, Food
Technology Research Unit, National Council For Scientific Research,
PO Box 310158, Airport Road, Chelston, Lusaka, Zambia

Peter Fellows
Barrie Axtell
February 2004

Contents

	Page
Preface	3
About the authors	5
Acknowledgements	7
Contents	9
How to use this book	11
1 Introduction	13
2 Markets for dairy products	17
Tips for success	17
2.1 Introduction	17
2.2 Types of markets	20
2.3 Overview of customer care concepts	24
2.4 The need for a feasibility study	27
2.5 Developing a marketing and selling strategy	28
2.6 Competitors	32
2.7 Product development	33
Summary of the chapter	35
Entrepreneur's checklist	36
Readers' notes	37
3 Setting up production	39
Tips for success	39
3.1 Introduction	39
3.2 Selecting the location	39
3.3 The building	40
3.4 Services	45
3.5 Equipment	50
3.6 Sources of packaging and ingredients	57
Summary of the chapter	60
Entrepreneur's checklist	61
Readers' notes	62
4 Processing	63
Tips for success	63
4.1 Introduction	63
4.2 Pasteurised milk	65
4.3 Cream	69
4.4 Butter and <i>ghee</i>	71
4.5 Cheese	77
4.6 Cultured milks and yoghurt	87
4.7 Ice cream	92
4.8 Milk confectionery	96
Summary of the chapter	100
Entrepreneur's checklist	101
Readers' notes	102

5	Quality assurance and legislation	103
	Tips for success	103
5.1	Introduction	103
5.2	Milk	103
5.3	Cheese, yoghurt and other dairy products	109
5.4	Risk analysis from production to consumers	109
5.5	Plant inspection and cleaning	112
5.6	Process control	114
5.7	Summary of legislation	116
	Summary of the chapter	124
	Entrepreneur's checklist	125
	Readers' notes	126
6	Planning and managing production	127
	Tips for success	127
6.1	Roles and responsibilities within the business	127
6.2	Production planning	129
6.3	Managing production	137
6.4	Contracts and agreements with customers	145
6.5	The use of records	145
	Summary of the chapter	148
	Entrepreneur's checklist	149
	Readers' notes	150
7	Planning and managing finances	151
	Tips for success	151
7.1	Start-up costs	151
7.2	Production costs	153
7.3	Managing finances	153
	Summary of the chapter	158
	Entrepreneur's checklist	159
	Readers' notes	160
Appendix I	Understanding the products and processes – the science of milk processing	161
Appendix II	Basic rules for hygiene, sanitation and safety in dairy processing	169
Appendix III	Bibliography and further reading	171
Appendix IV	Institutions that support small-scale dairy processing	175
	Glossary and acronyms	179
	Index	183
	Readers' questionnaire	187


How to use this book

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

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

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

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

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

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

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

The purpose of this book is to describe the activities that are needed to run a successful small-scale enterprise based on milk processing. This can be either processing fresh milk to preserve it for an extra few days, or 'secondary' processing to convert the milk into a range of different foods.

Tips for success

✓ Don't skip this chapter

Milk preservation at household level has been practiced for thousands of years in many ACP countries and in some socio-cultural groups it remains very important today (e.g. among nomadic herding communities such as the Fula in West Africa and the Maasai and Turkana in East Africa). Traditional preservation methods include boiling and fermentation to produce curd, cultured milks and soft cheeses. The main purpose is to preserve this highly perishable food to provide greater family food security. However, it is only relatively recently that commercial dairy processing has been established in ACP countries. One of the problems is that food safety depends upon a reliable system of transporting, storing and selling foods under chilled or frozen conditions – otherwise known as a 'cold chain' that stretches from the producer to the final consumer. In many ACP countries such chains are far from reliable: electricity cuts are common, ambient temperatures and humidity are high and the final consumer may not be sufficiently informed about the safe storage and use of dairy products.

Although the amount of milk consumption and processing varies from region to region, another problem for commercial dairy processors is the relatively small demand for dairy products compared to other types of processed foods. In many ACP countries milk consumption per person is typically 20 litres per annum compared to the 200 litres per annum recommended by the World Health Organization (WHO). Demand for other dairy products is often very small and confined to higher income groups or expatriates/tourists. There are many reasons for this, including the extent of animal husbandry and availability of milk, seasonal fluctuations in milk supply, the cost of milk and

dairy products in relation to average wage levels, cultural preferences and food taboos, and the incidence of lactose intolerance, which makes dairy products that contain lactose difficult to digest. In recent years higher income groups in urban areas and visitors have increased the demand for new, non-traditional dairy products, such as flavoured milks and hard cheeses.

The dairy industry is divided into two main production areas:

- primary milk production on farms – the keeping of cows (and other animals such as goats, sheep etc.) to produce milk for human consumption
- milk processing – with the objective of extending its saleable life. This objective is typically achieved by (a) heat treatment to ensure that milk is safe for human consumption and has an extended keeping quality, and (b) preparing a variety of dairy products (butter, hard cheese etc.), which can be stored.

Primary milk production on dairy farms is not covered, since this is related to the agricultural sector and the use of dried milk powder as a substitute for fresh milk is not included.

Dairy processing occurs worldwide; however the structure of the industry varies from country to country. In some ACP countries, milk is sold directly to the public, but in major milk-producing countries, it is mostly sold on a wholesale basis. The scale of operation of a dairy in a given ACP country reflects the demand for dairy products as well as the level of investment that is affordable, which is clearly related to consumer demand and the profitability of the operation. The two scales of interest in this book are small- and medium-scale operations. Small-scale dairies can be described as having basic equipment, a capacity of perhaps 200–400 litres of milk per day and a limited range of products (e.g. pasteurised milk and yoghurt). Medium-scale dairies may have more sophisticated equipment such as a plate heat exchanger for pasteurising milk, a larger scale of operation (e.g. 750–1000 litres of milk per day) and a larger range of products such as ice cream, butter or *ghee*, and cheese. Classification of scales of operation based on capital investment and employment are given in *Opportunities in Food Processing, Volume 1*, Chapter 1.

This book covers the important aspects of running a small dairy processing unit, including finding and developing suitable markets for products, setting up the unit, developing new products, quality assurance, and managing the

finance and business operations. It emphasises the need for strict hygiene in dairy processing because milk is a low-acid food that can easily transmit food-poisoning bacteria to consumers. It includes the following products that can be manufactured by small- and medium-scale enterprises:

- butters
- cheeses and cheese spreads
- creams
- cultured (soured) milks
- *ghee*
- ice creams
- milk confectionery
- pasteurised milk
- yoghurts.

Details of their production methods are given in Chapter 4. Other products, such as canned evaporated or sweetened condensed milks, dried milk and ultra heat treated (UHT) milk are not included because the technologies are large-scale, expensive and beyond small-scale processors' possible levels of investment.

The fictitious conversations in Table 1.1 show the types of response that a new entrepreneur might make, and also indicate where the information they need may be found in this book. The generic aspects of food processing are described in the companion publication *Opportunities in Food Processing, Volume 1*, which should be read in conjunction with this one.

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

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

Markets for dairy products

2

2.1 Introduction

Some small-scale dairy processors, especially in rural areas, think of themselves as part of the agricultural industry, justifying their role in the food-production chain by preserving milk for a few extra days. This attitude focuses on the supply rather than the demand. More successful processors have a different view: they see themselves as people who can create products to meet the identified needs of customers. The market for dairy products is constantly changing and can provide great opportunities for entrepreneurs (e.g. the introduction of pizza in some countries has generated a demand for grated cheese).

Small-scale dairy farmers sell untreated milk in local rural markets, to traders who transport it to retailers or boiling centres in nearby towns, or to processors' collection/cooling centres. Processors also transport the milk to their dairies and process it into the range of products listed on page 15. A few ACP countries also have large-scale UHT processing plants that operate milk-collection

Tips for success

- ✓ Be flexible, drop the products that are not doing well and concentrate on the winners
- ✓ Cultivate good relationships with customers and get feedback about your product – good or bad
- ✓ Get loyal life-long customers and accommodate their needs, particularly when they are experiencing difficulties
- ✓ Planning is very important. Do a proper feasibility study and don't take any short-cuts
- ✓ Do a proper market survey before venturing out – and use it
- ✓ Remember it is the final consumer, not the shopkeeper who decides if your product will sell
- ✓ Only supply quantities that can be sold within the shelf-life of the food
- ✓ Remember, complaints cause damage to your business even if you are not at fault
- ✓ Check the competition regularly and always keep ahead by developing new products
- ✓ Use the best packaging and promotion materials you can afford
- ✓ Ask yourself why someone should buy your product and not another
- ✓ Read Sections 3.1, 3.3, 4.1–4.3, 4.7 and 9.1–9.4 in *Opportunities in Food Processing, Volume 1*

centres. Large-scale dairy farmers, some of whom have cooling facilities, use their own vehicles to transport milk to processors' collection centres, to processors, or to nearby towns where it is sold to retailers or milk-boiling centres. Some may also have on-farm processing facilities, especially for yoghurt and occasionally for other products (Figure 2.1).

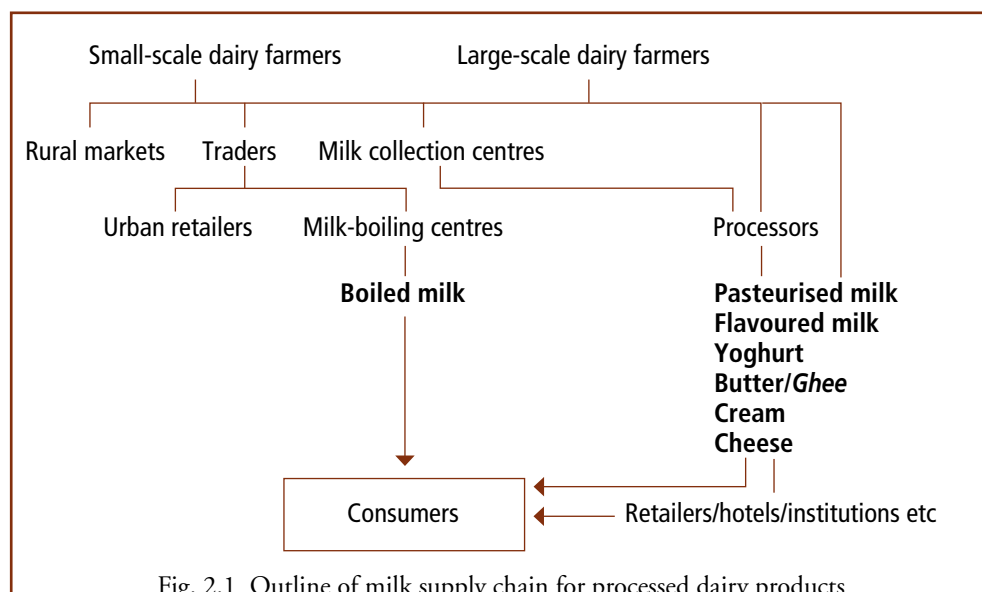


Fig. 2.1 Outline of milk supply chain for processed dairy products

Problems facing dairy industries in ACP countries

Quality

The quality of milk from farmers (especially small-scale farmers) may be substandard because of a combination of such factors as: failure to understand the need for high quality; insufficient finance available for cooling equipment; problems with road infrastructure that affect ability to distribute milk to wider markets and/or take excessive time to reach cooling centres. Processors may accept lower-priced, poor-quality raw milk to reduce costs, which results in lower-quality processed dairy products. Improvements in quality assurance may be required to enable processors to compete with imported cheese, yoghurt, butter etc., or to generate sales from people who want to buy the products, but do not like their present quality (see also Section 2.5).

Competition

Milk processors who produce pasteurised milk may face strong competition from lower-priced untreated or boiled milk, and in some countries, competition from UHT milk, or from imported cheeses and UHT yoghurt.

Case study 2.1 Competition

'Supermarkets tend to have larger amounts of imported products, which 'drown out' the local product. There is more aggressive marketing of the imported products and this may account for what is seen in the supermarkets. Maybe the supermarkets are offered better terms of payment. I am aware that there is a push from at least one importer to put UHT yoghurt with a longer shelf life onto the market, but I am not sure it can be labelled 'yoghurt'.'

Low demand

In many ACP countries there is a relatively low demand for dairy products, especially the more expensive ones like cheese. In some countries, a high incidence of lactose intolerance in the population reduces the demand for milk and other dairy products that contain lactose. However, yoghurt and other fermented milks or some soft cheeses (e.g. *Wagashi*, Chapter 4, Section 4.5) may be popular because most of the lactose is removed during processing.

Profitability of production and product diversification

Processors may compete with each other to produce the same products, and as a result lower their profits. In many countries there is little product innovation (e.g. cultured milks, flavoured milks, fruit-flavoured yoghurts, speciality cheeses, spreads etc), and little research and development into new products. This may be due to a lack of insight and market research by producers and also their failure to take risks.

Organisational problems

Small-scale farmers in particular may lack membership of farmers' organisations, and operate mostly as single families. This prevents them gaining benefits of scale and joint marketing. Support for the dairy sector may be lacking in some countries or the support institutions, agencies and organisations may be poorly co-ordinated.

2.2. Types of markets

There are four main types of markets for dairy products: domestic; food service establishments and other food businesses; institutional; and wholesale (Table 2.1).

Market type	Typical products	Typical outlets	Examples of market segments
Domestic	Butter cheese cream cultured milks <i>ghee</i> ice cream confectionery milk yoghurt	Supermarkets, shops, market traders (each can be different types including up-market, budget etc.), bus parks, kiosks, bicycle salesmen, street vendors, directly from the dairy	Mostly women from families that can be urban wealthy, rural wealthy, urban poor etc. There may also be differences in approach if housemaids do the shopping and are targeted as customers, rather than the housewife
Food service establishments and other food businesses	Milk butter yoghurt cheese ice cream	Restaurants, takeaways, hotels, coffee/snack bars, kiosks, bars, hotels, canteens in large factories or offices, bus stations, ferry terminals, airports, entertainment venues, sports stadiums etc.	Professional buyers in these establishments. Consumers may be factory or office workers, tourists or other travellers
Institutional	Milk butter yoghurt	Hospitals, schools, prisons, army barracks	In some countries dairy products are bought by professional buyers in the ministries that run these establishments, but in others the staff in the institution may have this responsibility. Consumers may be staff, patients, children, prisoners etc.
Wholesale	Cheese	Wholesale agents	Professional buyers (usually only for long shelf life products such as cheese) who distribute products to retail outlets

Table 2.1 Markets for dairy products

Domestic retail markets

The retail market for dairy products is mainly household purchases for home consumption. In some countries, milk or yoghurt is sold directly into customers' own containers, but the majority of dairy processors pack their products into retail containers. These may either be sold from an outlet at the dairy or distributed to retail food stores. Retail packs of milk also compete with boiled milk that is sold in open markets from jerry cans, usually at a lower price. The processor must therefore offer potential consumers a reason to buy more expensive milk in packets. Benefits such as guaranteed quality; freedom from contamination; and a guaranteed volume of milk can be promoted as positive benefits to consumers.

Within each market segment, there are different identifiable groups of customers that can be described by:

- location, e.g. rural, urban, rural town
- income levels, e.g. wealthy, poor
- age, e.g. foods that are mostly eaten by children
- gender
- special dairy products for festivals, birthdays or other ceremonies
- employment, e.g. yoghurts or flavoured milks eaten by office workers at lunchtime.

Each group may prefer a particular type of product and may also have different requirements for quality, price, packaging etc. When processors have decided who are their target customers, they should then devise promotion and sales methods that suit the selected groups. Customers' perceptions are not just about price and quality, but may also include status, enjoyment, attractiveness, convenience, health or nutrition. Processors should decide which factors are special for their product (known as its 'unique selling point' or USP) and emphasise these in their promotion and advertising.

Yoghurts or flavoured milks, for example, are more likely to be consumed as snacks or lunches by travellers, young people or students. Their USP may be freshness, high-quality ingredients, novelty, unique taste, etc. They can be promoted using posters or by giving away samples at popular takeaways and in shops, bus stations, etc. where there are large numbers of target customers.

People in this type of market are also likely to be more willing to experiment with new products.

Case study 2.2 Know your customers

'My market is local. I sell to the supermarkets and individuals that now know the product and ask for it. I have information on some consumers who are health conscious, are into low fat and 'natural' foods, and some are into fitness. The owner is a member of a gym and that was partly responsible for her deciding to produce yoghurt. I guess that the market share would be small, less than 10%.'

To be successful, this approach requires a market that contains sufficient numbers of affluent customers, who have the money to buy the products and a willingness to try something new. In practice, this means that in most ACP countries, a dairy should have an outlet located in an urban centre to attract more wealthy shoppers, business people, senior government or diplomatic staff. Examples include location inside new high-class shopping 'malls' in large towns or cities, sports facilities and places of entertainment, or close to more affluent residential areas. Alternatively the outlet should be close to hotels or tourist venues.

Food service or other food processing businesses

If the enterprise has a comparatively small number of large customers, such as hotels, it is not the final consumer that needs to be targeted by promotion; they are after all captive consumers of the hotel. Product quality, reliability of supply and relationship between the hotel and the producer are the keys in such situations. Hotels, restaurants, bakeries and other food businesses are often good markets for butter, milk, yoghurt and other products made by small-scale dairy owners (Case study 2.4).

Wholesale or institutional markets

These markets may include sales to schools and colleges and other government institutions (prisons, army barracks, etc.). Wholesale or institutional customers are more likely to be professional buyers who are experienced at negotiating prices, terms and conditions of sale, and buy products using contracts. They

are also likely to know in detail what competitors are offering, and it is worthwhile for a processor to conduct research into competitors' service standards and prices before entering into negotiations with them. In many countries, contracts for supplies to government institutions are by open tenders that are advertised in the press. Processors should be sure that they

Case study 2.3 Markets for dairy products

'The market size is not easy to estimate now. In 1992 when the market was smaller it was easier. We have not done an extensive survey but we do interact with our main customers, although we do not have much information about our final consumers. We have regular contact with supermarkets, hotel chefs, bakery and fast food managers, and monthly contact with actual customers. There is also a suppliers' day at the main Cash & Carry warehouse.

The product is sold to hotels, supermarkets and small shops. It has also been included on some airlines through the local flight kitchen where the menu calls for yoghurt. The largest part of the market is tourists who visit Saint Lucia and stay at hotels. These are mainly from the USA and to a lesser extent from Europe, with tourist from UK making up the larger proportion of these. The product is also aimed at the health conscious person with disposable incomes and children.

Mrs. P related the case she experienced with a large supermarket. 'Because it was the largest retailer, it 'asked' for special consideration and made a proposal to lower the cost of the product'. She indicated that if she did so, she would also have to lower the product price to others who were loyal wholesale customers. She believed that loyalty should have privileges too! The supermarket was not satisfied and stopped buying products from her, but her sales increased anyway.

'I did not advertise at first. I thought that we could generate sufficient business to start with by approaching and targeting the purchasing managers at the hotels and supermarkets. I have recently done taste sampling to promote the products at various supermarkets and I have also reduced the price of the product to increase sales.'

Case study 2.4 Food service markets

'We sell island-wide, to everyone from tourists who stay in the hotels to rural people. The tourists like the regular flavours that they are accustomed to (vanilla, strawberry, lemon), but they are willing to try the local fruit flavours like soursop, coconut and passion fruit. The business makes about 850 lb of ice cream and 12,000 popsicles per month, which I estimate is about 80% of the market.

We sell to hotels, supermarkets and some institutions (hospitals, schools). We sell a lot of fresh milk to the hotels, so a large proportion of our customers are expatriates from Europe and USA. Our market share is about 3% or 14,000 litres per year for fresh milk. Hotels also buy heavy cream.'

have the capacity to meet the volume and quality requirements of orders before accepting such contracts, because defaulting may prove costly.

Wholesale merchants, institutions and owners of bakeries or other food companies are valuable customers because they buy dairy products in relatively large amounts. However, the price that they are willing to pay is usually lower than can be achieved by retail sales, and even when the higher packaging costs of retail packs are taken into account, the profitability of the retail market is likely to be higher.

Small-scale dairies may not have the resources to target more than one or two market segments, but to be successful, a company should aim to supply a mix of both retail and wholesale/institutional customers to spread the risk and obtain the benefits of each type of market.

2.3 Overview of customer care concepts

Every dairy processor should recognise that their customers are the most important people in their business. They should also remember that a customer is the person who buys a food and a consumer is the person who eats it – these are not always the same people. Customers can also be wholesalers or retailers as well as consumers. The only way a business can survive is if its customers and consumers are satisfied with the product and service offered to them.

To achieve this satisfaction, business owners must develop attitudes, ways of thinking and actions that all reflect the importance of their customers, and are focussed on the aim of satisfying them. This can include:

- talking to customers and finding out what they like and dislike about each product
- developing customer-oriented attitudes so that they feel valued when the processor deals with them
- making sure that all actions taken by staff reinforce the idea that 'the customer comes first'.

Case study 2.5 Customer care

'We believe that customer loyalty is strong because of the long-standing, time-tested manner by which our enterprise conducts its business. This has been cultivated by being close to the customers to the extent that I know all the wholesalers personally, and all the others in the countryside who come to purchase products at the outlet. In addition, because of the state of the economy the terms have been more flexible because one knows the customers personally.'

The producer has a responsibility, by working with customers, to ensure that foods reach the final consumer in a safe and wholesome condition. It should be explained to owners and managers of shops and hotels that correct storage and handling of dairy products is essential if consumers are to be protected against food poisoning. Typical advice includes:

- check and maintain the correct temperatures in refrigerators and freezers
- never place raw foods in the same display unit as processed milk products
- use squares of greaseproof paper or plastic film to handle unpackaged dairy products
- check stock 'use-by' dates daily
- make sure that the doors of refrigerators and freezers are kept closed
- never allow staff with septic cuts, colds or stomach illnesses to handle dairy products
- use the product label to inform final consumers how to store and use the food, clearly indicating:
 - use-by date
 - storage conditions required
 - de-frosting times for frozen foods.

These may be a legal requirement in some ACP countries (see Section 2.5).

Case study 2.6 Problems of storage by customers

'There are refrigeration problems at the point of sale. The refrigerator temperatures are not well managed, especially where milk is placed in a refrigerated display cabinet with other products. The constant opening of the display cabinet by customers makes it very difficult to maintain the proper temperature. There is also a lack of care for the product. For example, when milk is delivered to some hotels, it is left un-refrigerated for a length of time.

The owner is concerned about the security of the product because the lids on the packs are the clip-on recloseable type and the integrity of the product could be compromised. She is looking into obtaining security seals and introducing codes on the packs.'

A high percentage of enterprises surveyed had systems in place to monitor the way products were stored and displayed in shops and supermarkets. This included checking the temperatures in freezers and chilled displays. A simple system to ensure stock control of short shelf life products at retail stores is to use self-adhesive stickers (e.g. Red = Monday, Blue = Tuesday etc.). Any product with a 7-day shelf life and a red label would be considered 'out of date' by the end of the week.

The greatest public health risk from dairy products occurs after sale to the final consumer. As part of their marketing strategy, manufacturers should ensure that the final consumer understands how to handle and store the food after purchase. Any bad practices by the consumer can result in complaints that will damage the name and reputation of the enterprise. Each dissatisfied consumer may talk to a dozen or more people and cause great damage to the image of a business, even though the consumer was, in fact, at fault.

Dairy processors should devise simple, straightforward methods for dealing with customer complaints as part of their marketing strategy (*Opportunities in Food Processing, Volume 1, Sections 2.5 and 9.3*). The aim is to ensure customers feel that their complaint has been dealt with fairly and promptly, and that the processor values the customer and is willing to listen and act if something goes wrong.

Case study 2.7 Customer complaints

'We handle customer complaints in the nicest way, investigate the nature of the complaint and replace returned products even if the fault is not with the product or the company. We check the products in the shops, and any goods that have passed their expiry date (6 weeks from date of manufacture) are withdrawn and replaced with fresh products.

For complaints, the owner visits the customer and assesses the complaint. The customers are compensated for loss with a similar product, or refunded the purchase price if this is the customer's preference.

I cannot remember when we had customer complaints and returned goods. We welcome feedback, and customers know they can approach the business. The few complaints were about the sweetness of a product. This was discussed with the people involved in production and they were cautioned to be more careful with the measurements.

Customer complaints and returned goods are investigated to determine their legitimacy. There is an arrangement with supermarkets that if a consumer reports a problem, the supermarket accepts the defective product and gives consumer a new one. Subsequently, the company makes good the loss to the supermarket. Two days before the expiry date all products are withdrawn from sale and fed to calves, but when buying is brisk, this is not necessary.'

2.4 The need for a feasibility study

The first step towards operating a successful new dairy business is to have a good idea for the types of product to make, but this alone is not enough. It is also necessary to investigate 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 information on the different components of the proposed business, and when the information is written down this is known as a business plan (Table 2.2).

Component	Examples of aspects to include
Background to the business	Name, address and contact numbers of business owner, type of product(s) proposed. Any relevant experience of the owner
Market analysis	Overview of the type(s) of market for the dairy products, 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 (waste production, air/water pollution, etc.)
Plant and equipment	Proposed production capacity, sources and costs of equipment, production inputs (raw materials, ingredients, packaging), other equipment (vehicles, office equipment, etc.). Machinery commissioning plan and timetable
Staff	Production and administration staff (number of people and skills required) and training to be given. Staff recruitment plan/timetable
Production and marketing plans	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, sensitivity analysis)

Table 2.2. Main components of a business plan

2.5 Developing a marketing and selling strategy

Some processors confuse marketing with selling, but these are very different. Marketing is deciding what to do to meet customer's needs, how a product can be made more competitive and how to produce the correct 'marketing mix' in a marketing plan. Selling is the process that results in a customer buying a product. So, good marketing paves the way for selling and makes

it easier, by making a customer ready to buy a product. The first thing to consider is the marketing mix.

Marketing mix

When a processor has identified the main customers, where they live or work, and how they buy their food, this information is added to that about the quality and price consumers expect, to produce a marketing mix (Figure 2.2).

<p>Product</p> <p>Better quality and appearance More nutritious More varieties Different flavours</p>	<p>Place</p> <p>Longer opening hours More attractive and cleaner sales outlet Popular location Delivery service Fast and friendly service</p>
<p>Promotion</p> <p>Targeted advertising to specific groups of customers Free samples Trade fairs, shows and special events Special promotions In-shop displays</p>	<p>Price</p> <p>Lower prices Discounts for larger quantities Special offers Credit facilities for retailers</p>

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

The processors can then use this information to refine their products and the way that they are sold, to better meet customers' needs. This involves:

- creating or modifying a product so that it has the appearance, flavour, size, etc. required by the customers
- where necessary, developing an attractive package
- making sure that the places where the product is sold are the ones that intended consumers use
- using promotion methods that reach intended customers
- setting a suitable price.

Further details of product development are given in Section 2.7, and pricing is described in Chapter 7.

This is not a single exercise that is done only when a business starts. It should be regularly updated and reviewed to improve, or even to change it completely. Producers should be constantly aware of feedback from customers

and retailers, any changes that competitors make to their products, and any customer complaints that are received. The following sections briefly examine each component of the marketing mix.

Product

To be successful, processors must differentiate their product from those of competitors. They can do this by:

- using attractive packaging
- offering better service than their competitors when supplying customers
- developing new products to create a wider market.

Processors may also be able to increase sales by offering customers special deals, credit, promotional materials or other incentives that encourage them to promote the products instead of those of their competitors. The costs involved in doing this need to be compared to the increased income to determine the value of this type of strategy.

Place

Many small-scale dairies only supply shops and marketplaces in their immediate locality, and similarly most domestic customers only buy milk from local shops or marketplaces. In this situation, the dairy should be located close to its customers (see also Section 3.2). Other dairy products, including yoghurt and cheese, have longer shelf lives and processors have the opportunity to use sales outlets located further from the dairy. This is particularly so when supplying wholesale agents or institutional customers.

Promotion

The types of promotion that are available to processors include:

- newspapers.
- radio and television
- signboards, posters, leaflets and cards
- personal contacts
- special promotions.

Different types of promotion may be needed for each market segment. For example, low-income customers are unlikely to have access to television,

but may listen to a radio or read newspapers. Posters or signboards along main roads and special promotions in retailers' shops are likely to reach more people. Personal contacts with hotel owners and supermarket managers may also be effective.

The package is one of the most important means of promoting a product.



An example of attractive packaging is given in Figure 2.3.

Fig. 2.3 Attractive packaging by a small-scale dairy processor (Photo: R. Zulu)

Case study 2.8 Promotion

'I use TV and radio and I advertise in the newspapers. I also subscribe to the *Hotelier Magazine*, *Industrial Review* and the *National Farmers Newsletter*. TV advertising made us known to more people although this has not necessarily converted into higher sales.

I do not do much advertising because it is relatively expensive. However the good name of the brand and the way we do business have kept customers loyal. I have done, and will likely continue to do, some promotions, (e.g. sponsorship for selected community activities, sporting events and school activities).

I do not promote or advertise the product. Production is small, the demand is small and the resources are not sufficient to do so. However, people who purchase and consume the product tell others about it.

We advertised the product on TV and radio, and also use tasting sessions at supermarkets. Advertising in the electronic media is expensive and the business cannot afford to have a sustained advertising campaign, but the adverts reached the children segment of the market, which seems the most lucrative.'

Pricing

The simplest way to work out the price for a product is to calculate the production costs and add a percentage for profit. Details are given in Chapter 7, Section 7.3 and in *Opportunities in Food Processing, Volume 1*.

2.6 Competitors

Successful processors know who their customers are, what they want and what they dislike. They also know the strengths and weaknesses of competitors, and constantly strive to improve their products and the service they offer, so gaining advantage over their competitors. Many small-scale dairy owners that were interviewed for this book complained about the activities of their competitors. For example, they considered that some competitors use underhand practices to win customers, make false allegations or make substandard products to increase their profits.

Case study 2.9 Competitors

'I know who our competitors are and the products they put on the market. I also know that the playing field is not level as most of them do not pay taxes and are well connected so are protected.'

It is difficult in a book of this type to describe in detail the ways in which small businesses can compete effectively and honestly, but in summary the following actions can assist a genuine processor:

- develop good relationships with customers, treat them with respect and deal with them honestly
- deliver what is promised and on time
- do not make false claims in promotional materials
- do not spread rumours about competitors
- find out from consumers and trade associations what competitors are doing and saying
- identify competitors' strengths and weaknesses
- use the information to be 'one step ahead'.

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

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

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

2.7 Product development

In order to produce a wider product range, a dairy processor should have:

- sources of recipes and ideas for new products
- technical knowledge and skills to produce different products to a consistently high quality
- facilities and equipment to produce the products
- careful market analysis to ensure that each type of product meets consumer needs
- careful production planning to ensure that all ingredients are available when required and that changeovers between different products take place without loss of productivity
- detailed product costing for each type of product
- detailed analysis of sales data to identify which products are more popular and more profitable.

Details of recipes and processing methods for dairy products are given in Chapter 4, production planning is described in Chapter 6 and costing in Chapter 7.

Case study 2.10 New product development

'When we saw that the market was changing, we introduced mozzarella cheese for the pizza industry and sliced cheeses for fast food outlets and supermarkets. We also introduced smaller packaging. When we started in 1992, we had one product and one pack size, but now we have 20–25 products.

We are developing different products for different markets. The yoghurt is for health-conscious and lactose-intolerant people. We are giving thought to developing a milk product with alcohol that will be aimed at the 30–40-year-old men.

She uses standard recipes, some of which were developed, and others obtained from books. The owner-generated recipes were developed by trial and error and are not documented.

There are plans to produce different yoghurts for adults and children, and icicles in a tube. I also plan to produce cheesecake, which will be marketed in supermarkets, fast food outlets and possibly on airlines through their flight kitchens.

Standard recipes were developed by the owner and others were obtained from suppliers of stabilisers, fruit, or starter culture, who were happy to provide recipes.

Using money he had saved while working abroad, the owner sourced some of the equipment and began experimenting with recipes. When satisfied, he began making his ice cream using his own formulations. It took 2 years to get started and he now has four workers (two male producers and two female sales persons).

We have standard recipes for all the products and I normally get them from dairy manuals. We introduce new products but don't modify the recipe once it is working.'

Summary of the chapter

- ✓ There are four types of markets for dairy products (domestic, food service/ other food businesses, institutional and wholesale).
- ✓ Always put the customer first and develop work practices that focus on meeting customers' needs.
- ✓ Decide how products, selling methods/places, prices and types of promotion can each be made to suit your intended customers in a particular market segment.
- ✓ Define why your product is different from those of competitors and emphasise these benefits when advertising.
- ✓ A feasibility study will help to plan your business.
- ✓ Prepare a marketing plan to guide the development of your business
- ✓ Always take account of competitors, but do not let them distract you from your business aims.
- ✓ Choose your retailer or distributor carefully and take care to see that distribution and sales are taking place properly.
- ✓ Develop close relationships with customers and maintain contact. Good customer care is a key to success.
- ✓ Keep in regular contact with consumers and ensure that they are satisfied with your products.
- ✓ Formal contracts with customers can benefit both parties.

Entrepreneur's checklist

- Have you identified the market segment likely to buy your products?
.....
- Have any market surveys been carried out?
.....
- Do you know precisely which type of customers you are targeting?
.....
- What changes can you make to your business to improve customer care?
.....
- Does your product meet customer needs? If not, what do you need to change?
.....
- Do you sell your products at places where your intended customers visit?
.....
- Have you planned your product promotion?
.....
- How can you improve your promotion to reach more customers?
.....
- Are your prices competitive?
.....
- Have you done a feasibility study?
.....
- Do you have formal contracts with your customers?
.....
- Do you know your competitors and what they are doing with their business?
.....
- Do your products need refrigeration? If so what strategies do you have to ensure a reliable cold chain to the consumer?
.....

3.1 Introduction

Before setting up a dairy processing plant, it is necessary to identify the correct-sized unit, a convenient site, and methods of producing foods that are safe and wholesome to eat under hygienic conditions that conform to local legislation.

Because dairy products have a high public health risk, aspiring entrepreneurs should seek advice from local universities, Bureaus of Standards or Public Health Authorities. In almost all ACP countries, dairy-processing enterprises must obtain Public Health licences, and advice at the planning stage can avoid future problems and costs.

3.2 Selecting the location

Dairies that produce milk and other short shelf life products, such as yoghurts, creams and soft cheeses, tend to be located on the fringe of urban centres close to consumers. Manufacturers of longer shelf life products, such as

Tips for success

- ✓ Know your local politician and be connected to your local society
- ✓ Fast start-up is important or you may lose enthusiasm
- ✓ Choose a site that is close to your customers or your milk supply
- ✓ Choose a building with enough space for workers to move around easily
- ✓ A clean attractive production building in clean surroundings attracts customers
- ✓ Include water treatment and waste disposal when designing your processing unit
- ✓ If the production process involves chilling or freezing, include the cost of a back-up generator
- ✓ Seek advice on the best sources of equipment, packaging and ingredients before you start
- ✓ Spend time planning and designing the production unit, mistakes will be costly to rectify
- ✓ Design systems that prevent any cross-contamination in the processing room
- ✓ Only purchase milk from reputable suppliers. Pay extra for premium quality
- ✓ Read Sections 5.1–5.4 in *Opportunities in Food Processing, Volume 1*.

butter or cheese, can be located in rural areas, closer to the sources of milk. It is cheaper for processors to transport products rather than to transport milk.

Case study 3.1 Location of the dairy

'Our location was selected because the land was available on the farm and it made good sense to have the plant near the source of the raw milk. Milk comes by various means – car, pick-up truck or bicycles, so we need to be nearby.'

However, locating the processing unit in a rural area means that there may be problems with:

- inadequate water supplies or potential contamination of supplies
- inadequate power supplies
- poor access for workers and staff (poor public transport, distance down an access road, road quality)
- absence of other facilities (good schools, medical facilities, shops and entertainment) that make working there less attractive than an urban location
- insects, birds or straying animals getting into the building.

If an urban location is required, industrial buildings may not be permitted in urban residential neighbourhoods, and an aspiring dairy owner should check with the Town or City Council before going ahead, in order to avoid future problems. A further factor to consider is the level of rent or cost of land, since these are generally higher in busy or more affluent areas of towns and cities. This cost needs to be balanced against the higher prices for products and increased sales volumes that are possible to achieve in such areas, together with better access to services, spares and supplies. Each of these factors should be assessed before choosing a site for the processing unit.

3.3 The building

It is important that a suitable room is used exclusively for dairy processing. A household kitchen, for example, is unsuitable because of the risk of contaminating products. It is essential that all areas of the processing room and all equipment can be easily cleaned.

Buildings in rural areas may cost more to construct because of higher transport costs for building materials, but rents in rural areas are usually lower than those in urban centres. The investment in construction or the amount of rent paid should be appropriate to the size and expected profitability of the business. The size of the building depends on the quantity of milk processed during the peak production period (e.g. a small-scale unit that processes 100–500 litres per day requires a building area of approximately 50 m²).

The dairy should be hygienically designed and easily cleaned to prevent contamination of products by insects, birds, rodents or micro-organisms. Within the building, food should move between different stages in a process without the paths crossing. This reduces the risk of contaminating finished products with raw milk, as well as reducing the likelihood of accidents, or operators getting in each other's way.

Incoming milk should be stored in a cold room at below 4°C, and that room should not be used to store finished goods or any other materials. Finished products should be held in a dispatch room either frozen or at 2°C +/- 2°C. A dry storeroom should be used for minor ingredients and packaging, and cleaning materials should have their own store or cupboard. An area or room should also be set aside for quality assurance testing and to store samples for shelf life testing.

For cheese making, the building should contain a ripening cellar, in which a high relative humidity (~80%) and a low temperature (8–12°C) can be maintained. This can be achieved in tropical countries using a room that is partly or fully below ground level. It should be about 2.5 m high, with the floor dug to a level of at least 1.5 m below ground. Windows or openings in the upper walls create a circulating draught to lower the temperature of the cellar (Figure 3.1).

Roofs and ceilings

Overhanging roofs keep a building cooler, and fibre-cement tiles provide greater insulation against heat from the sun than galvanised iron sheets. A panelled ceiling should be fitted in processing and storage rooms, rather than exposed roof beams, which allow dust to accumulate that might contaminate products. Beams are also paths for rodents and birds, creating contamination risks from hairs, feathers or excreta.

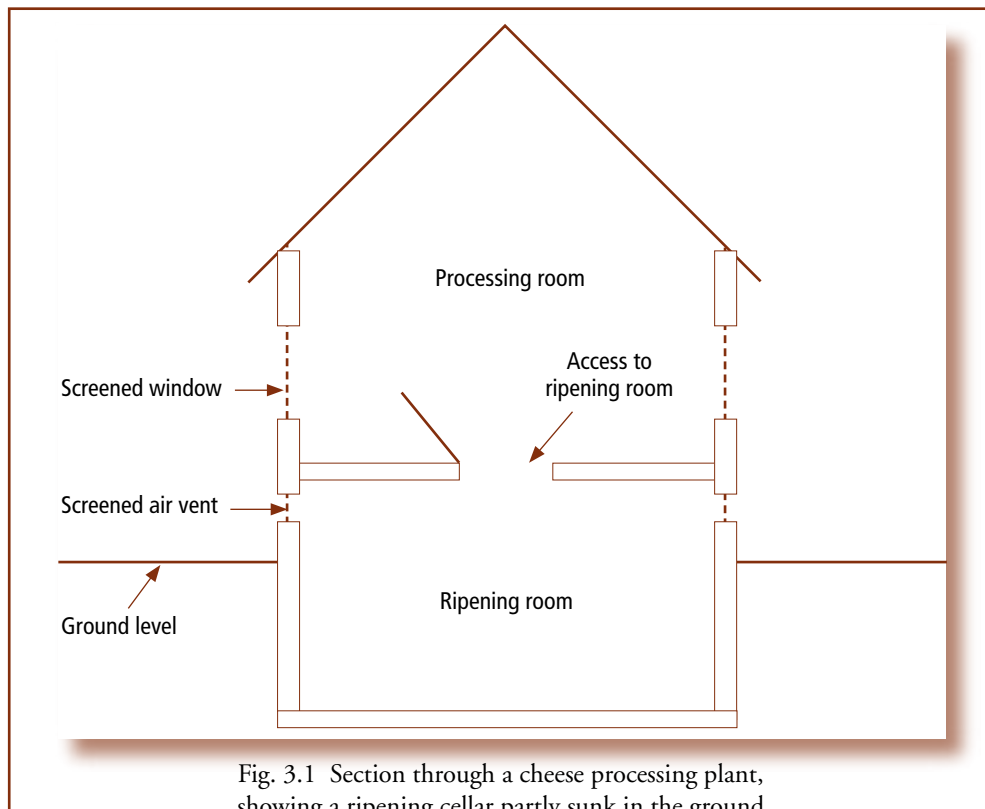


Fig. 3.1 Section through a cheese processing plant, showing a ripening cellar partly sunk in the ground

It is important to ensure that there are no holes in the ceiling or roof, and no gaps where the roof joins the walls, which would allow birds, rodents and insects to enter.

An inspection hatch should be fitted to allow access to the roof space for cleaning.

Walls, windows and doors

All internal walls should be plastered or rendered with concrete. The surface finish should have no cracks or ledges, which could harbour dirt or insects. The lower parts of the walls are most likely to get dirty from splashes when washing equipment, and they should either be tiled to at least 1.0 metre above the floor, or painted with waterproof white gloss paint. Food can lodge in the plaster grout between tiles and it is important that this is smooth with a flush finish that can be easily cleaned. Higher parts of walls can be painted with good quality emulsion paint if tiling is too expensive.

Natural daylight is preferable to, and cheaper than, electric lighting in processing rooms. The number and size of windows depends on the amount of money that a processor wishes to invest, and the security risk in a particular area (windows are more expensive than walls, especially when security bars or grilles are needed). Storerooms do not need to have windows. There is a natural inclination for workers to open windows to let in fresh air, but this provides easy access for flying insects. Windows should therefore be screened with mosquito mesh. Windowsills should be made to slope, to prevent dust accumulating and to prevent operators leaving cleaning cloths or other items lying there, as these can attract insects.

Storeroom doors should not have gaps beneath them, and should be kept closed to prevent insects and rodents from getting in and destroying stocks. Normally doors in processing rooms should be kept closed, but if they are used regularly there is a tendency for them to be left open, allowing animals and insects to enter the plant. Thin metal chains, or strips of plastic or cloth can be hung from door lintels to deter insects and some animals, while allowing easy access for staff. Alternatively, mesh door screens can be fitted.

Floors

Floors in dairy processing rooms should ideally be tiled with floor tiles. However, these are expensive and may be slippery when wet. Good quality concrete, smooth finished and without holes or cracks can be used instead. Paints can be used to protect floors, but vinyl-based floor paints are expensive. Red wax household floor polishes should not be used because they wear away easily and could contaminate products. The best way to protect floors is to clean up spillages as they occur and make sure that the floor is thoroughly washed after each day's production.

To prevent dirt collecting in corners where the floor and the walls join, the floor should be curved up to meet the wall. The concrete floor should have a 2–3% slope for draining water used to clean equipment. Proper drainage prevents pools of stagnant water forming, which would allow insects to breed. The drainage channel should be fitted with metal gratings that are easily removed so that the drain can be cleaned. Rodents and crawling insects can also get into the building through drains, and a wire mesh cover should be fitted over drain openings. This should also be easily removable for cleaning.

Layout of equipment

When designing the layout of a dairy, it is important that:

- the best use is made of the available space
- food passes from one process stage to the next in a straightforward way, without allowing processed products and raw milk to come into contact and without causing operators to block each other's workspace
- sufficient space is left around equipment for maintenance and cleaning.

A possible layout for a dairy is given in Figure 3.2.

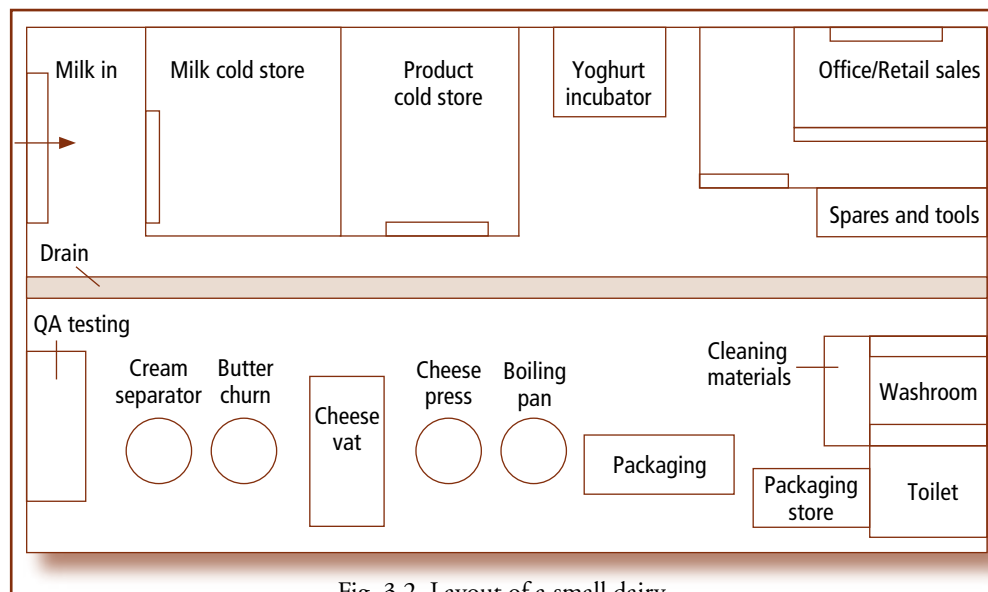


Fig. 3.2 Layout of a small dairy

The building should have sufficient space for the intended scale of operation and should include:

- space for cold storage of milk
- space for cold storage of finished products
- space for customers (customers should not be allowed into the processing area)
- cupboard with lock for spares and tools
- first aid box
- hand-washing and toilet facilities, with space to store workers' clothes.

3.4 Services

Lighting and power

Where lighting is needed and electricity is available, fluorescent tubes use less electricity than light bulbs. Power points should be located at least 1.5 m above the floor so that there is no risk of them getting wet when the floor and equipment are washed down. Ideally, waterproof sockets should be used. Each power point should only be used for one application, and multiple sockets should not be used because they risk overloading a circuit and causing a fire. All plugs should have fuses that are appropriate for the power rating of the equipment, and the mains supply should have an earth leakage trip-switch. Cables should be properly fixed to walls or run vertically from the ceiling to machines. There should be no exposed wires at any connection.

The production of some dairy products involves chilling or freezing and a reliable electric power supply is essential to prevent product losses, or place the public at risk through products becoming warm and allowing food-poisoning micro-organisms to grow. To avoid problems at night or at weekends, a back-up generator should start automatically during power cuts. A competent electrician should calculate the electricity demand for the cooling equipment and install a generator with an output 50% above this demand to allow for expansion. Refrigeration systems should no longer use chlorofluorocarbons (CFCs) because the release of these gases into the atmosphere depletes the ozone it contains.

Energy conservation

Clearly, it is in the financial interests of dairy owners to reduce energy consumption as much as possible. This can be done by careful production planning (Chapter 6) so that equipment is only switched on when it is needed. Other measures to reduce energy consumption include setting the thermostat of refrigerators and cold rooms to the maximum that is suitable for maintaining the quality of products, switching off lights when a room is not in use, and reducing vehicle use by co-ordinating deliveries of products with collection of raw materials. Although these measures may seem minor, their cumulative effect can be significant. When widely implemented, reductions

in energy consumption can result in national environmental and economic benefits.

Water supply and sanitation

Water is essential in all dairy processing (Table 3.1) and an adequate supply of clean water should be available from taps in the processing room. Water is used in products and also for cleaning equipment to maintain hygiene standards. Between 2 and 5 litres of water are required to process 1 litre of milk at a small scale of operation (compared to 1.3–2.5 litres water per litre of milk in modern dairy processing plants). To achieve low consumption requires advanced equipment, good housekeeping and awareness of water saving among both employees and management.

Area of use	Consumption (% of total)
Incorporated into products	40
Equipment washing	16
Cheese room	13
Cleaning	12
Miscellaneous (cold storage, staff use, receipt area, filling room, etc.)	19
Total	100

Source: Goff, 1995.

Table 3.1 Water consumption in dairy processing

There are two potential problems with the water quality: particles such as sand and contaminating micro-organisms. If a processing unit is located in a rural area, there may be no mains supply, or it may be unreliable or contaminated. Water from boreholes is likely to be relatively free from micro-organisms, but may be contaminated with sand. River water is likely to be contaminated with micro-organisms and should only be used if no other source is available. Samples of water should be periodically checked for microbial contamination at the Bureau of Standards, university food science department or a commercial testing laboratory.

To remove sediment, two high-level covered storage tanks should be installed, either in the roof space or on pillars outside the building. These are filled

when mains water is available or with water pumped from boreholes. While one tank is being used any sediment in water in the other tank settles out. The capacity of each tank should be enough for a single day's production. The tanks should have sloping bases and be fitted with drain valves at the lowest point to flush out any sediment that has accumulated. Hoses and self-closing pistol grip guns with adjustable sprays (Figure 3.3) should ideally be used for washing down floors and equipment. At the end of each working day, it should be possible to detect a slight 'chlorine' odour in the processing room, which indicates that it has been properly cleaned.



Fig. 3.3 Spray gun, adjustable to give a single jet or a wide spray. (Photo: P. Fellows)

If necessary, water should be treated to remove micro-organisms. There are four ways of treating water on a small scale:

- filtration
- heating
- ultra-violet light
- chemical sterilants, such as hypochlorite (also known as 'chlorine solution' or bleach).

Other water treatment methods are likely to be too expensive for small-scale producers. Domestic water filters are likely to be too slow for the large amounts of water required, and larger industrial filters should be considered. They are expensive, but once they are installed their operating costs are relatively low. Micro-organisms can also be destroyed by boiling water for 10–15 minutes. The main disadvantages of this method are the high fuel costs and the time required to do this each day. Heating does not remove sediment, and boiled water may also need to be filtered. Ultra-violet light destroys micro-organisms in water and commercial treatment units are suitable for processors that use a lot of water. Again, this method does not remove sediment from the water.

Dosing water with bleach is fast, cheap and effective against a wide range of micro-organisms. Water for cleaning should contain about 200 ppm of chlorine (achieved by mixing 1 litre of bleach into 250 litres of water). Water that is

used in products should not contain more than 0.5 ppm chlorine (2.5 ml of bleach to 250 litres of water), to avoid contaminating products with a chlorine odour. Care is needed when using bleach because it damages the skin and particularly the eyes, and can cause breathing difficulties if inhaled. It also corrodes aluminium equipment.

Case study 3.2 Water treatment

‘We have access to safe water but we also have special filters to sterilise it. We have made a lot of innovations, including using old fridge parts for cooling water and milk.

Water from the municipal system is reliable and safe, but it is filtered through a charcoal filter to remove sediment.’

Good sanitation is essential to prevent contamination of products and to prevent pests from breeding in the dairy.

Insects and rodents are attracted to food that is left lying around. Equipment should be thoroughly cleaned after each day’s production, using a cleaning schedule that is clearly understood and followed by production workers (see Chapter 5, Section 5.5). There should also be proper cleaning materials and equipment and adequate time allowed for cleaning machinery and processing areas after production has finished. Cleaning equipment should involve the following stages:

- rinse with cold or warm water to remove most of the food residues
- scrub equipment with a brush dipped in a suitable detergent dissolved in hot water. The detergent removes fat, milk solids, and other solid particles and suspends them in water
- rinse with cold or warm water to leave completely clean surfaces
- disinfect surfaces with dilute chlorine solution
- allow to dry in the air (do not wipe with cloths).

Solid wastes should be placed in bins and removed from the building at intervals, rather than letting them accumulate during the day. Wastes should never be left in a processing room overnight and they should be disposed of away from the processing site.

Toilets should be separated from the processing area by two doors or be located in a separate building. Workers should have hand-washing facilities with soap and clean towels. Details of sanitation facilities that are required in a dairy, including provision of toilets and hand-washing facilities, are described in Section 5.3 of *Opportunities in Food Processing, Volume 1*. Managers and dairy staff should develop personal hygiene rules together to ensure product safety. A summary of guidelines on hygiene and sanitation is given in Appendix II. If staff report a stomach illness or skin infection, they should be transferred to jobs that do not involve handling products.

Effluent treatment and environmental impacts

Dairy processing plants create large volumes of liquid effluents, from incomplete drainage of storage tanks, spills and leaks from pipes, cleaning of machinery etc. The cumulative effect of minor milk losses can be as high as 3–4% of the incoming milk. These effluents contain milk fat, lactose and protein as well as detergents and acidic or caustic cleaning agents. The polluting potential of dairy effluent is commonly expressed as the 5-day Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand or COD. The COD of dairy processing effluents varies from 180 mg per litre (for wash water) to 60,000 mg per litre for discarded whey from the production of cheese, with a typical COD for dairy effluent of about 4000 mg per litre. These effluents are highly polluting and so present a potential environmental hazard. In particular, whey contains more than half the solids from the original whole milk and is 80–90% of the volume of milk used in cheese making. Wherever possible the whey should be used rather than discarded down the drain. Possible uses include drinks or whey cheese.

Local regulations may require special treatment to reduce the pollutants in dairy effluents and producers should consult local authorities to plan proper effluent disposal. This should prevent local pollution of streams or lakes, which can remove oxygen from the water and kill all wildlife, including fish. Most dairies use a minimum treatment to neutralise pH, sediment solids and remove fat using grease traps.

If mains drainage is not available, for small-scale production a soak-away should be constructed in a place that cannot contaminate drinking water supplies. Wastewater should not be allowed simply to soak into open ground,

because this will create swampy conditions in which the milk rots, creating smells and attracting insects that could contaminate products, as well as introducing a health hazard.

Case study 3.3 Waste disposal

‘National environmental laws have affected our business. Some 18 months ago the Solid Waste Management Law made it an offence for commercial businesses to dispose of their waste in domestic waste skips. Commercial bodies now have to make their own private arrangements for the collection and transfer of waste to the solid waste landfill. In effect, this increases the cost of doing business.’

For larger-scale operations, dairy effluents should be held in a lagoon to allow sedimentation and biological degradation before they are irrigated onto land. However, if not managed correctly, dissolved salts contained in the effluent can adversely affect soil structure and cause salinity problems. Sludge produced by this treatment can be applied to pastures, and can also be used to produce methane biogas, which can then be used as an energy source. Care is needed in both the storage and application of slurries to land to avoid pollution of surface waters and groundwater, and contamination of drinking water supplies.

3.5 Equipment

Principles of hygienic design and methods of construction for food processing equipment are described in Section 5.3 of *Opportunities in Food Processing, Volume 1*.

Dairy products present a high risk of containing food-poisoning micro-organisms and equipment that is correctly and hygienically designed is essential to enable high quality products to be made.

All dairy equipment should be designed and constructed so that it can be easily dismantled for cleaning. When dismantling is easy, operators are more likely to do it properly without cutting corners. There should be no blank ends to pipework that would harbour stagnant milk. Any build-up of food in cracks, joints or recesses will rapidly become contaminated and infect subsequent

batches. Mixing bowls, boiling pans, etc. should have a smooth internal surface without corners, and all welds should be ground to a smooth finish. Ideally, all dairy equipment should be constructed from stainless steel, but stainless steel welding facilities are not common in some ACP countries. Alternatives include polished aluminium, or food-grade plastic for containers and equipment that are not heated. Dairy processing equipment cannot be constructed from mild steel because it will rust and contaminate products.

Case study 3.4 Sources of equipment

'My equipment consists of a mixing tank, batch freezers, blast freezer and walk-in cold room. All equipment was imported from the USA and financed by myself and with a loan from the bank. The investment was EC\$130,000 (2.68 Eastern Caribbean (EC)\$ = US\$1.00). One freezer is rated at 5 gal per hour and another at 2.5 gal per hour and these are the limiting factors of production.

He was ably assisted by the bank and equipment suppliers. The latter were very important as very little time was spent contacting numerous suppliers of equipment, materials, ingredients and packaging. He almost got a turnkey business.

Although there were other options that would have been more cost-effective, the owner chose to buy a packaging machine for about EC\$50,000 which sealed foil caps onto imported pre-formed 4-oz plastic containers. The initial investment in the packaging machinery was too high, although it has technical advantages.

The owner was the manager of a small dairy and when he left the company he found that there was a gap in the market for yoghurt, which was all being imported. He went to the government statistical department and got information on imports of yoghurt. This would have to be a small operation as the market was small. He did a 5-year feasibility study with the assistance of a financial controller and then approached a bank for financing. The equipment supplier of the dairy he worked for sourced the equipment, ingredients and packaging for him.'

Many small-scale dairy owners buy equipment that is immediately available or that they can afford, without careful consideration of alternatives. This may lead to the selection of inappropriately sized equipment. It is better to look at a number of other businesses and research suppliers to find out what is available from further afield before deciding what to buy.

If the quality of fabrication is adequate, local engineering companies are the preferred option, because spare parts and people who are skilled in maintenance and repair are readily available. However, the lack of adequate stainless steel welding facilities and design and construction skills in some ACP countries is a major constraint on sourcing locally made dairy equipment. In some countries there are import agents in the capital city who can supply dairy equipment, or information can be obtained on overseas suppliers, from international development agencies, university food technology departments or trade sections in embassies of other countries. When ordering imported equipment, it is important to specify the capacity required (in kg, or kg per hour), single or three-phase power supply, the number and types of spares required, and the specific application for which the equipment is to be used. Where possible the model number of a machine should also be given.

For efficient production and high productivity, the capacity of each piece of equipment in a process should be matched to the others. This prevents money being wasted on equipment that is larger than necessary, or creating 'bottlenecks' caused by one piece of equipment that is too small.

The equipment required in a small dairy during collection of milk includes 30–50 litre aluminium milk churns and a lacto-densimeter (Chapter 5, Section 5.2). Equipment required for production of different dairy products is shown in Table 3.2. The main items of equipment are described in more detail in Chapter 4.

The ancillary equipment that is required for most dairy products is shown in Table 3.3 and a summary of the maintenance and cleaning requirements of dairy processing equipment is given in Table 3.4.

The costs of setting up a small-scale dairy to process 15,000 litres of milk per month have been described by Bonfoh (2005) as shown in Table 3.5.

Product	Main items of equipment
Butter	Cream tank, cream separator, pasteuriser, butter churn, butter pats, butter moulds
Cheese	Double-walled vat, pasteuriser, cheese cutters, cheese press, cheese moulds
Confectionery	Boiling pan
Cream	Cream separator, pasteuriser, filler, pot sealer
Cultured milks	Incubator, filler, pot sealer
Ghee	Cream separator, filter, boiling pan, filler, bottle capper
Ice cream	Ice cream maker, pasteuriser, freezer
Pasteurised milk	Pasteuriser, filler, sealer
Yoghurt	Pasteuriser, incubator, pot sealer

Table 3.2 Equipment required for dairy processing

Case study 3.5 Dairy processing equipment

'My yoghurt processing equipment includes a jacketed processing tank heated by an liquid propane gas (LPG)-fired boiler, a funnel blender, a cold room (4°C) and a packaging machine. They were financed from our own funds, with a bank loan and by the supplier. The investment was EC\$170,000 and included 18 months' supply of packaging and processed fruit costing EC\$60,000. The process can handle 513 litres per batch, which yields 4,050 4-oz cups of yoghurt. The processing tank can do a batch in 30 mins. Currently we produce on one shift per day on 2 or 3 days a week, packaging on the other 2 days.

We are planning to modify the way in which the culture is cooled in the mixing tank by using water that is chilled in the cold room. This is intended to improve the efficiency of the process, reduce energy costs for cooling, and reduce the cost of water (the cooling water is presently sent to waste after it has done its job). In the modified system the cooling water will be stored in metal tanks in the cold room, and recirculated in a closed circuit using a small pump.

Our equipment is a mixing/blending tank, imported Taylor ice cream machine (10 lb ice cream per hour from 4 lb starting materials), a locally designed and fabricated brine tank, display freezers, chocolate coating container and chest freezers (bought locally but imported).'

Ancillary equipment	Use
Buckets/bowls	Plastic, aluminium or stainless steel, for mixing ingredients
Cheese cloths	Filtering whey from curd, pressing cheese
Filters	Filtering incoming milk
First aid box	Materials for treating cuts and burns
Funnels	To transfer liquids into narrow-necked containers
Measuring jugs, scoops, spoons	For measuring correct volumes of liquid or powder ingredients
Milk churns	Temporary storage of milk
Nail brushes	To clean hands of operators
Refrigerator	Storage of products
Scales	Weighing ingredients
Standby generator	Refrigerator power
Storage bins	For bulk ingredients
Thermometers	0–110°C for testing product temperature and 0 to –30°C for checking refrigerator and freezer temperatures (preferably an electronic thermometer that covers both ranges of temperatures).
Work tables	Processing/packing, made from aluminium or stainless steel.

Table 3.3 Small items of equipment used in a dairy

Packaging equipment

Heat sealers simultaneously melt and press plastic to weld two layers together, thus sealing a bag. A relatively wide seal (3–5 mm) is required for liquid foods and bar-type sealers are preferable to wire types. The wire type is suitable for packing cheese or other solid dairy products. Care should be taken to ensure that there is no product on the inside of the film where the seal is to be made, as this will prevent proper sealing.

Form-fill-seal equipment forms a tube from a roll of plastic film, and then seals the bottom of a bag (Figure 3.4). It deposits a weighed amount of



Fig. 3.4 Form-fill-seal machine
(Photo: P. Fellows)

Type of equipment	Spares kept in stock	Maintenance required	Cleaning
Boiling pans/ pasteurisers	None	None	After use with specialist detergent to remove milk scale. Rinse with clean water
Cheese presses/ cloths	None	Periodic check for wear on screw and bearing	After use with detergent and clean water. Boil cloths for 10–15 minutes
Fermentation tanks	None	None	After use with detergent and clean water, followed by sterilisation using dilute bleach
Fillers	None	None	After use with detergent and clean water
Filters	Filter cloths	None	After use with detergent and clean water, followed by sterilisation using dilute bleach or boiling for 10–15 minutes
Freezer	None	Periodic de-icing	Periodic cleaning with detergent and clean water after de-icing
Heat sealers	Heating element	None	Weekly wipe with damp cloth. Remove any burned-on plastic immediately
Pasteuriser	None	None	After use with detergent and clean water
Pot sealers	Heating element	None	Weekly wipe with damp cloth
Refrigerator	None	None	Periodic cleaning with detergent and clean water

Table 3.4 Summary of the maintenance and cleaning requirements of dairy processing equipment

food into the bag and then forms the top seal, simultaneously cutting the bag from the roll and forming the bottom seal for the next bag. Small machines, capable of packaging 5–100 bags per minute are suitable for larger scales of operation.

Pot sealers can be made locally by fixing a domestic electric iron to a drill stand. Commercially available pot sealers have a thermostatically controlled sealing head (Figure 3.5), which can be adjusted for sealing foil or plastic lids.

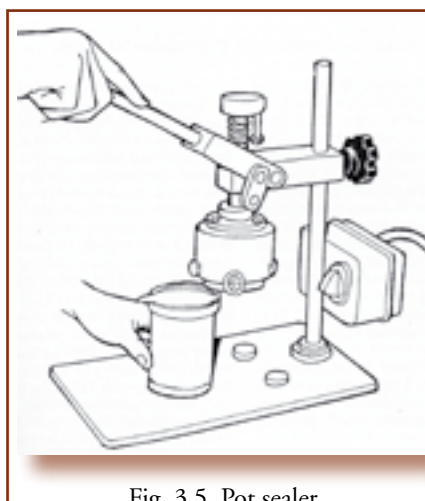


Fig. 3.5 Pot sealer

Component	Description	Quantity	Unit cost (US\$)	Amount (US\$)
Construction				
Building (80 m ²) Annexes (toilets, water tower, fencing, etc.)			163/m ²	13,000 845
Total				13, 845
Equipment and materials				
600-litre milk tank (second hand)		1	1950	1950
200 litre per hour pasteuriser		1	1495	1495
Heat sealer		1	1625	1625
12 kVa power plant		1	780	780
50-litre milk cans		10	65	650
230-litre deep freezer		1	520	520
Other small equipment		1	390	390
Mini-laboratory (for quality control)		1	390	390
Office equipment		1	300	300
Total				8,100
Monthly running costs				
Personnel (manager, collector, vendor, cleaner)			195	195
Consumables (packaging, gas etc.)			260	260
Services (transport, telephone, etc.)			98	98
Others			33	33
Total				586
Grand total				22,531

Table 3.5 Set-up costs for a small dairy

Vacuum sealers are used to pack cheese in some larger dairies. These machines use a vacuum to draw the plastic wrapper tightly around the cheese and then seal the open end with a heat seal (Figure 3.6). This type of packaging extends the shelf life of the cheese by excluding air, and also has an attractive appearance. However, vacuum sealers are expensive to buy and maintain, particularly the vacuum pump, which needs regular servicing and a supply of spare parts.



Fig. 3.6 Vacuum sealer (Photo: P. Fellows)

3.6 Sources of packaging and ingredients

Dairy products such as milk, cream and yoghurt are typically packed in wax-coated or plastic-lined paperboard cartons, plastic bottles and cups, plastic bags or reusable glass bottles. Other products, such as butter and cheese, are wrapped in foil, plastic film or packaged in small plastic containers. In many ACP countries, the lack of locally produced plastic films and glass or plastic containers is a major constraint on the production of dairy products. The only option for many producers is to import packaging from a more industrialised country. However, even when an overseas supplier is located, there is usually a minimum order size that far exceeds the annual production capacity of a small-scale dairy, and this either prevents the manufacture of these products or has serious effects on the cash flow in a business. In some countries, import agents have begun to stock a range of packaging materials, which they are able to sell in smaller quantities to processors, and their details may be available from manufacturers' associations.

Case study 3.6 Packaging supplies

'Packaging for icicles is wax-coated paper bags imported from Canada. The supplier gives us a 30-day credit. Sticks used in the popsicles are imported from Canada once a year. Five sizes of plastic containers for the ice cream are imported from Jamaica and Trinidad. The covers are transparent so that the customers are able to see the ice cream in the containers.

The packaging suppliers have a dominant relationship with our enterprise, but the relationship between us and suppliers of ingredients is between equals.

We are not really satisfied with the price of packaging, but can't do much about it. Costs are high because of the low level of operation and ordering small quantities.

Our packaging is imported wax-coated cardboard cartons, and the minimum order is not less than 25,000 units with payment in advance. There are always delays in getting the packaging.

Packaging is the major cost item and is about 60–65% of the product cost. These costs are high because as a small-scale producer, one has to order minimum quantities and for a small business these attract a substantial cost.

The quality of the labels is specified – it has to be a food grade self-adhesive label that can stand up to the low storage temperatures of the product.

Packaging is imported stackable food-grade plastic tubs with printed labels and recloseable lids. A 60-day credit term is given to the business by the supplier.

The design for the labels was done by the manufacturer with input from business owner. He got his own Universal Product or bar code from the American Association. The welded foil lid provides security for the product and the package provides a 6-week shelf life if the product is stored as recommended'.

Most common ingredients that are used in dairies, including starter cultures, rennet and some types of food flavourings/colours, can be obtained reasonably easily, especially if a large number of processors exist in a particular area or country, or the ingredients can be obtained from specialist import agents.

Case study 3.7 Ingredient supplies

'Fresh milk is bought from the farm and stored in bulk tanks. Chocolate and egnog flavours are imported and sugar for yoghurt and flavoured milk is bought locally.

Powdered milk is purchased from a local supplier 70 bags at a time and stored at the plant. A 30-day credit is obtained. Some fresh fruit (soursop, passion fruit, coconut) for the local fruit flavours is bought for cash as needed, and is not stored for more than a day. Sugar is purchased for cash from the Government's central supply and stored at the factory'.

Summary of the chapter

- ✓ Select a location either close to your customers or close to your milk supply.
- ✓ Make sure that the building is adequate for your present needs and planned expansion.
- ✓ Always look at different options before buying equipment.
- ✓ Check that equipment has been hygienically designed and is easy to maintain and clean.
- ✓ Time spent considering the construction of the processing facility is well spent. Making changes later can be very expensive.
- ✓ Place equipment so that there is space to work and also space to maintain and clean it.
- ✓ The throughput of equipment at different stages in a process should be similar to avoid bottlenecks.
- ✓ A back-up generator may be required if refrigeration is used.
- ✓ If you cannot rely on the local water quality put in a treatment system.
- ✓ Materials must flow through the processing plant to avoid cross-contamination between raw milk and products.
- ✓ Make sure that effluent does not damage the environment. Install treatment facilities if you are not connected to mains drainage. Make sure that local authorities are involved at the design stage.
- ✓ Research sources of packaging materials and ingredients to find the best deal.

Entrepreneur's checklist

- Is the location of your dairy either close to your customers or close to your supply of milk?

- Have you considered all the requirements of the production unit? Is the building adequate for your present needs and planned expansion?

- Are you aware of local regulations for establishing a food business and do you have copies of those that apply?

- Have you looked at different options before buying equipment? Is the equipment hygienically designed and easy to maintain and clean?

- Is the equipment arranged so that it can be easily cleaned and maintained?

- Have you considered a back-up generator?

- Do you know how to treat water to make it safe for use in dairy products?

- Have you an approved system of waste disposal?

- Do you know where to obtain packaging materials ingredients?

4.1 Introduction

Although cow's milk is the most popular in many ACP countries, milk from goats, horses, camels and sheep is also important in some areas. Milk has a low acidity and a high nutrient content, which make it the perfect breeding ground for bacteria. As a result, it both spoils quickly and can support bacteria that cause food poisoning (pathogens). The main reason for processing milk is to preserve it and make it safe by destroying any bacteria that contaminate it. The bacteria may come from the animal, from insects that fall into the milk, from utensils used in processing, or from the hands of operators. Infections in the animal that cause illness may also be passed directly to consumers through the milk.

Tips for success

- ✓ Ensure that the product is produced in a clean environment
- ✓ Label packages attractively
- ✓ Keep processing procedures simple and do not add unnecessary steps to them
- ✓ No matter how small the enterprise and how good the product, you must be prepared to change it to satisfy the market
- ✓ Only buy good quality fresh milk
- ✓ Cool milk quickly as it will spoil rapidly in hot climates
- ✓ Have a diversified product range to make meaningful returns
- ✓ Be innovative and experiment with new products and ideas.
- ✓ Invest in good books to improve your products
- ✓ Read Sections 2.1–2.5 in *Opportunities in Food Processing, Volume 1*.

It is therefore extremely important that quality assurance procedures (Chapter 5) are in place to ensure that no harmful bacteria remain in the processed products.

Contamination of milk with antibiotics is caused by their overuse for treatment of cattle diseases, particularly mastitis. This has been brought under control in some ACP countries by strict limits on the use of antibiotics, regular testing

of milk for antibiotic residues, enforcement of regulations, and education. Milk containing antibiotics should not be used in processes that involve fermentation, e.g. production of yoghurt and cheeses, as they interfere with the fermentation.

The main methods of processing milk are:

- heat treatment, e.g. pasteurisation or boiling to destroy naturally occurring enzymes and contaminating micro-organisms. Canning and UHT processing are other types of heat treatment but they require specialist equipment, expertise, and a high level of investment and are therefore not suitable for small-scale processors
- increasing the acidity by fermentation to produce yoghurt or cultured milks or by addition of an acid such as citric acid or vinegar to control the growth of pathogens
- removing water by concentration (boiling), by separation (churning butter, draining whey from cheese) or by evaporation (drying milk, but remember, the equipment necessary to make dried or evaporated/sweetened condensed milk is likely to be too expensive for small-scale processors)
- adding sugar to make milk confectionery, or salt for cheese or butter production.

Some types of processing involve more than one of these methods.

Shelf life

Most dairy products have a short shelf life and a high public health risk. It is essential that both customers (shops, hotels or institutions) and final consumers be given clear advice regarding sell-by and use-by dates. The calculation of shelf life is based on microbiological tests and the experience of producers. Very few small dairies have the expertise or facilities for microbiological testing, and the shelf life should be calculated using the knowledge and facilities at a university food science department or Bureau of Standards. The shelf life of new products, or those for which the recipe is changed should be assessed as follows:

- prepare several batches of the product
- store the product under the normal storage conditions (e.g. in a refrigerator at 4°C or in a freezer at -18°C). Check the temperature daily

- remove samples of short shelf life products daily or weekly for frozen products. Keep the samples cold or frozen in an insulated box and take them quickly to an analytical laboratory
- the laboratory should check the Total Viable Count and the numbers of *Escherichia coli* and *Salmonella* spp. These are indicator micro-organisms that are commonly used to define microbiological quality.

Over a period of time the microbiological quality of the product declines to a level that is unacceptable for consumption. The time taken to reach this stage is the maximum shelf life. However, the actual shelf life is considerably less than the maximum in order to have a safety factor, for example, if the maximum life for cultured milk is found to be 7 days, the recommended use-by date should be 4 days from the date of manufacture.

These tests assume that the product will be stored exactly as recommended, but this may not always be the case. For this reason 'abuse' tests are done alongside the shelf life tests. These tests involve placing the food in a warm place for a few hours, to simulate conditions when a consumer takes the food home from a shop, and then placing it in a refrigerator at 8°C (the more usual domestic refrigerator temperature). The tests described above are then conducted. Abuse tests give a more accurate estimate of the likely use-by date as they take into account the conditions that the product faces during distribution and home storage.

4.2 *Pasteurised milk*

Milk is known as an 'oil-in-water' (O/W) emulsion (see technical details in Appendix I) in which tiny droplets of milk fat are dispersed throughout the milk. The fat is solid below 20°C and an oil above 30°C. Milk contains between 3.5% and 8% fat depending on a number of factors including the type of animal from which it came (Table 4.1), the particular breed, the animal's diet and its health.

Animal	Fat (%)
Buffalo	7.4
Camel	5.4
Cow	3.7
Goat	4.2
Horse	1.6
Llama	3.2
Sheep	7.9
Yak	8.0

Table 4.1 Fat content of milk from different types of animals

The processing stages for pasteurised milk include:

- receipt and filtration of raw milk
- separation of all or part of the milk fat (to standardise milk, or produce milk that has a specific fat content for making yoghurt or cheese)
- pasteurisation, followed by cooling to 10°C
- homogenisation (not usually done on a small scale)
- packaging and cold storage
- cold distribution.

Standardisation

Raw milk can be 'standardised' to produce milk that has a constant butterfat content, by partially skimming off the cream. This makes it possible to standardise the composition of finished products and to set aside part of the cream for butter production. Different types of pasteurised milk include 'full cream', 'skimmed', and 'semi-skimmed' milks. These are described in legislation (Chapter 5, Section 5.7). Flavoured milks are becoming popular in some ACP countries, and may include chocolate, vanilla and fruit flavours with appropriate colourings that are added before pasteurisation.

The payment system for raw milk is usually based on the volume delivered plus a premium for the percentage of milk fat. If, for example, milk is received with a fat content of 3.5%, but a fat content of 2.5% is required, the amount of skimmed milk (0.5% fat) that should be mixed with the raw milk to lower its fat content is calculated using a Pearson Square (Figure 4.1) as follows:

- the required % fat is written in the centre of the square
- the percentages of fat in the milk and skimmed milk are written in the two left-hand corners
- the two values are subtracted along the diagonals to give the amounts of each to be used.

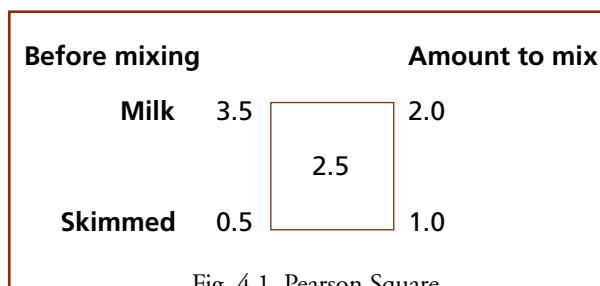


Fig. 4.1 Pearson Square

Thus, 3.0 litres of milk with a 2.5% fat content are obtained by blending 2.0 litres of milk with a 3.5% fat content and 1.0 litre of skimmed milk with 0.5% fat content. If the normal daily reception is, for example, 350 litres of milk

with an average fat content of 3.5%, it is necessary to skim 100 litres of milk to standardise the batch. A hand-operated cream separator (Section 3.5), having a throughput of 60–100 litres per hour is suitable for doing this. Another method of calculating how much of each ingredient to mix in order to obtain a standardised product is to use a mass balance (see Worked example 1, page 70).

Pasteurisation

Milk is properly pasteurised using the following temperature/time combinations, both of which should be followed by rapid cooling to 10°C to ensure it is safe from food-poisoning bacteria:

63°C for 30 minutes

72°C for 15 seconds.

Other combinations of temperature and time are possible but the law in many ACP countries may specify minimum pasteurisation conditions. In practice, these time/temperature combinations may be exceeded; particularly if there is a risk that raw milk may be contaminated with significant numbers of bacteria. Heating to 80–85°C for up to 5 minutes is often used as this also helps to prevent recontamination of milk before packaging.

At smaller scales of operation, milk can be pasteurised using a simple stainless steel (or less desirably aluminium) pan placed directly over the heat source. However, milk is sensitive to over-heating and likely to burn in this type of pan unless great care is taken to control the heat and thoroughly stir the milk as it is being heated. This equipment also slows down production because the pan must be cleaned between batches. The more usual method in small dairies is to heat milk in a jacketed stainless steel boiling pan. Steam from a boiler heats the space between the outer jacket and inner pan to give more uniform heating and avoid localised burning of the pan contents. A milk stirrer and thermometer are needed to ensure that this is done accurately.

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 their use presents no risk of contaminating the product. In rural areas, supplies may not be available or reliable and other types of fuel (e.g. charcoal or kerosene) have to be considered, or a generator used for the electricity supply.

The milk is then cooled, either by immersing milk cans in a tank of cold running water, or by running cold water through the double sides of a cheese vat. In either method, the milk should be stirred constantly to achieve uniform cooling.

The higher-temperature, shorter-time pasteurisation (72°C for 15 seconds) cannot be achieved using boiling pans so a plate heat exchanger (Figures 4.2 and 4.3) is required. These are expensive and may only be affordable in larger dairies in ACP countries, unless second-hand equipment can be located. This equipment also requires pumps, a boiler, a source of chilled water and spare gaskets to seal the plates.

After pasteurisation, milk should be kept covered and cool until it is filled into containers and sealed. Glass bottles sealed with foil are used in countries that have a



Fig. 4.2 Plate heat exchanger
(Photo: P. Fellows)

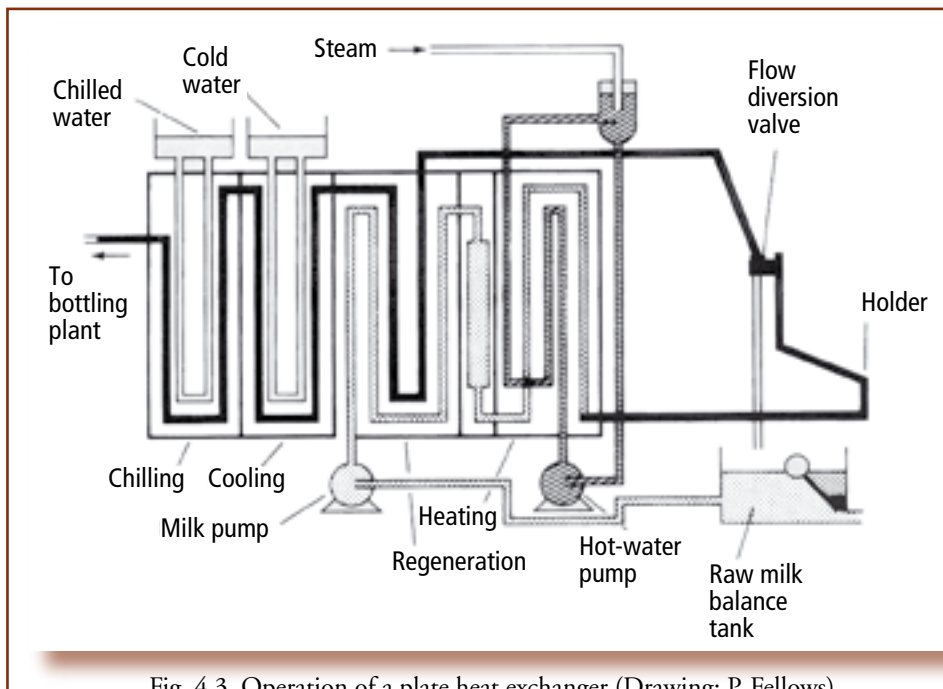


Fig. 4.3 Operation of a plate heat exchanger (Drawing: P. Fellows)

glass-making industry, but in most ACP countries milk is filled into polythene bags and sealed using a form-fill-seal machine (Section 3.5). Alternatively paperboard cartons that have an internal coating of wax or plastic are sometimes used. Increasingly, plastic (PVC or polythene) bottles are becoming available, but these are more expensive than bags, although their filling/sealing equipment is cheaper than a form-fill-seal machine. Pasteurised milk has a shelf-life of a few days when stored under refrigeration.

4.3 Cream

Crems are rarely used in most ACP households but are more common as a bakery ingredient in some countries. They are pasteurised and packaged in a similar way to that described for milk in Section 4.2. Cream is an O/W emulsion with a fat content of 35–40%. The simplest method of separating cream is to allow it to float to the surface of the milk and then skim it off with a ladle. However, this is time-consuming and even in a small-scale operation a cream separator is preferable. The equipment can either be a tubular bowl centrifuge, or more commonly a disc bowl centrifuge (Figure 4.4). The tubular bowl centrifuge has a vertical cylinder, which is rotated at 1500–1600 rpm inside a stationary casing. The milk is fed in at the base of the cylinder and cream and skimmed milk are separated, emerging from separate outlets. The disc bowl centrifuge has a stack of rotating conical discs inside a casing. The milk passes along the surfaces of the spinning discs and cream is separated, again emerging from a separate outlet to the skimmed milk. Manual or electric versions of disc bowl centrifuges are available with capacities from 50–150 litres per hour.

The efficiency of a cream separator (E_s) is assessed by the amount of

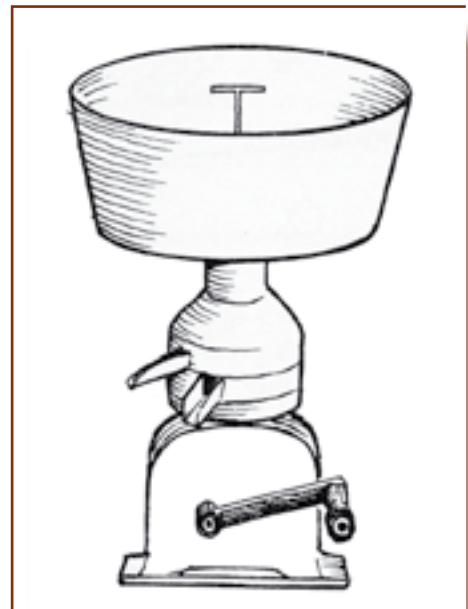


Fig. 4.4 Disc bowl cream separator

fat transferred from the milk to the cream. It can be calculated using the following formula:

$$E_s = 1 - f_s/f_m$$

where:

f_s = % fat in the skimmed milk

f_m = % fat in the milk.

A sample calculation is given in Worked example 2 (page 74).

There are a range of cream products that have legally defined fat contents, including cream, half cream, whipped cream, heavy whipped cream and double cream (Chapter 5, Section 5.7). A method used to standardise the fat content of cream is shown in Worked example 1.

Worked example 1: Mass balance

A mass balance states that the mass of material going into the process = mass of material going out of the process. If for example, a dairy has 240 kg of 40% cream and this is to be standardised to cream with a fat content of 18% by blending it with skimmed milk:

x = weight of skimmed milk (kg) and y = weight of 18% cream (kg),

The mass balance is: $240 + x = y$

The mass balance for fat states that the fat into the process = fat out of the process, i.e. $0.4 (240) = 0.18 (y)$

That is 40% of 240 kg comes into the process and 18% of y goes out of the process, i.e. $0.4 (240) = 0.18 (240 + x)$

$$96 = 43.2 + 0.18 x$$

So:

$$0.18 x = 96 - 43.2$$

$$x = (96 - 43.2)/0.18$$

$$= 293 \text{ kg skimmed milk}$$

Whipped cream

A planetary mixer, fitted with a balloon whisk, is used to whip cream. Further details of the structure and composition of whipped cream are given in Appendix I.

Sour cream

Cultured or sour cream uses a similar lactic acid bacteria starter and fermentation conditions to those used for cultured milks (Section 4.6), but the fermentation is stopped when acidity reaches 0.6% lactic acid. It has a fat content of 12–30% and is usually pasteurised at 75–80°C.

4.4 Butter and ghee

Butter is a W/O emulsion of more than 80% milk fat, containing water in the form of tiny droplets, so small that the butter looks dry. It should have a uniform pale yellow/cream colour, be dense and have a smooth consistency so that it spreads easily and melts in the mouth. It is used as a spread, for cooking, or as a baking ingredient. There are five types of butter, which can be made from fresh or fermented milk, or from the whey that remains after making cheese (Table 4.2).

Type of butter	Description
Cultured (or 'lactic') butter	Made from soured milk or cream, may be salted or unsalted, slightly acid taste
Fresh (or 'sweet') butter	Made from cream, unsalted and unripened, mild creamy flavour
Fresh salted butter	Made from cream, salted (1–8% salt), unripened, mild creamy flavour
<i>Ghee</i>	A pale golden-brown fat made by heating unsalted butter to remove the moisture
Whey butter	Made from whey, salted or unsalted, slightly acid flavour

Source: Bonfoh, 2005.

Table 4.2 Types of butter

Cream or fermented milk is churned to make the fat droplets join together and form grains of butter. The liquid by-product from butter making is 'buttermilk', which is either drunk or fed to animals. Churning changes the emulsion from the oil-in-water (O/W) emulsion of cream to a water-in-oil emulsion (W/O). Details of changes to the structure of the cream during butter making are given in Appendix I.

Most butters contain about 16% water, and any contaminating micro-organisms are found in the water droplets. When salted butter is made, the salt (1–3%) dissolves in the water droplets, so the effective salt concentration is approximately 10% in the water. It acts as a preservative to improve the shelf life by suppressing the growth of any micro-organisms that are present, and is also used to improve the flavour.

Fresh (or 'sweet') and salted fresh butter

Traditionally, butter was made from cream that had been allowed to stand and sour naturally. The cream was skimmed from the top of the milk and butter was made by hand using churns. However, natural souring is prone to infection by contaminating micro-organisms, which spoil the product. In modern butter making (Figure 4.6), milk is preheated and passed through a cream separator (Figure 4.4) to produce the cream. The cream should be sweet (with a pH >6.6, and a total acidity of 0.1–0.12%) and not be rancid or oxidised. It is pasteurised to destroy enzymes and micro-organisms that would reduce the shelf life of the butter.

After pasteurisation, cream is cooled to refrigeration temperature and held for several hours to allow the fat to partly crystallise. This helps the churning process. During churning, the cream is agitated violently to make the fat globules coalesce into butter grains. Small butter churns (Figure 4.5) have a paddle that is rotated either manually or using an electric motor. On a larger scale, a specially shaped drum is rotated end-over-end to churn the cream.

After filling the churn, the following steps are taken:

- rotate the churn at 25–35 rpm for 5 minutes
- stop the churn and release the gases

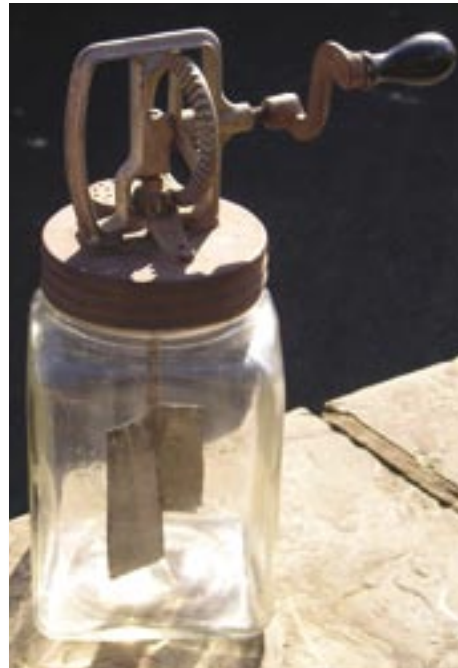


Fig. 4.5 Small butter churn
(Photo: P. Fellows)

- churn again at 25–35 rpm for 35–45 minutes
- drain the buttermilk into pails
- add the same amount of cold water as the amount of buttermilk removed, and churn at 10–15 rpm for 5 minutes
- drain off the water
- churn at 10–15 rpm for 10–20 minutes
- Remove the butter.

Stage in process Optional	Notes
Cooled raw milk	Milk with a high fat content gives a higher butter yield
Filter	
Separate	Pre-heat milk to 36–40°C. Separate into skimmed milk and cream in an electric or manual cream separator. The fat content of the cream is measured using a cream butyrometer and should be standardised to approximately 40% fat using the separated skimmed milk. This optimises the churning efficiency and the butter yield
Pasteurise	At 72°C for 15 seconds or 63°C for 30 minutes. To improve the keeping quality of the butter, it is advisable to exceed this minimum heat treatment (e.g. 75°C for one minute). Start timing when it reaches the correct temperature and continually stir to ensure even heating
Chill	To below 4°C for several hours (or overnight) to 'age' the cream and improve churning efficiency and butter yield
Churn	In a butter churn. Keep the temperature as low as possible during churning. The cream viscosity increases and finally the cream 'breaks' to give a clear separation into butter grains and buttermilk. Churning should be continued until butter grains adhere together into large lumps
Separate	Drain off the buttermilk
Wash	Add clean chilled water to the butter and slowly churn to remove residual buttermilk and thus improve its shelf-life
← Salt	For salted butter, add salt (1–3% of butter weight) with continued slow churning to achieve even salt distribution
Work/Mould	Work to correct consistency with butter pats and mould into solid blocks
Pack/Store	Into greaseproof paper, foil or plastic bags and store below 4°C in a refrigerator

Fig. 4.6 Processing fresh and salted butter

The efficiency of churning (E_c) is assessed by the amount of fat transferred from the cream to the butter, and can be calculated as follows:

$$E_c = 1 - f_{bm}/f_c$$

where

f_{bm} = % fat in the buttermilk

f_c = % fat in the cream.

These can be used to predict the expected yield of butter per kg of milk (Worked example 2).

Worked example 2: Calculation of butter yield

If there is 3.6% milk fat in milk, 0.05% milk fat in skimmed milk, 40% milk fat in cream and 0.3% milk fat in buttermilk:

$$\text{The separation efficiency } (E_s) = 1 - 0.05/3.6 = 98.6$$

$$\text{The churning efficiency } (E_c) = 1 - 0.3/40 = 99.25$$

The efficient operation of a dairy requires that losses of milk and products be minimised at each stage of processing. If churning takes place at too high a temperature, there are higher losses of fat in the buttermilk.

The butter is then worked with butter pats (Figure 4.7) to produce an even distribution of the finely dispersed water droplets. It is then either pressed



Fig. 4.7 Butter pats (Photo: P. Fellows)

into a butter mould, and packaged in greaseproof paper, plastic or aluminium foil, or placed directly in plastic tubs (usually 250 g or 500 g)

Alternatively butter can be moulded in small butter moulds that may have special shapes, especially for use in hotels. Small plastic single-serve portion pots (10–15 g) of butter

are another type of product that is supplied to airlines and hotels in some countries.

If a refrigerator or chilled water is not available, it is possible to make butter but there may be the following problems:

- If the cream is not allowed to age at a low temperature, the fat globules do not develop the crystalline structure needed for good separation into butter and buttermilk.
- A higher temperature during churning reduces the butter yield, because some of the butterfat liquefies, and is lost with the buttermilk. The water used for washing butter must be potable or else it will recontaminate the butter and reduce its shelf life.
- The shelf life of butter is reduced if it is stored without refrigeration. At refrigeration temperatures, butter will keep for several months, but at ambient temperatures off-odours develop after only a few days. However, in many ACP countries, butter with a slightly rancid flavour is acceptable.

The main cause of butter spoilage is the development of rancidity, and in some countries the use of an anti-oxidant such as butylated hydroxy-anisole (BHA) or butylated hydroxy-toluene (BHT) may be permitted by law to prevent this. However, butter is not usually stored for long periods in ACP countries and these chemicals are not needed.

Cultured or lactic butter

Traditional butters, made from fermented milk, are more acidic than products from commercial dairy plants, but may be preferred by people in some countries because of their pronounced flavour. They can be made more easily than fresh butter on a small scale as they do not require chilling or the use of a cream separator. Fresh milk is pasteurised and cooled to about 37°C. A starter culture or a small amount of butter from a previous batch is added, and the milk is fermented to form yoghurt, for either several hours or up to 3–4 days depending on the ambient temperature. Churning the yoghurt produces the butter. In some areas the containers are coated inside with wood smoke to disinfect them before each batch. The wood smoke imparts a characteristic flavour to the butter and the buttermilk. The resulting yoghurt is cooled, salted (by adding approximately 0.5% salt) and churned manually in gourds, leather bags or wooden churns to produce the lactic butter. The containers

are shaken and/or rocked back and forth until the butter grains form. The tightly closed mouth of the container is fitted with a vent to release the air that builds up during the first few minutes of shaking. The butter grains float on the surface of the milk, growing in size as the agitation nears completion. They are collected and washed with water two or three times. The butter is then packed for distribution in containers or in plastic bags.

Cream may also be 'ripened' with mixed cultures of *Streptococcus cremoris*, *S. lactis diacetyl lactis*, and *Leuconostoc* sp. that increase the flavour of butter. Dried cultures may be obtained from specialist suppliers in some ACP countries, or imported. The cream is ripened for 12–15 hours at 21°C to pH 5.5 and then at 13°C to pH 4.6. The lower the temperature during ripening, the more flavour develops. Alternatively, a culture may be inoculated during churning. Ripened butter is usually not washed or salted. Butters that have their flavour enhanced using this process are termed 'lactic,' 'ripened' or 'cultured' butters. Although the product is claimed to have a superior flavour, its storage life is more limited than sweet/salted butters.

Ghee

Ghee is made by heating cream to break down the emulsion, release the water and boil it off (Figure 4.8), leaving a clear golden fat with a characteristic flavour. It is made from cow's or buffalo milk and has a high demand in some ACP countries as a domestic cooking oil and as an ingredient for bakeries or confectionery manufacturers. The main quality factors are the colour and clarity of the oil, which depend on proper filtering, and the flavour and odour, which depend on the time and temperature of heating. *Ghee* is preserved by a combination of heat, which destroys enzymes and contaminating micro-organisms, and by removing water from the oil to prevent micro-organisms growing during storage. It has a long shelf life if it is stored in a cool place, using airtight, lightproof and moisture-proof containers to slow down the development of rancidity.

Stage in process	Notes
Milk	Fresh, filtered cow or buffalo milk
Pre-heat	In an aluminium pan to 36–40°C to optimise the efficiency of the cream separator
Separate	Preheated milk is separated into cream and skimmed milk using a cream separator. (Traditionally milk is boiled and cooled several times and the fatty scum is skimmed off)
Heat	Cream is boiled with constant stirring to evaporate water. The end point of the boiling stage is shown by the correct colour and texture of the <i>ghee</i> . There is no simple test for this and it is judged by experience
Cool	After the heating is stopped and the product is left to set, and particles settle at the bottom of the vessel
Filter	The product is filtered carefully using cheesecloth so that it is clear without any particles
Pack	Into airtight glass or metal containers (iron or copper should not be used because they accelerate the development of rancidity). Containers should be dry and thoroughly cleaned, especially if they are re-used
Store	At room temperature away from heat and sunlight. The shelf life can exceed 12 months with proper packaging and storage conditions

Fig. 4.8 *Ghee* production

4.5 Cheese

There are hundreds of varieties of cheese produced in different parts of the world, but each relies on similar principles of coagulating the proteins in milk to form curds, and then separating them from the liquid whey. The different cheese flavours and textures arise from variations in the type of milk, the amount of fat in the milk, bacteria that are used to ferment the milk and variations in the processing conditions. Cheeses may be broadly classified into 'soft', 'semi-hard' and 'hard' cheeses (Table 4.3). Production of soft cheeses is more straightforward than hard cheeses, and these are the more common traditional types that are in demand in ACP countries. The demand for hard cheeses may be more limited and a careful market analysis is needed before starting their production.

Type of cheese	Moisture content (%)	Fat content (%)	Texture	Shelf-life
Soft cheeses	45–75	<40	Soft, white, spreadable	A few days
Semi-hard cheeses	35–45	<35	Firm, crumbly, can be sliced	A few months
Hard cheeses	30–40	<30	Very firm, dense, sometimes grainy	One year or more

Source: Goff, 1995.

Table 4.3 Types of cheeses

The coagulation of milk proteins can be achieved in a number of different ways (Table 4.4):

- using rennet (see Appendix I), an enzyme found in the fourth stomach of ruminant animals, or made synthetically
- fermenting to form lactic acid
- adding acid (e.g. lime juice or vinegar)
- boiling
- using plant extracts.

Coagulating agent	Rate of addition to milk
Citric acid (from lemon or lime juice)	1–1.5% by weight
Cut stems of <i>Bryophyllum</i> species	4 stems per litre
Fig bark (ficin enzyme)	Data not available
Lactic acid (from yoghurt)	2–2.5 g per litre
Leaves of <i>Calotropis procera</i>	1 leaf per litre
Papaya sap (papain enzyme)	Data not available
Pineapple pulp (bromelin enzyme)	Data not available
Rennet tablet, powder or liquid	1 tablet per 100 litres, 1 teaspoon of powder per 40 litres or 20–30 ml liquid per 100 litres

Source: Goff, 1995.

Table 4.4 Coagulants used in cheese making

Milk is coagulated in cheese vats (Figure 4.9) using rennet, or bacterial cultures. Rennet causes the milk proteins to form a semi-firm gel. Lactic acid production by bacterial cultures helps the whey to separate from the curd and also determines the final cheese flavour and texture. The curd is cut into small cubes using vertical and horizontal curd cutters. These may either be motorised and fitted to a cheese vat (as shown in Figure 4.10b) or hand cutters as shown in Figure 4.10a. Cutters are stainless steel frames strung with thin wires or blades. The vertical cutter (A) is first pulled through the length of the cheese vat until all of the curd is cut in one direction. It is then used to make vertical cuts across the vat. Finally, the horizontal cutter (B) is used to cut the curd in one direction only, to form the curd into cubes. The whey (mostly water and lactose) drains from the curds and the cubes are then poured into cheese moulds and pressed to remove more whey.



Fig. 4.9 Cheese vat (Photo: R. Zulu)

Simple cheese moulds can be made from plastic drainage pipe cut into 10–25 cm lengths with holes drilled to allow drainage. The moulds are fitted with plastic

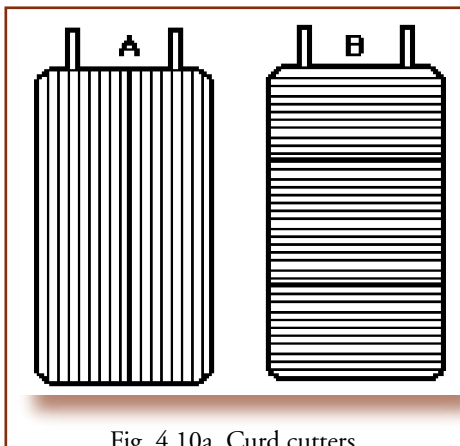


Fig. 4.10a Curd cutters



Fig. 4.10b Cutting the curd (Photo: R. Zulu)

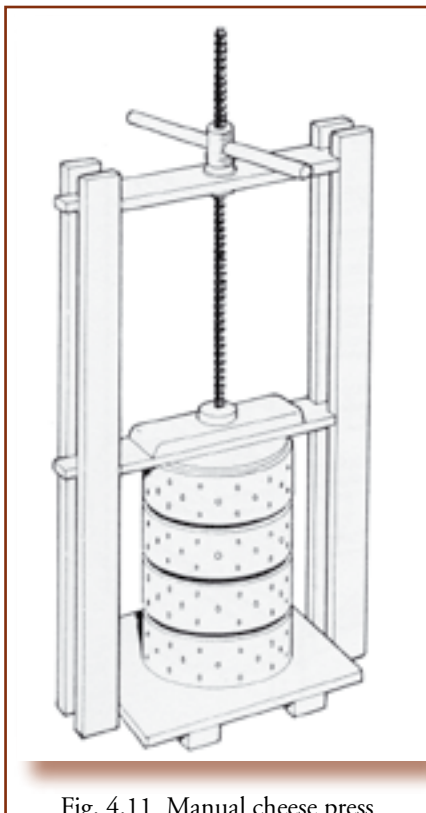


Fig. 4.11 Manual cheese press

or wooden discs for the lid and base sections. The simplest curd press is made by placing weights or cement blocks on cheese in moulds. Manual cheese presses have a press plate, which is raised and lowered by a screw (Figure 4.11). In operation a muslin or cotton bag is placed in the mould and curd is poured in. The bag is closed and the press plate lowered. Whey drains through the holes in the mould, and after a suitable time the screw is raised and the bag removed. To clean the press, the mould is removed, washed thoroughly with detergent and rinsed with clean water. The other components are cleaned while the mould is removed. The press bags should be washed with detergent and then sterilised by boiling for 10–15 minutes before drying in the sun.

Seven types of cheeses can be grouped, according to texture and manufacturing processes, as follows. The production of other types of cheeses is described in the bibliography (Appendix III).

Acid-coagulated fresh cheese (e.g. Cottage, Quark and Cream cheeses)

'Fresh cheese' is produced by acid coagulation to pH 4.6–4.8 at 30–32°C without added rennet. Acid is produced by lactic acid bacterial cultures but some fresh cheese may also be produced by direct acidification. After cutting, the curd is heated to 52°C to inactivate the culture and prevent further acid development. Washing the curd before salting also reduces the acidity. In many ACP countries, traditionally produced soft cheeses have a sour taste and pronounced flavour. They are made using fermented buttermilk (from traditional butter-making), which is heated gently for about 30 minutes until completely coagulated. It is then cooled, and the whey is drained off using a straw mat or stainless steel mesh, leaving the cheese behind. It is packed in

plastic bags and sold fresh, within 24 hours if refrigeration is not available. Alternatively the cheese is pressed into blocks and stored in brine until it is sold from the brine tub (Figure 4.12).

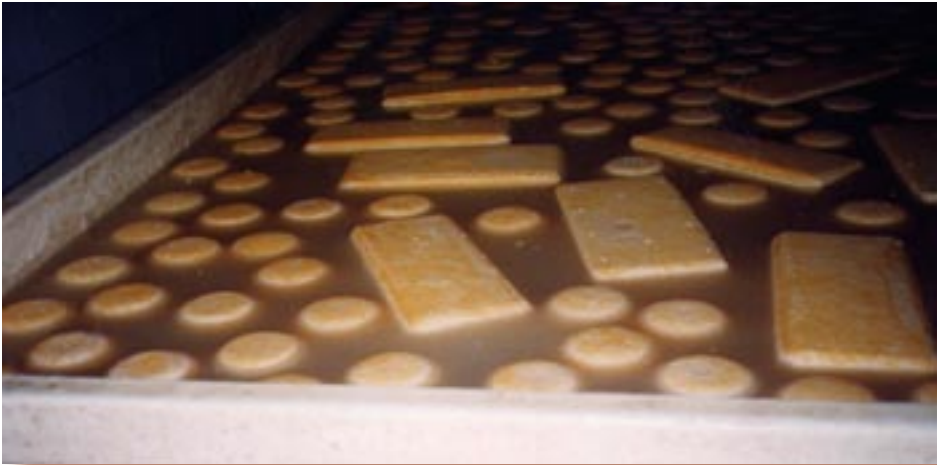


Fig. 4.12 Soaking cheeses in brine (Photo: R. Zulu)

A similar soft cheese known as Wagashie in West Africa, has a slightly sour, fermented flavour and may be coloured dark red using dried sorghum leaves. It is made by preheating slightly acidified milk (pH 5.6–6.0) to about 40°C, adding juice from leaves or bark of the Sodom Apple tree and heating it to 60–70°C for approximately 1 hour, stirring continuously to avoid charring until it is partially solidified. The curd is worked by hand, washed to remove lactose, salted in boiled water and then boiled with dried sorghum leaves to impart the red colour. After cooling, the curd is dried and cut or moulded into small pieces and fried carefully in oil until it is slightly browned. The product has a shelf life of 1–5 months.

Rennet-coagulated fresh cheese (e.g. Queso Blanco, Queso Fresco, Halloumi)

Fresh rennet cheese is produced without bacterial cultures. Without acid production, the cheese pH remains high (6.5–6.7) and for safety, these cheeses must be handled with extra attention to hygiene, sanitation and refrigeration. Such cheeses have a moisture content of 60–70% and a shelf life of 2–3 weeks.

Heat/acid precipitated cheese (e.g. Ricotta, Paneer)

Milk proteins are coagulated in one of three ways:

- Coagulation of milk protein (casein) with rennet, and acid production by lactic acid bacteria.
- Coagulation of casein by acid produced using a natural fermentation at 20–35°C. In this temperature range, a pH of less than 4.9 is needed to form the curd.
- Coagulation by lactic or citric acid added to hot milk at 75–100°C, but no fermentation is involved. The whey proteins (Appendix I) bind water so that a firm cheese with a high moisture content (55–80%) is produced. At high temperatures less acidification is needed, so the final cheese is much less acidic (pH 5.2–6.0) than fresh cheese (pH 4.4–4.8). The inclusion of whey proteins prevents cheeses from melting so that they can be used as frying/cooking cheeses.

Heat/acid precipitated varieties are normally consumed fresh. An exception is Mizithra, a type of ricotta that is cured, dried, and eaten as grating cheese.

Soft-ripened cheese (e.g. Feta, Camembert, Brie)

Coagulation is by rennet, but compared to cooked and pressed varieties, there is a larger lactic acid bacteria inoculum and the ripening period before renneting is extended. The setting time is increased for greater acidification and curd is broken up with paddles and left to stand in a warm room for several hours. Conversion of lactose to lactic acid continues until the accumulation of lactic acid stops the culture growing. The pH is 4.3–4.6 on the day following manufacture although the pH of mould-ripened varieties (e.g. Camembert and Brie) increases during the curing period (2–8 weeks). The moisture content is typically 45–60%.

Semi-hard washed cheese (e.g. Edam, Gouda, Colby, Montasio, Muenster)

This is the largest and most diverse group of cheeses, Production of rennet-coagulated cheeses that have moisture contents of >40% requires a washing treatment to remove lactose. The aim is to limit the amount of lactose, to restrict lactic acid development and produce a pH of 5.0–5.2 (but not less than

pH 5.0). The amount of moisture expelled from the curd (known as 'syneresis') is controlled by the temperature and time of cooking and by the wash water temperature. Higher temperatures during cooking or washing cause the curd to contract and expel more moisture. Typically, these cheeses have moisture contents of 40–50% after curing for between 2 weeks and 9 months.

Hard cheese: low temperature (e.g. Cheddar and Pasta Filata)

Hard cheeses are characterised by lower moisture contents than other types. Low moisture is achieved by high-temperature cooking or by controlled fermentation and curd handling. The moisture content is typically 35–39% for cheddar types and up to 52% for Pasta Filata types. It is controlled by the cooking temperature and time, stirring after draining and the amount of culture and salt used. The method of manufacture is similar in the early stages, but Pasta Filata types are worked and stretched in hot water and salted using brine. Cheddar types are salted before hooping and pressing. As with semi-hard cheeses, the aim is to have a minimum pH 5.0–5.2 within 1–3 days after manufacture. The lactose and moisture contents are reduced by fermentation during cheddaring and salting. The cheeses are ripened for 1–36 months.

Hard cheese: high temperature (e.g. Parmesan, Swiss, Romano)

The pH is controlled by the type of culture, the time and temperature of pressing, and lactose removed by syneresis. Moisture is removed by a high renneting temperature and a high cooking temperature and the cheese is ripened for 10–36 months. Some properties of cheese are categorised according to type of coagulation and procedures used for pH and moisture control (Table 4.5).

A summary of the processing stages for cheese manufacture is shown in Figure 4.13.

Preparation of starter cultures

Starter cultures are used because the naturally occurring lactic acid bacteria in milk are inefficient, uncontrollable or unpredictable, or are destroyed by the heat treatments given to the milk. A starter culture produces a more

Process	Varieties	Coagulation ¹	MNFS ²	pH	Curing time
Acid-coagulated	Cottage, Quark, Cream cheese	Acid coagulation at pH 4.6–4.8	72–80%, a _w 0.980–0.995 Controlled by cooking and washing	4.3–4.8 Inhibition of culture by low pH, high temperature cooking or cooling, and/or washing	Consumed fresh, short shelf life
Heat-acid coagulated	Indian Paneer, Chhana, Ricotta, Requeson	Heat denatured whey proteins are precipitated with caseins by acid	75–84% Decreases with cooking after acidification	5.0–5.8 due to added acid. 3–6% lactose in cheese due to absence of fermentation	Consumed fresh, limited shelf life unless packed in brine
Unripened: rennet-coagulated	Some Latin American, Middle Eastern and European varieties	Rennet ++, Little or no culture	60–80% Controlled by cooking, stirring and draining conditions. Syneresis often occurs in the package	5.8–6.6 High pH prevents melting	Consumed fresh. High pH limits shelf life
Soft ripened: high acid	Feta, Camembert, Blue	Rennet +++, Culture +++, Ripening time +++, cutting at pH < 6.5	60–70%, a _w 0.96–0.99 Syneresis induced by acid development and salting	4.5–4.8 Acid inhibits culture, salting and cooling	2–8 weeks
Semi-hard: washed	Gouda, Edam, Colby, Havarti, Montasio	Rennet ++, Culture +, Ripening time ++, cutting at pH < 6.6	55–65, a _w 0.95–0.97 Controlled by temperature of cooking, wash water, rate of acid development, curd handling, salting treatments	4.8–5.2 Washing to remove lactose	2 weeks–9 months
Hard: low temperature	Cheddar, Provolone	Rennet ++, Culture ++, Ripening time ++, cutting at pH < 6.6	52–60, a _w 0.94–0.96 Controlled by cooking, curd handling, rate of acid development and salting	Rate of acid development and moisture control determines residual lactose; draining pH is critical	1–24+ months
Hard: high temperature	Swiss types, Italian types, Parmesan	Rennet +, Culture +, Ripening + (little or none for Swiss), cutting at pH 6.6	39–52% Controlled by temperature of cooking (52–55°C)	Acidity and moisture determine residual lactose; draining pH is critical	1–24+ months

¹ '+' symbols indicate amounts of rennet and culture and ripening time relative to other categories.

² Moisture in non-fat component.

a_w = water activity (see glossary in Annex E)

Milk Solids-Not-Fat (MSNF) = proteins, lactose, minerals, acids, enzymes, vitamins.

Total Milk Solids = fat + MSNF

Source: Aguhob and Axtell, 1996.

Table 4.5 Some properties of cheeses categorised according to type of coagulation and procedures used for pH and moisture control

Stage in process		Notes
Soft and semi-hard cheeses	Hard cheeses	
Raw milk		Collect the milk in carefully cleaned, covered vessels. Filter milk and cool immediately to control growth of micro-organisms and enzyme activity. Milk that is likely to contain antibiotics should not be used as they will inhibit the action of lactic acid bacteria
Standardise		To approximately 26 g per litre fat content
Pasteurise		At 63°C for 30 minutes in a double-walled cheese vat. The milk should not be boiled as this adversely affects the flavour of products
Coagulate		By adding acid or vegetable extract while milk is hot
	Cool	Cool the milk to 35–40°C by running cold water through the vat or by re-circulating refrigerated water in the vat
	Ferment	Add starter culture and leave for 15–30 minutes
	Coagulate	With rennet (strength 1/10,000 – see text) at 30°C in the same vat. Rennet added at 20–25 ml per 100 litres of milk. If required, add 5–50 g calcium chloride per 100 litres of milk. Leave for 10–15 minutes
	Cut	To approximately 1–3 cm cubes using cheese knives. Two sets of knives are used, one with vertical blades and the other with horizontal blades (Figure 4.10a)
	Stir	For 5–10 minutes
Drain	Drain/wash	Drain whey from the vat through a tap. Replace with water or brine and stir for 10–20 minutes
	Drain	Drain, remove the curd and allow water to drain using cheesecloth on a slatted table. Cheesecloth should be sterilised by boiling for 10 minutes after use
Salt	Salt (Optional)	Mix 30 g salt per kg curd
Mould	Mould	Place curds in wooden or plastic moulds, lined with sterilised cheesecloth
Press		In a cheese press (Figure 4.11) for 1–5 hours. Turn the moulds 2 or 3 times
Salt	Salt (Optional)	Soak cheese in brine (200 g salt per litre water) for 8–24 hours to form a rind on the outside (Figure 4.12)
	Ripen	To develop characteristic flavour and texture and to lose moisture. Use wooden racks in a storeroom at 12–15°C and 85–95% relative humidity for several weeks/ months, depending on the type of cheese. In tropical climates this can be achieved using an underground cellar
	Smoke	(Optional for speciality cheeses)
Pack	Pack	Pack soft cheese in pots. Hard cheeses can be dipped in food-grade wax or packed in polythene film, clingfilm or greaseproof paper

Milk Solids-Not-Fat (MSNF) = proteins, lactose, minerals, acids, enzymes, vitamins.

Total Milk Solids = fat + MSNF

Fig. 4.13 Generalised process for making different types of cheese

controlled and predictable fermentation and inhibits undesirable micro-organisms. Milk used for the preparation of a starter culture is held at 63°C for an additional 15–30 minutes longer than the pasteurisation process to ensure that the large majority of bacteria are destroyed. After pasteurisation, it is cooled to 45°C and then poured into 1-litre bottles and a 5-litre covered container. The dried starter culture is added to bottles of the milk, shaken well to dissolve the powder, and grown at 40–45°C for 3–4 hours. This forms the 'mother culture' and it is incubated at 20–22°C for 15–16 hours. All subsequent starter cultures will be made from this. Part of the mother culture is then used to prepare an intermediate culture in 5 litres of milk, and part of the intermediate culture is used to prepare a 'bulk starter culture' for use in production of the batch of cheese. If the cultures are prepared carefully, each packet of commercial culture can be sub-cultured for 1–2 months.

Unlike commercial dried starter cultures, rennet can be made locally if advice from a university laboratory is obtained. Abomasa (the fourth stomachs of calves), preferably from un-weaned calves, are washed and the fat and veins are removed. They are then inflated with air to avoid the two sides touching, and the neck and base are tied with string. The inflated abosama are hung in a well-ventilated area to dry for about 1 month. When dried, the flattened abosama can be kept for up to a year without signs of deterioration. Each abosamum is sliced into 5-mm wide strips, and soaked for 24 hours at 20–25°C in a plastic or stainless steel tank, containing 10% brine with 1% sodium benzoate preservative. After soaking, the liquid is poured into a container. The same abosama strips and brine may be renewed 4–5 times before the enzyme activity diminishes. Commercially produced liquid rennet can also be obtained in some ACP countries.

Processed cheese

Sub-standard cheeses and cheese trimmings can be melted to make saleable products such as processed cheese spread. The cheese rind is removed and the cheese is cut into small pieces, mixed with emulsifying salt and heated for 10 minutes up to 90°C. It is then cooled and packaged while still liquid. Products may be varied by adding a variety of ingredients, including flavourings, pieces of mushroom, nuts, meats, etc. The product can be packaged for sale in plastic tubs or wrapped in aluminium foil.

4.6 Cultured milks and yoghurt

Fermented milk products such as cultured milk and yoghurt are produced using lactic acid bacteria that ferment the lactose in milk to form lactic acid. The acid helps to prevent the growth of pathogens, and also inhibits the growth of spoilage bacteria to preserve the milk for a short time. The removal of lactose enables people who suffer from lactose intolerance to consume these dairy products. There are many different types of cultured milks that are liquid or semi-solid and have different flavours depending on the types of bacteria that are present, the type of milk and the incubation conditions (Table 4.6).

Type of product	Bacteria used	Description
Acidophilus milk	<i>Lactobacillus acidophilus</i> , <i>Streptococcus lactis</i> , <i>Torula</i> yeast, <i>Betabacterium caucasium</i>	Liquid, acidic flavour, slightly fizzy and alcoholic
Cultured milks	<i>S. lactis</i> , <i>S. cremoris</i> , <i>S. diacetilactis</i> , <i>Leuconostoc citrovorum</i>	Liquid, made from skimmed milk or buttermilk (from butter making), strong acidic flavour
Yoghurts	<i>Lactobacillus delbrueckii</i> subsp. <i>bulgaricus</i> and <i>Streptococcus salivarius</i> subsp. <i>thermophilus</i> in a ratio of 1:1	Gel-like or highly viscous, creamy, slightly acidic

Source: Goff, 1995.

Table 4.6 Examples of cultured milk products

Acidophilus milk

Acidophilus milk is a traditional milk made from skimmed or whole milk that is fermented with *Lactobacillus acidophilus*, which is believed to have therapeutic effects on the digestive system. The milk is heated to 95°C for 1 hour to reduce the numbers of contaminating micro-organisms and prevent competition for the slow growing *Lactobacillus* culture. Milk is inoculated with 2–5% *Lactobacillus* culture and incubated at 37°C until coagulated. Some acidophilus milks have an acidity as high as 1% lactic acid, but 0.6–0.7% is more common. Sweet acidophilus milk has the *Lactobacillus* culture added but there is no fermentation, thus delivering the therapeutic benefits without the high acidity and strong flavour that are considered undesirable by some people.

Cultured milks

Traditional soured milk is thick, clotted and has a stronger flavour and a more acidic taste than yoghurt. It has a shelf life of 3–8 days at ambient temperatures and is used as a drink or as an accompaniment to meals. Raw milk is allowed to sour by naturally occurring bacteria in lidded containers, placed in warm room for 1–2 days. The product may be sold in portions directly from the culture vessel, or alternatively the inoculated milk may be poured into pots and allowed to ferment in them. The returnable or disposable pot plus the contents is then sold. In an upgraded method, the milk is inoculated with a *Lactobacillus* or *Leuconostoc* starter culture in a stainless steel vessel and held at 25–30°C in a thermostatically controlled water bath. It is packed in polythene bags or plastic pots and has a shelf life of up to 1 week under refrigerated storage.

Yoghurt

Yoghurt is produced by fermenting milk using two types of lactic acid bacteria (Table 4.6) either bought as a dry powder or taken from a portion of a previous batch of product. They produce lactic acid, which causes the characteristic curd to form and restricts the growth of some spoilage bacteria, so that yoghurt can be kept for up to 10 days under refrigerated storage. *Streptococcus* grows faster and produces both acid and carbon dioxide. This stimulates *Lactobacillus* growth. *Lactobacillus* produces peptides and amino acids, which are used by *Streptococcus*. The yoghurt mixture coagulates during fermentation due to the drop in pH. The *Streptococcus* causes the initial pH to drop to approximately 5.0, and then the *Lactobacillus* cause a further decrease to pH 4.0. The taste and texture of yoghurt are determined by the amount of lactic acid produced during the fermentation and this in turn depends on the amount of starter added and the temperature/time of incubation.

In processing (Figure 4.15), milk is standardised to the required fat content and the different ingredients are blended in a mixing tank. The mixture is pasteurised to both destroy contaminating bacteria, and to denature and coagulate whey proteins to enhance the texture of the final product. The yoghurt is cooled to 40–45°C and fermented for 4–6 hours until the acidity is 0.85–0.90% (Chapter 5, Section 5.3). It is then cooled and for stirred yoghurt (below) it is stirred to break the gel. The product is then packaged and stored

at refrigeration temperatures (5°C) to slow down chemical and microbiological changes that would shorten its shelf life.

Stage in process	Notes
Optional	
Milk	Collect the milk in carefully cleaned, covered vessels. Filter milk to remove visible dirt and 'ropiness', and cool immediately to control growth of micro-organisms and enzyme activity. Milk which is likely to contain antibodies should not be used as they will inhibit the action of lactic acid bacteria
Pasteurise	At 63°C for 30 minutes or at 72°C for 15 seconds
Cool	To 40–45°C
Ferment	Add a starter culture of the yoghurt bacteria. Keep the milk at the same temperature for 4–6 hours while the fermentation takes place
— Fill	If set yoghurt is required, fill the pots with the culture after inoculating with bacteria
— Fill	For liquid yoghurt, stir the yoghurt after fermentation to break the gel and then pour liquid yoghurt into pots
Cool	To 5–10°C
Seal	Seal pots with a foil or plastic lid
Cool/store	In a cool place away from sunlight and preferably in a refrigerator

Fig. 4.15 Process for making yoghurt

Yoghurt incubators can be locally made using a wooden or steel box approximately 75 cm each side that is insulated with approximately 10 cm thick expanded polystyrene or other insulating materials. A 40W light bulb is sufficient to maintain the temperature at 40–45°C inside the cabinet. Alternatives include using a shallow water bath fitted with a small electric heating element and thermostat to keep the culture warm. Indentations can also be made into a block of 10-cm thick polystyrene to hold plastic pots, with a polystyrene lid placed on top. The insulating effect of the polystyrene prevents heat loss sufficiently to maintain the temperature of the product during a 4–6 hour fermentation. On a very small scale, the warm yoghurt mix can also be filled into large commercial thermos flasks to keep it warm.

The correct balance of the two types of bacteria is important for good quality yoghurt. Dried yoghurt cultures can be obtained in most large ACP cities, and they can be grown in pasteurised milk and kept in a refrigerator. A part of this 'mother culture' is then used each day for a week. The last part is re-inoculated into milk to form a new mother culture. With good hygiene, this method can be continued for several months, but eventually undesirable bacteria will contaminate the culture and it must be replaced. If a refrigerator is not available, it is possible to add one or two teaspoonfuls per litre of milk of commercial yoghurt (which has not been pasteurised) as the starter culture. Alternatively, part of the yoghurt production can be used as a starter and added to a new batch of milk the following day. However, there is a greater risk of contamination using this method and it is not recommended unless the other methods are not possible.

There are two potential problems in making cultured milk products:

1. Spoilage by bacteria or moulds. This is caused by unclean equipment, contaminated milk or poor hygiene of production staff. It is prevented by thoroughly cleaning and sterilising all equipment and utensils with chlorine solution (diluted bleach: see Chapter 3, Section 3.4) or boiling water. This should be done before and after processing, and followed by thorough rinsing in clean water. Other causes of spoilage are the use of old milk and poor hygiene by production workers. They should follow the rules for safe processing described in Appendix II.
2. Maintenance of correct incubation temperature. The alternative equipment described in Section 3.5 can be used to maintain the temperature during fermentation.

Product variations

Although milk of different animals is used to make yoghurt in various parts of the world, most yoghurt production uses whole cow's milk, partially skimmed milk, skimmed milk or cream. The raw milk must have a low bacteria count and be free from antibiotics, viruses, cleaning chemicals, mastitis milk, colostrum, and rancid milk. Other yoghurt ingredients may include:

- non-fat dried milk or whey to increase the non-fat solids content. Thicker stirred yoghurt is made by adding dried skimmed milk (at approximately 50 g per litre) to the milk before pasteurising

- sweeteners, such as glucose, sucrose or aspartame
- flavours, colourings or fruit pulps, including natural and artificial flavouring
- thickeners/stabilisers, such as gelatine, carboxymethyl cellulose, locust bean gum, guar gum, alginates, carrageen, starch or pectin The use of thickeners adds to the cost of the product and they are not necessary.

Other yoghurt products include 'fruit-on-the-bottom' style, in which a layer of fruit pulp at the base of the pot is covered by inoculated yoghurt and incubation occurs in the sealed cups. Fruits or chopped nuts can be added to stirred or set yoghurt, but care is needed to ensure that they are thoroughly cleaned, and that nuts are blanched to avoid contamination by moulds or bacteria. Less-acidic fruits such as melon or pawpaw are more successful because they do not react with the milk. Acidic fruits (lemon, lime, pineapple etc.) may cause excessive curdling and separation of the yoghurt. In some countries a layer of fruit syrup on the top of set yoghurt is a popular alternative.

Case study 4.1 Yoghurt production

'Initially 1012 lb of finished product (4050 x 4-oz packs of yoghurt) were made per day. One batch is made per day although it takes 4–5 days to complete because after inoculation the product is put into the cold room for 2–3 days to mature before mixing with fruit and packaging.'

Drinking yoghurt is stirred yoghurt with added flavouring and colouring, and has a total solids content not exceeding 11%. It may be homogenised to further reduce the viscosity. Cultured buttermilk is the fermented by-product of butter manufacture, but it is also produced as a product from skimmed or whole milk using a culture of *S. lactis* or *S. cremoris* sp. Milk is heated to 95°C and cooled to 20–25°C before adding the starter culture at 1–2%. The fermentation is continued for 16–20 hours, to an acidity of 0.9% lactic acid. This product may be used as an ingredient in bakeries as well as being packaged for retail sale. There are a great many other fermented dairy products, including kefir, koumiss, labneh, and others that are specific to regional areas and have various flavours, textures, and gas or ethanol from the fermentation process, depending on the starter organisms used.

4.7 Ice cream

Ice cream is both a foam (air bubbles in the water phase), and an oil-in-water (O/W) emulsion of tiny globules of milk fat in a complex water phase containing ice crystals, concentrate, unfrozen solution of sugars, milk solids, flavouring, colouring, emulsifiers and stabilisers. It is made by freezing, and at the same time aerating, a liquid mix that has all the required ingredients (Figure 4.17). The incorporation of air increases the softness and lightness of the product and allows it to be easily scooped. The increase in volume of the product due to the air is known as the 'overrun' and the percentage overrun in commercial ice creams varies from 60–100%.

$$\text{Overrun \%} = 100 \times \frac{\text{weight of a given volume of mix} - \text{weight of same volume of ice cream}}{\text{weight of same volume of ice cream}}$$

If, for example, 3 kg of mix fills a container and 1.6 kg of ice cream fills the same container, the overrun

$$\begin{aligned} &= 100 \times \frac{(3 - 1.6)}{1.6} \\ &= 100 \times 1.4/1.6 \\ &= 87.5\% \end{aligned}$$

Stage in process	Notes
Optional	
Weigh	Weigh all main ingredients into pasteurisation vessel, premix minor dry ingredients with 3 or 4 times their weight of sugar
Heat	To 50°C and add any solid fats
Pasteurise	At 65°C for 30 minutes or 72°C for 10 minutes with thorough mixing
Homogenise	
Cool	For a minimum of 4 hours at 3–5°C to allow fats to crystallise and the viscosity to increase
Freeze	To –5°C as quickly as possible
Pack	Fill into pots or cardboard cartons
Harden	At below –20°C
Cold store	At –18° to –20°C

Fig. 4.17 Production of ice cream

Manual or electric ice cream makers have a stainless steel bowl that is immersed in a freezing liquid (e.g. an ice/salt mixture), placed in a freezer, or surrounded by refrigeration coils. Two types of larger ice cream makers are used for small- and medium-scale production:

- vertical freezers with capacities of 4–20 litres per batch
- horizontal freezers with capacities of 8–35 litres per hour.

Both have freezing times of approximately 15 minutes.

The ice cream mixture is placed in the bowl and a rotor scrapes the frozen ice cream from the bowl wall and simultaneously incorporates air. Freezing is continued until all of the liquid is frozen at approximately -4°C to -7°C . This soft ice cream is then either sold directly or hardened in a freezer at -18°C . Fast freezing results in very small ice crystals, which are not detectable in the mouth and thus gives a smooth creamy consistency to the product. Further details of the structure and composition of ice cream are given in Appendix I.

There are important differences between the batch and horizontal types that affect the type of ice cream mix that is needed. A mix for a batch freezer requires a fat content of 6–8% and a sugar content of 12–13%, whereas the mix for a horizontal freezer should have a fat content of 9–10% and a sugar content of 14–15%. Batch freezers can only beat small amounts of air into the mixture as it freezes, to give an overrun after freezing of 50% or less. Horizontal freezers are more efficient at incorporating air and overruns can be up to 85%. As ice cream is usually sold by volume, the amount of air in the product has an important effect on profitability.

Non-dairy ingredients

Vegetable fats, including hydrogenated palm and coconut oils and salt-free margarine, are commonly used in ice cream in order to reduce costs. Sugars not only improve the flavour but also counterbalance fattiness and assist in providing a smooth texture. Dextrose or corn syrup modifies the melting point of ice in the ice cream to make it harder or softer. Stabilisers bind together the complex mixture of fats, sugars, air and ice crystals. Carboxymethylcellulose is widely used as a stabiliser and is blended with small quantities of gums to improve its action. Manufacturer's recommendations on quantities of stabilisers used should be closely followed. Both synthetic and natural flavours are used, often with a colour that matches the flavour (e.g. yellow with

banana flavour, orange with mango flavour etc.). Further details are given in Appendix I.

Formulating an ice cream mix

It is important that small-scale producers understand how to develop new ice cream mixes to expand their range of products and compete effectively with other producers. 'Balancing' a mix involves maintaining the correct proportions between:

- fat and sugar that controls the 'fattiness' of the product
- water to solids that controls the texture.

Correct formulation of an ice cream mix requires knowledge of the composition of the ingredients, their cost and availability, and also depends on the type of freezer that is used. The typical fat and milk-solids-not-fat (MSNF, i.e. proteins, lactose, minerals, acids, enzymes, vitamins. Total milk solids = fat + MSNF) contents of dairy products used as ingredients in a mix are shown in Table 4.7 and typical formulations for different types of ice cream are shown in Table 4.8. Methods to calculate the formulation of a new ice cream are given in references in the bibliography (Appendix III) and further details of the structure and composition of ice cream are described in Appendix I.

A summary of the effect of each component on the quality of ice cream is shown in Table 4.10.

Product	Fat	MSNF	Sugar	Water
Full cream milk	4.0	8.8		87.2
Liquid skimmed milk		9.0		86.0
Full cream milk powder	27.0	70.0		3.0
Skimmed milk powder		97.0		3.0
Double cream	48.0	4.5		47.5
Single cream	18.0	7.2		74.8
Butter	84.0			16.0
Sweetened condensed milk	9.0	22.0	44.0	25.0
Evaporated milk	9.0	22.0		69.0

Source: Bonfoh, 2005.

Table 4.7 Typical composition (%) of common ice cream dairy ingredients

Component	(%)						
	Standard		Premium				Super
Type of ice cream							
Milk fat	10.00	11.00	12.00	13.00	14.00	15.00	16.00
MSNF	11.00	11.00	10.50	10.50	10.00	10.00	9.50
Sucrose	10.00	10.00	12.00	14.00	14.00	15.00	15.00
Corn syrup solids	5.00	5.00	4.00	3.00	3.00	—	—
Stabiliser	0.35	0.35	0.30	0.30	0.25	0.20	0.15
Emulsifier	0.15	0.15	0.15	0.14	0.13	0.12	0.10
Total solids	36.50	37.50	38.95	40.94	41.38	40.32	40.75
Water	63.50	62.50	61.05	59.06	58.62	59.68	59.25
Overrun (%)	100–120 ¹	60–90	25–50				

¹ 120% overrun is a legal maximum in some countries
Source: Bonfoh, 2005.

Table 4.8 Different mixes for hard-frozen ice creams

Component	(%)								
	Low fat and light					Soft frozen		Sherbet and sorbet ¹	
Type of ice cream									
Milk fat	3.00	4.00	5.00	6.00	8.00	10.00	10.00	0.50	1.50
MSNF	13.00	12.50	12.50	12.00	11.50	12.50	12.00	2.00	3.50
Sucrose	11.00	11.00	11.00	13.00	12.00	13.00	10.00	24.00	24.00
Corn syrup solids	6.00	5.50	5.50	4.00	4.00	—	4.00	9.00	6.00
Stabiliser	0.35	0.35	0.35	0.35	0.35	0.35	0.15	0.30	0.30
Emulsifier	0.10	0.10	0.10	0.15	0.15	0.15	0.15	0.30	0.30
Total solids	33.65	33.45	34.45	35.50	36.00	36.00	36.30	36.10	35.60
Water	66.35	66.55	65.55	64.50	64.00	64.00	63.70	63.90	64.40

¹ Plus fruit: 25% of the mix and 5% solution of citric acid
Source: Bonfoh, 2005.

Table 4.9 Mixes for other ice creams

Ingredient	Contribution	Effect of too much
Butterfat	Increases the richness of flavour Produces a smooth texture Gives body to the ice cream Produces good melting properties	Increases costs Hinders whipping ability Produces excessive richness
MSNF	Improves the body and texture Allows a higher overrun without producing a flaky texture Proteins contribute to the structure by improving emulsification and whipping properties and increasing the water holding capacity leading to a thicker, less icy product	Off-flavours Too much lactose crystallises during freezing and can cause sandiness or lower the freezing point of the finished product so that it is too cold to eat
Sweeteners	Improve texture and palatability and enhance flavours Sugars ¹ contribute to lower freezing point, so the ice cream contains some unfrozen water, without this it would be too hard to eat	Too sweet
Stabilisers	Increase the viscosity in the unfrozen water to produce a firmer ice cream Provide resistance to melting Produce a stable foam Prevent shrinkage Slow down moisture loss	Too high viscosity before freezing, causing undesirable melting characteristics and a heavy, chewy texture Without stabilisers, ice cream is coarse and icy due to larger ice crystals
Emulsifiers	Develop the fat structure and distribution of air in the foam for a smooth texture and good melting characteristics	

¹ Corn syrup produces a firmer and chewier ice cream than sugar, and improves the shelf life. It is available in different dextrose equivalents (DE, a measure of the reducing sugar content of the syrup calculated as dextrose and expressed as a % of the total dry weight) Product sweetness increases with DE and increases the freezing point depression. Lower DE corn syrups contain more dextrans, which bind more water and have a greater stabilising effect.

Source: Bonfoh, 2005.

Table 4.10 Effects of ice cream components

4.8 Milk confectionery

In ACP countries that have significant Asian populations, there is a demand for a variety of dairy confectionery products such as *rasagolla*, *champakali*, *rasmalai*, *gulab jamun* etc. They are made from intermediary products such as *khova* – made by reducing milk whilst stirring constantly until it's almost solid

and heat-acid coagulation (*chhana*) of milk. Both are granular, whitish creamy in colour, soft and spongy with a characteristic bland and fatty flavour. Figure 4.18 shows stages in production of *chhana*.

Rasagolla is a round, creamy white, milk-based sweet made from *chhana* suspended in sugar syrup (Figure 4.19). It has a smooth surface, distinct spongy and springy texture and the flavour of *chhana*.

Khova is obtained by evaporating milk (Figure 4.20). It is used in the preparation of many sweetmeats (*galub jamun*, *burfi*, milk cake, *doodh peda*, etc). Like *chhana*, it has a shelf life of 2–3 days under refrigerated conditions.

Gulab jamun is a milk-based sweet made from *khova*, refined flour and cane sugar. It is round or elliptical in shape with deep brown slightly crisp, outer surface and dull white, soft and porous inside (Figure 4.21). It is stored floating in sugar syrup, the product has a distinct flavour of deep-fried milk solids, sugar syrup and added flavours.

Stage in process	Notes
Cow's milk	Only fresh milk should be used
Heat	Boil for 10 minutes. Milk should be regularly stirred to avoid cream forming on the surface and prevent milk burning onto the pan
Cool	To about 80°C
Mix	Lemon juice or citric acid or curd is added slowly to the milk (20 g per 10 litres milk), with constant and slow stirring. Continue until coagulation is complete. Maintain the temperature at 80°C. It's important not to put in the lime juice/curd when the milk is boiling, and to wait till it cools slightly While the acid is being stirred in, turn on a very low flame to maintain the temperature, then switch off and allow to settle
Settle/drain	Allow to settle for 15 minutes. The coagulated milk is hung in a muslin cloth bag for about 2 hours to drain the whey. The coagulum is the finished product
Pack	In vegetable parchment paper or polythene bags
Store	The product has a shelf life of 2–3 days under refrigeration

Fig. 4.18 Production of *chhana*

Stage in process	Notes
Chhana	Good quality fresh <i>chhana</i>
Mix	Add wheat flour (20 g per kg of <i>chhana</i>) gradually while kneading to smooth and pliable consistency
Shape	Take a small quantity of dough to make 2-cm diameter balls, slightly flatten them by pressing with fingers, place a cardamom seed in the centre of each ball, fold and shape into smooth balls. Keep the balls covered with a wet cloth
Mix	Prepare sugar syrup (1 litre of water to 1 kg sugar), heat to dissolve, filter and boil
Heat	Transfer balls to simmering sugar syrup and cook for 10–15 minutes on medium heat. On cooking the balls absorb syrup and swell
Cool	To room temperature
Pack/store	In glass jars

Fig. 4.19 Production of *rasagolla*

Stage in process	Notes
Milk	Milk should be fresh, without any undesirable off-flavours or acid development. Buffalo milk with a minimum of 5% fat is preferred as it yields more <i>khova</i> with a better texture than cow's milk
Heat (high)	Boil whilst continuously stirring to avoid cream separation. Continue boiling until the milk starts to coagulate which is marked by an abrupt change in colour
Heat (low)	Once coagulation starts the temperature should be lowered to 85–88°C. Stir briskly and regularly scrape the milk solids from sides of the pan. The end point is marked by the solid mass leaving the sides and bottom of the pan
Cool	To room temperature
Press	Pat to form a compact mass
Pack	In vegetable parchment paper or polythene bags
Store	The product has a shelf-life of 2–3 days under refrigeration

Fig. 4.20 Production of *khova*

Stage in process	Notes
Khova	Break fresh <i>khova</i>
Mix	Sieve flour (105 g) and baking powder (7.5 g) together before adding to <i>khova</i> . (900 g). Excess flour gives a leathery and soggy product while insufficient flour results in bursting and disintegration of the product during frying. Mix a little water, just enough to make a smooth mixture while kneading, and thoroughly mix to get a homogeneous mixture
Knead	To smooth and soft dough. Cover the dough with a wet cloth and put it aside
Mix	Prepare sugar syrup by dissolving 3 kg sugar in an equal quantity of water and boiling it for 5 minutes. If desired rose or cardamon essence can be added
Shape	Take small quantities of dough and shape them into balls of 2-cm diameter or oval forms. The balls should be smooth without any cracks on the surface
Fry	Heat <i>ghee</i> (clarified unsalted butter) in a shallow pan in a shallow pan until hot but not smoking. Fry the balls slowly on medium / low flame until they turn deep brown. It is important to avoid the formation of an uncooked hard core at the centre, which happens when the outside browns too fast
Transfer	Remove the fried balls from the <i>ghee</i> using a perforated ladle and immediately transfer them into sugar syrup. The fried balls swell in size and become soft as they absorb the syrup
Store	In syrup in closed glass jars or wide, deep stainless steel containers

Fig. 4.21 Production of *gulab jamun*

Methods for the production of other milk confectionery are described by Fellows, 1997.

Summary of the chapter

- ✓ New products can develop new markets. It is important to keep up with new market trends.
- ✓ When developing new products seek specialist advice about storage conditions and shelf life.
- ✓ Processes are described for making:
 - Butters
 - Cheeses
 - Creams
 - Cultured milks
 - Ghee*
 - Ice creams
 - Milk confectionery
 - Pasteurised and flavoured milks
 - Yoghurts.

Entrepreneur's checklist

Are you planning to make a new product?

Do you know the process needed to make:

Butters

Cheeses

Creams

Cultured milks

Ghee

Ice creams

Milk confectionery

Pasteurised and flavoured milks

Yoghurts

Do you know where to find specialist advice about storage conditions and shelf life?

5.1 Introduction

As milk carries a high risk of causing food poisoning, it is essential that processors pay great attention to the quality of milk that they buy.

In many ACP countries, there are poor control and inspection systems by public health officials, and the high temperatures in tropical countries make risks even higher. Two types of danger exist: infections from the living animal (e.g. brucellosis) and infections caused by contamination of the milk. External microbiological contamination of milk in the milking shed can come from contact with hides, soil and faeces, poor quality water, dirty equipment and poor hygiene by milking staff. Further details of contaminating micro-organisms are given in Appendix II.

5.2 Milk

To ensure the milk they purchase is of good quality dairy processors should:

Tips for success

- ✓ Produce a quality product and be consistent
- ✓ Ensure that you only use good quality ingredients for your products
- ✓ Do not stop the search for other suppliers offering more competitive prices
- ✓ Keep process control records to see where improvements could be made
- ✓ Carry out a risk analysis for all products from production to consumption
- ✓ Your products face the greatest risk after purchase by consumers, so provide advice on the label
- ✓ Pay maximum attention to high-risk products
- ✓ Have a reliable cold chain from production to consumption to protect the consumer
- ✓ Obtain copies of local food legislation; and if it is not clear seek help
- ✓ Identify local institutions that can provide specialist technical assistance
- ✓ Keep in touch with suppliers; they can provide a lot of useful information
- ✓ Read Sections 6.3–6.6 and 10.2 in *Opportunities in Food Processing, Volume 1*.

- only buy from reputable suppliers, and never buy the cheapest
- take advice to find the best managed milking parlours and investigate the animal inspection systems that they use
- identify institutions that can provide advice, support and training
- increase their knowledge and awareness of potential problems.

Case study 5.1 Quality assurance

'A quality assurance system is in place. The owner checks the raw materials and ingredients when a new container is opened. The pH of each batch is checked during production and the final product is also checked. Records are kept of production dates and each batch is date coded. The finished product is check-weighed. We have not done bacterial counts but would like to do so in the future.'

The case studies show that small-scale milk processors can have considerable control over the quality of raw milk that they buy by using quality specifications or formal agreements. They do not rely on the local street market or middlemen for their supplies.

Testing milk quality

The following tests are made on incoming milk to ensure that it is fresh, safe, has been properly handled, and has not been adulterated by adding water. When milk from all producers has been collected and mixed, a sample is tested for acidity, density and fat content.

Sensory examination

Fresh milk should be slightly more viscous than water, white with a yellowish tinge depending on the fat content. There should not be discoloration, lumps or a high viscosity. It should have a bland, slightly sweet taste and a pleasant characteristic smell. It should not have any other odour from strong-smelling contaminants such as diesel, smoke or foods that may have been stored too close to the milk. If a finger is dipped into a sample of milk and slowly withdrawn, there should be no strings or threads of milk attached. A simple test of quality is to mix a little detergent with the milk. If it remains liquid it is suitable for use.

pH and acidity

The pH of milk is usually between 6.6 and 6.8, falling to approximately 4.3 as it sours. The total acidity of fresh milk is approximately 0.14% for goat's milk and 0.16–0.19% for cow's milk. In storage, the acidity increases due to the action of micro-organisms and the milk acquires a sour taste when the acidity reaches around 0.3%. It tastes very sour at 0.4% and curdles at 0.6%. Acidity is measured by titration as follows:

- measure exactly 10 ml milk into each of two small white bowls (a and b)
- to (a) add 1 ml of roseaniline acetate solution and stir. (This can be made by dissolving 0.12 g of roseaniline acetate in 50 ml of ethyl alcohol that contains 0.5 ml of glacial acetic acid. Make the solution up to 100 ml with alcohol and store in the dark in a refrigerator.)
- to (b) add 1 ml of phenolphthalein indicator and titrate with 0.1m sodium hydroxide solution, stirring continuously until the pink colour matches that in bowl (a)
- record the volume of sodium hydroxide used and multiply by 0.009 to calculate the acidity (as grams of lactic acid in the 10 ml sample). Multiply the result by 10 to obtain a percentage lactic acid.

Density

The density of milk can be measured using a hydrometer known as a 'lactodensimeter' (or 'Lactometer' Figure 5.1), which is calibrated from 1.025 to 1.035 (or 25° to 35° as lactometer readings). Measurements should be taken at 20°C. If a reading is obtained that is lower than 1.028, it indicates that the milk may have been diluted with water.

Method:

- pour a milk sample into a measuring cylinder without making foam
- place the lactodensimeter in the measuring cylinder and allow its movement to stop before taking a reading
- compare the density to the cow's milk values in Table 5.1.



Fig. 5.1 Lactodensimeter (Photo: R. Zulu)

Lactodensimeter reading ¹	Type of milk
>1.034	High fat
1.028 – 1.033	Normal
< 1.028	Diluted

¹ Readings may vary with the breed of cattle, the season and the cow's diet.

Table 5.1 Lactodensimeter readings for different types of cow's milk

Fat content

The standard test used to measure the fat content in milk and dairy products is known as the 'Gerber' method. However, this requires chemicals and laboratory apparatus that are not likely to be available or affordable in a small dairy, and a dairy owner should take samples to a Bureau of Standards or university food science department for testing. A low fat measurement indicates that some of the cream has been skimmed off the surface of the milk, or that it has been diluted with water.

Details of the milk quality and volume are recorded for each farmer who supplies the dairy, and payments for the milk are made weekly or fortnightly. An example of a record sheet for an individual dairy is shown in Table 5.2.

Date	Name of farmer	Amount delivered (litres)	Fat (%)	Acidity (%) pH	Density	Visual assessment
12.6.04	P. Ahmed	10	4.1	0.15 6.6	1.030	Satisfactory
12.6.04	L. Mulbila	15	4.2	0.17 6.7	1.029	Satisfactory
13.6.04	Z. Ncheda	50	4.5	0.17 6.6	1.038	Satisfactory
Total		75				

Table 5.2 Record of milk received at a small dairy

Microbiological tests

The appropriate microbiological test for small-scale dairy processors is the 'Methylene blue' test. Other tests are either too expensive, or require specialist equipment and skills that are not usually available to processors. If necessary other tests can be made at a Bureau of Standards or university food science department.

Methylene blue test

1. Mix a 20-ml sample of milk to ensure that the cream is evenly distributed.
2. Place in a test tube and add 0.5 ml of dye solution (the dye is a 0.0075% solution of methylene blue made by dissolving the powder in distilled water to the required concentration. The powder may be available from pharmacies or specialist suppliers in large cities). Once made, dye can be kept for 2 months and should be stored in a cool, dark place away from sunlight.
3. Seal the tube with a stopper and mix by inverting the tube.
4. Place in a water bath at 36–38°C in the dark.
5. Record how long it takes for the dye to fade. For instance, if the milk is not decolourised within 30 minutes it has a satisfactory quality, but please note, times may vary with local dairy regulations that should be consulted at the Bureau of Standards.

If a microbiological problem is identified in a product, samples should be sent for analysis. Other tests that can be done by a government or university laboratory include:

- Testing the cleanliness of equipment after cleaning using a technique known as swabbing. Swabbing involves wiping the surface with a sterile swab of cloth. This is then incubated in a special solution that encourages bacterial growth, and the type and number of micro-organisms are determined. The test provides clear information on the cleanliness of the item being checked. Health checks on staff for potentially dangerous micro-organisms such as *Salmonella* sp. and *Staphylococcus* sp. All workers should have regular checks to show that they are fit to handle food. This is a legal requirement in some ACP countries. Health checks may be seen as threatening by staff if they fear

loosing their job because of a negative result. Staff should be reassured that they will be employed on duties that do not involve handling foods until their health problem is solved.

- Periodic checks on the product for quality and shelf life to confirm the use-by date (Section 4.1).

Effectiveness of pasteurisation

Phosphatase is a naturally occurring enzyme in milk that is destroyed by the same heating conditions that are used for pasteurisation. Phosphatase activity can be measured by mixing a dye with the milk and comparing the colour change using a 'Lovibond comparator', fitted with discs APTW or APTW7. Absence of phosphatase activity shows that the milk is properly pasteurised. The test has the following steps:

1. Prepare a solution of 0.15 g of disodium p-nitrophenol phosphate in 100 ml solution that contains 3.5 g anhydrous sodium carbonate and 1.5 g sodium bicarbonate. Store it in a refrigerator, protect it from light and use it within 1 week.
2. Put 5 ml of the nitrophenol solution in a test tube and heat to 37°C in a water bath.
3. Add 1 ml of milk, stopper the tube and shake it to mix the liquids.
4. Keep at 37°C for 2 hours and then compare the colour in the Lovibond comparator.
5. A reading of 10 µg or less shows that the milk is properly pasteurised.

Case study 5.2 Testing milk

'Product quality is assured by a phosphatase test on raw milk and microbiological tests on each batch of processed milk. This is done for a fee by the hospital laboratory. We also use a date code and check weighing. The microbiological tests are costly. We keep records of the amount of raw milk that is received and processed and of microbiological tests and phosphatase tests.'

5.3 Cheese, yoghurt and other dairy products

The acidity and microbiological testing of other dairy products uses similar methods to those described above for milk.

Rennet

Where rennet is extracted from abosama it is purified by acidifying the extract with hydrochloric acid to pH 4.8, stirring vigorously, and keeping it for 2 hours. The pH is then increased to 5.5–5.6 using disodium-phosphate. The liquid is then filtered through large filter papers. The strength of rennet is measured as ‘the number of volumes of coagulated milk that are clotted by one volume of rennet in 40 minutes at 35°C’. This is normally 1 litre rennet:10,000 litres milk.

This can be checked as follows:

1. Put 500 ml of milk in a flask in a water bath at 35°C.
2. Remove 1 ml of rennet and dilute it in 10 ml of water.
3. Add 10 ml of diluted rennet to the milk, stirring constantly. Rotate the flask so that a film of milk is formed on the sides.
4. Note the time taken for the liquid to flocculate.

The strength of each of the 4–5 rennet extractions from the abosama is determined, and the strength is standardised by mixing them to give a strength of 1:10,000. Rennet can be stored in coloured or opaque glass bottles or plastic containers at 5–7°C for 3 months.

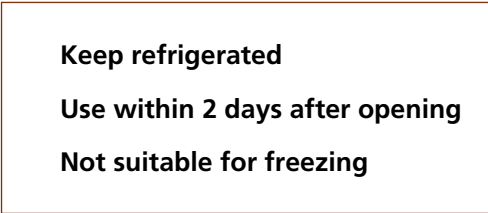
5.4 Risk analysis from production to consumers

All food manufacturers have a responsibility to ensure that quality assurance systems are in place to provide consumers with a product that is wholesome and safe to eat.

The manufacturers’ responsibility does not end when the product leaves the dairy. Although in law a food manufacturer may claim that illness due to eating a product is caused by a retailer failing to keep the food at the correct temperature or the consumer using the product after its use-by date, any complaint will damage the name and image of the producer.

Control of quality by the processor during distribution and retail display can prevent quality problems that would cause consumer complaints.

Control can be achieved by processors using their own insulated or refrigerated transport containers, by giving clear advice to retailers on methods of storage and display, and by giving advice on the label to consumers on how to store and use the product (Figure 5.2).



Keep refrigerated
Use within 2 days after opening
Not suitable for freezing

Fig. 5.2 Advice on a label

Risks arise after purchase by the consumer by, for example:

- being left in a hot vehicle, which warms or thaws the food leading to rapid microbial growth
- re-freezing a frozen food that has thawed
- operating a home refrigerator at the incorrect temperature
- contamination by flies and other pests in the home
- improper preparation, or use after the use-by date.

The level of control required in the cold chain depends on the risk associated with the particular product. The following dairy products described in this book are low, medium or high-risk foods:

- Low risk: Butter, *ghee*
- Medium risk: Cultured (soured) milks, cheeses, milk confectionery, yoghurt
- High-risk: Cream, ice cream, pasteurised milk

This is described in detail in Section 10.2 of *Opportunities in Food Processing, Volume 1*. Dairy manufacturers should carry out a risk analysis for each of their products as described in the example (Table 5.3). Shops, restaurants and hotels should also be involved in the risk analysis to inform them of their role in ensuring safety in the cold chain.

Case study 5.3 Product testing

‘We have systems in place for ensuring product quality, including pre-shipment inspection of products to check for defects and date codes (but no batch codes because we only make one batch a day). Records are kept, shelf life samples and tests are done regularly. Scales are checked every 6 months by the Bureau of Standards. We do not have the facilities for chemical testing or microbial analyses.’

Where risk occurs	Typical risks	Possible actions
In the milking parlour	Contamination from contact with animals or workers' hands, or improperly cleaned milking equipment and churns. Inadequate cooling or delays in cooling the milk	Implement hygiene and sanitation systems to ensure that contamination cannot occur. Train workers in correct hygiene procedures. Ensure that cooling equipment functions properly
In the transport chain	Delays in transport that allow the milk to warm up. If containers other than churns are used, there is a risk of contamination by odours from strong-smelling materials that may be transported with the milk	Use only milk churns to transport milk (or a purpose-built tanker at larger scales) Explain to the transport company how you want the milk transported and the maximum journey time. Use a reliable company even if it is a little more expensive
During processing	Incorrect processing conditions, poor dairy sanitation, poor worker hygiene	Ensure that staff understand the process and tolerances for process conditions. Train all staff in good personal hygiene and ensure that a cleaning schedule is in place and properly done each day (see below)
During retail display and home consumption	Poor temperature control in refrigerated display cabinets. Product stored beyond the use-by date Increase in product temperature due to long journey times home or lack of refrigerators in the home. Ignoring the use-by date	Provide advice to retailers on display temperatures and sell-by dates Put storage and use-by information on labels for consumers

Table 5.3. Risk analysis for a dairy product

Dairy owners should agree with farmers/suppliers the following actions to ensure the safety of milk:

- keep milking premises clean, remove all dirt, excreta etc. and prevent access by rodents or insects
- wash and disinfect all milk containers before and after use
- wash udders with a clean cloth and clean water. Boil the cloth each day to sterilise it and dry by hanging on a line in the sun (NB: If cows have mastitis or if it is not possible to properly clean udder cloths then washing is not recommended)
- check animals daily for disease. If required test for mastitis using a test-kit (available from veterinary suppliers)
- observe personal hygiene rules (Appendix II)
- keep milk containers covered
- cool milk as quickly as possible
- transport milk to processor in shortest time possible.

5.5 Plant inspection and cleaning

Cleaning and inspection should be a planned activity that has time and materials set aside to ensure that it is done properly. A cleaning schedule should be prepared that indicates:

- the equipment or part of the plant to be cleaned
- who is responsible for cleaning
- how frequently it is done and realistic times for the work
- who is responsible for checking that cleaning has been done properly.

An example of a cleaning and inspection schedule for a small cream processing business is shown in Table 5.4. It should contain actions that are required each day, week, month and year.

The wastes produced in dairy processing are high in protein and fat which makes cleaning difficult. Wash all equipment with hot water and an acidic or caustic dairy cleaning agent that is recommended for use with dairy products, then rinse it with chlorinated water. Allow equipment and surfaces to dry in the air, because wiping with cloths can re-contaminate them. If cloths are used, they should be washed with detergent and boiled for 10–15 minutes to sterilise them. They should be hung on a line to dry and not placed on

Case study 5.4 Cleaning schedule

'There is a documented cleaning schedule done by staff. There is no documented maintenance schedule and maintenance is done when called for.'

Task	Responsible person	When/ how often	How
Clean milk churns	Bertha	Immediately after emptying	Wash with detergent and hot water, followed by sterilisation with bleach and rinsing with clean water
Wash cream separator and check machine components	Ahmed	After each use	Dismantle separator, check cones and motor. Wash internal components and casing in hot water using detergent. Sterilise with dilute bleach and rinse with clean water. Dry completely before re-assembling. Check that equipment is properly assembled
Wash cream tank	Bertha	Each day	Wash with clean water and detergent, sterilise with bleach, rinse and invert on a worktable to dry
Clean work tables	Bertha	Each day	Wipe all surfaces with bleach after they have been washed
Clean floors and walls	Ahmed	Daily	Wash with hosepipe and spray gun. Brush floors with strong brush to ensure no standing pools of water or milk residues remain
Check and clean drains	Ahmed	Weekly	Check and clean drainage channel and covering metal grids
Check quality of walls and floors	Ahmed	Monthly	Check walls and floors for any dirt on grouting between wall tiles and remove as necessary. Check that grouting is in place and intact
Review cleaning plan	Salem	Yearly	Review the cost and effectiveness of cleaning. Ask staff for suggested improvements, review prices of cleaning materials

(All actions checked by Salem, the Manager)

Table 5.4 Example of part of a cleaning and maintenance schedule

equipment or windowsills. Coloured cloths should be used because the coloured material can be seen more easily than white threads if they are lost in machinery or in the product. If they are available, brushes with coloured bristles are preferred. Special dairy cleaning compounds, designed to deal with materials that contain fat and protein, may be locally available from specialist suppliers.

Chlorine content of water

The measurement of chlorine levels is carried out using a chemical dye that reacts with chlorine to produce a red colour that is proportional to the amount of chlorine present. The test requires a 'comparator', supplied with glass discs of different red hues. A few drops of dye are added to a sample of the water in a test-tube, and the colour is matched to one of the discs to determine the chlorine content.

5.6 Process control

The recipe and processing conditions that are used for a particular product should be standardised so that consistent quality products are made each time.

This involves controlling factors in the process that affect the quality of the product. These are known as 'control points' and are the points at which checks and measurements should be made. A process control schedule should be prepared for each product. Table 5.5 is an example of a process control schedule for yoghurt production.

Fill weight of packages

In most ACP countries, a minimum net weight is required for packaged food as a legal requirement. The weight should be the same as that declared on the label. Net weight is checked by placing an empty package on the scales and adjusting them to zero. Packaged foods can then be weighed, and the measured weight is the net weight (the weight without packaging). In general the pack should be overfilled by 2–4%.

Stage in process	Activity	Process control points
Milk reception	Collect the milk in covered vessels, filter milk to remove visible dirt and 'ropiness' and cool quickly to 10°C	Visual inspection of milk for colour, viscosity, taste and odour. Density measurement and methylene blue test. Check cooling time
Pasteurise	Heat milk to destroy micro-organisms and enzymes.	At 63°C +/- 1°C for 30 minutes +/- 0.5 minutes. Phosphatase test for pasteurisation effectiveness
Cool	By immersing vessel in cold water and stirring milk	To 44°C +/- 2°C within 20 minutes
Ferment	Add yoghurt starter culture and ferment for 4–6 hours.	Check that starter culture is active and check weight of starter added. Maintain temperature at 44°C +/- 2°C. Check texture of yoghurt to determine end of fermentation time (5 hours +/- 1 hour)
Fill pots	Stir the yoghurt to break the gel and then pour liquid yoghurt into pots	Check the weight of yoghurt in each pot (minimum 200 g net weight)
Seal	Seal pots with a foil lid	Check that the seal is properly formed
Label	Attach label to pots	Check that correct label is used and that they are correctly positioned
Refrigerate	Hold below 4°C	Check refrigerator temperature is 1–4°C

Table 5.5 Process control points in yoghurt production

Case study 5.5 Process control

'The system in place for ensuring quality includes checking raw material sensually on receipt and before use; check mixing for consistency; checking final product; using date code (use-by date) and check weighing. We have not really found any implementation problems, but getting workers to consistently observe the product characteristic takes some time.

The supervisor is responsible for quality assurance. This includes examination of raw materials and ingredients before entering storage, examination of raw materials and ingredients and packaging before use, checking on weighing and blending/mixing processes, consistency of the final product, and for supervision of cleaning and maintenance activities.

Production and QA records include the weight of each ingredient that goes into every batch of product, the quantity of final product and date of production.'

Case study 5.6 Labelling checks

'Before I did not attach a label listing the ingredients but it now complies fully with the legal requirements.

The quality of the label is checked to ensure it is what was ordered in terms of the design, colours and information (e.g. nutrition information). We check to ensure the correct batch code and use-by date are written on the labels.'

5.7 Summary of legislation

In most ACP countries, two main types of food regulations exist, general regulations that apply to all foods and those that are specific to a particular type of food. The general regulations govern labelling, advertising, weights and measures and hygienic practice when handling foods, and these are described in Chapter 6 of *Opportunities in Food Processing, Volume 1*.

As a minimum the legislation requires that a label clearly states:

- the name and address of the producer with sufficient information for a customer to readily contact the manufacturer
- the net weight
- a list of ingredients in decreasing order of content
- a Public Health registration number in the many countries where it has to be declared
- a use-by date.

Additional information may also be required including:

- recommended storage conditions for the product
- nutritional information
- suggestions for preparation and use.

Food laws are also related to the level of risk to consumers if errors occur. The legislation for high-risk dairy foods is more stringent than for many other types of food. Special regulations govern the manufacture, labelling and sale

of dairy products that are eaten cold without cooking. Such legislation relates to the:

- microbiological quality of products
- chemical quality of products
- design and safety of the plant, including waste discharges/treatment.

These regulations govern all aspects related to the operation of a dairy and may include the necessity to obtain:

- Health Permit from the Ministry of Health or Local Authority licensing the premises to be used for food production
- Manufacturing Licence from the Local Authority or Ministry of Health
- Medical Certificates from the Health Authority to certify that workers are fit to handle food.

Dairy processors should contact the responsible ministry and request copies of national regulations related to their range of products. As the regulations tend to be written in language that is not easy to understand advice should be sought from a university or Bureau of Standards if it is necessary to clarify what the regulations mean.

Many ACP countries base their laws on *Codex Alimentarius* (CODEX) Standards (Appendix III) and a summary of specific CODEX standards for dairy products is shown below. However, processors should check the details of their own national laws with the local Bureau of Standards.

Butter

Butter should have the following percentage composition:

- minimum milk fat content = 80
- maximum water content = 16
- maximum MSNF = 2

Permitted food additives in butter are shown in Table 5.6.

The regulations also specify a maximum level for lead contamination (0.05 mg per kg) and specify that pasteurisation of cream must ensure its microbiological safety. It should be labelled to indicate whether it is salted or unsalted according to national legislation.

INS No	Name/ Colours	Maximum level
160a (i)	β -carotene (synthetic)	25 mg per kg
160a(ii)	Carotenes (natural extracts)	600 mg per kg
160b	Annatto extracts	20 mg per kg
160e	β -apo-carotenal	35 mg per kg
160f	β -apo-8'-carotenic acid, methyl or ethyl	35 mg per kg
Acidity regulators		
339	Sodium phosphates	2 g per kg
500(i)	Sodium carbonate	Limited by good manufacturing practice (GMP)
500(ii)	Sodium hydrogen carbonate	Limited by good manufacturing practice (GMP)
524	Sodium hydroxide	Limited by good manufacturing practice (GMP)
526	Calcium hydroxide	Limited by good manufacturing practice (GMP)

Table 5.6 Permitted additives in butter

Cheese

Names of cheeses, described according to their percentage moisture content (on a fat-free basis), are specified as follows:

- Extra hard = <51
- Hard = 49–56
- Firm/semi-hard = 54–69
- Soft = >67.

The use-by date need not be declared for firm, hard or extra hard cheeses, for these the date of manufacture may be used instead.

Additionally the following terms may be used to indicate the percentage of fat in the dry matter:

- High fat = >60
- Full fat = 45–60
- Medium fat = 25–45
- Partially skimmed = 10–25
- Skimmed = <10.

Permitted additives for ripened cheeses (including mould-ripened cheese) are shown in Table 5.7.

INS No	Name/ Colours	Maximum level
100	Curcumins (for edible cheese rind)	Limited by GMP
101	Riboflavins	Limited by GMP
120	Carmines (for red marble cheese only)	Limited by GMP
140	Chlorophylls (for green marble cheese only)	Limited by GMP
141	Copper chlorophylls	15 mg per kg
160a (i)	β -carotene (synthetic)	25 mg per kg
160a(ii)	Carotenes (natural extracts)	600 mg per kg
160b	Annatto extracts – normal coloured	10 mg per kg
	– orange coloured	25 mg per kg
	– deep orange coloured	50 mg per kg
160c	Paprika oleoresins	Limited by GMP
160e	β -apo-carotenal	35 mg per kg
160f	β -apo-8'-carotenic acid, methyl or ethyl	35 mg per kg
162	Beet red	Limited by GMP
171	Titanium dioxide	Limited by GMP
	Acidity regulators	Limited by GMP
170	Calcium carbonates	Limited by GMP
504	Magnesium carbonates	Limited by GMP
575	Glucono delta-lactone	Limited by GMP
Preservatives		
200	Sorbic acid	3000 mg per kg calculated as sorbic acid
201	Sodium sorbate	3000 mg per kg calculated as sorbic acid
202	Potassium sorbate	3000 mg per kg calculated as sorbic acid
203	Calcium sorbate	3000 mg per kg calculated as sorbic acid
234	Nisin	12.5 mg per kg
251	Sodium nitrate	50 mg per kg
252	Potassium nitrate	50 mg per kg
280	Propionic acid	3000 mg per kg calculated as propionic acid
281	Sodium propionate	3000 mg per kg calculated as propionic acid
282	Calcium propionate	3000 mg per kg calculated as propionic acid
For rind treatment only		
200	Sorbic acid	1 g per kg singly or in combination
202	Potassium sorbate	1 g per kg singly or in combination
203	Calcium sorbate	1 g per kg singly or in combination
235	Pimaricin	2 mg per dm ³ of surface area. Not present in a depth of 5 mm

Table 5.7 Permitted additives in cheese

Cream

The percentage wt/wt minimum milk fat content composition of different creams is defined by law as:

- Cream = 18
- Half cream = 10
- Whipping/ whipped cream = 28
- Heavy whipping/ whipped cream = 35
- Double cream = 45

Optional additions:

- Sugar = Limited by GMP
- MSNF (%) = 2
- Caseinates (%) = 0.1

No colours or preservatives are allowed in creams. Permitted additives in creams are shown in Table 5.8.

Cream should also be labelled 'Pasteurised' or 'Sterilised' where these heat treatments are used. The percentage milk fat should be declared on the label, and if milk other than cow's milk is used, this should also be declared on the label.

Ice cream

Ice cream has the following composition:

- greater than 10% milk fat by legal definition, and as high as 16% fat in some premium ice creams
- 9–12% MSNF – this component contains the proteins (caseins and whey proteins) and lactose
- 12–16% sucrose and glucose-based corn syrup sweeteners
- 0.2–0.5% stabilisers and emulsifiers
- 55–64% water from the milk or other ingredients.

Ice milk is very similar to the composition of ice cream but must contain between 3% and 5% milk fat by legal definition.

Two types of ice cream are produced which are legally defined in most countries:

Name	Maximum level
Stabilisers	
Sodium, potassium and calcium salts of :	
Hydrochloric acid	2 g per kg singly or 3 g per kg in combination
Citric acid	2 g per kg singly or 3 g per kg in combination
Carbonic acid	2 g per kg singly or 3 g per kg in combination
Phosphoric acid	2 g per kg singly or 3 g per kg in combination
Thickening agents	
Carrageenan	Maximum 5 g per kg singly or in combination
Sodium, potassium and calcium salts of alginic acid	Maximum 5 g per kg singly or in combination
Gelatine	Maximum 5 g per kg singly or in combination
Lecithins	Maximum 5 g per kg singly or in combination
Pectins	Maximum 5 g per kg singly or in combination
Sodium carboxymethylcellulose	Maximum 5 g per kg singly or in combination
Microcrystalline cellulose	Maximum 5 g per kg singly or in combination
Mono- and di-glycerides	Maximum 5 g per kg singly or in combination
Rennin	Maximum 5 g per kg singly or in combination
Agar-agar	Maximum 5 g per kg singly or in combination
Locust bean gum	Maximum 5 g per kg singly or in combination
Xanthan gum	Maximum 5 g per kg singly or in combination
Flavours	
Vanilla extracts, vanillin or ethyl vanillin	Limited by GMP

Table 5.8 Permitted additives in creams

- Ice cream containing not less than 5% fat and not less than 2.5% milk protein. Any milk protein, such as casein and whey solids may be used.
- Dairy ice cream must contain a minimum of 5% fat that is only derived from milk and must not contain any other type of fat.

It is a legal obligation to pasteurise the mixture before freezing to destroy any pathogenic bacteria. Before pasteurisation the mix must be kept cold to restrict the growth of any pathogens (for example, the mix must not be kept for more than one hour above 7°C). The pasteurisation conditions are defined by law as:

- above 65.5°C for at least 30 minutes
- above 71°C for at least 10 minutes
- above 80°C for at least 15 seconds.

Yoghurt

Yoghurt should have the following percentage wt/wt composition:

- minimum milk fat content = 3.0
- minimum MSNF = 8.2

partially skimmed yoghurt

- maximum milk fat content = <3.0
- minimum milk fat content = >0.5
- minimum MSNF = 8.2

skimmed yoghurt

- maximum milk fat content = <0.5
- minimum MSNF = 8.2.

The label on the yoghurt should reflect which type of product it is, and if milk other than cow's milk is used, this should also be declared on the label. The legislation specifies that *L. bulgaricus* and *S. thermophilus* should be used as cultures.

Permitted additives in yoghurts are shown in Table 5.9.

Name	Maximum level
Stabilisers	
Agar-agar	Maximum 5 g per kg singly or in combination
Gum Arabic	Maximum 5 g per kg singly or in combination
Carrageenan	Maximum 5 g per kg singly or in combination
Furcellaran	Maximum 5 g per kg singly or in combination
Sodium, potassium and calcium salts of :	
Guar gum	Maximum 5 g per kg singly or in combination
Locust bean gum	Maximum 5 g per kg singly or in combination
Sodium carboxymethylcellulose	Maximum 5 g per kg singly or in combination
Sodium, potassium and calcium salts of alginic acid	Maximum 5 g per kg singly or in combination
Gum Tragacanth	Maximum 5 g per kg singly or in combination
Xanthan gum	Maximum 5 g per kg singly or in combination
Gelatine	Maximum 5 g per kg singly or in combination
Pectins	Maximum 5 g per kg singly or in combination
Starches or modified starches	Maximum 5 g per kg singly or in combination
Preservatives	
Sorbic acid or sodium, potassium and calcium sorbates, sulphur dioxide and benzoic acid	50 mg per kg singly or in combination

Table 5.9 Permitted additives in yoghurts

Summary of the chapter

- ✓ It is important to analyse the risks associated with your products and put systems in place that protect consumers.
- ✓ Involve customers in shops and hotels in risk analysis.
- ✓ Identify reliable sources of milk and agree quality specifications.
- ✓ Routinely test incoming milk. Tests for milk include sensory examination, density, acidity, fat content and microbiological tests.
- ✓ Establish formal cleaning schedules because poor cleaning can result in product contamination.
- ✓ Control all stages of a process to produce uniform products.
- ✓ Carry out quality assurance checks and contract out other testing as needed.
- ✓ Integrate the cost of quality testing into the price of the product.
- ✓ Ensure that the fill weight of products is greater than the minimum weight declared on the label.
- ✓ Obtain copies of legislation related to your product range and make sure you fully understand it.
- ✓ Ensure that your products comply with the legislation – especially the fat content, levels of micro-organisms and permitted additives.
- ✓ Be aware of environmental laws and responsibilities, especially those for waste disposal.

Entrepreneur's checklist

- Do you understand where your products face the greatest risk of causing food poisoning and do you have plans to deal with the risks?

- Have you prepared cleaning plans? Do you have a quality assurance plan and do your staff know what is required of them?

- Are you aware of your responsibilities in terms of legislation concerning your products? Do you know how to analyse the risks associated with your products and put systems in place that protect consumers?

- Do you involve customers in shops and hotels in risk analysis?

- Can you identify reliable sources of milk and agree quality specifications? Do you routinely test incoming milk?

- Do you know how to control all stages of a process to produce uniform products?

- Do you carry out quality assurance checks? Have you factored the cost of quality testing into the price of the product?

- Do you know how to ensure that the fill weight of products is greater than the minimum weight declared on the label?

- Have you obtained copies of legislation related to your product range and do you fully understand it? Do you know how to ensure that your products comply with the legislation?

- Are you aware of environmental laws and responsibilities, especially those for waste disposal?

Planning and managing production

6

6.1 Roles and responsibilities within the business

Managing a dairy enterprise means having full control over what is happening in the business. It involves such aspects as planning, purchasing, production, marketing, finances and managing the staff that work in the business.

At the smallest scale of operation, where the business owner works on site and supervises a few workers, there is often little differentiation in the roles that each person has in the production process, and each worker can do all the different jobs. Owners or managers decide what workers will do throughout the day, and do all the other work (e.g. accounts, sales etc.) themselves.

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.

Tips for success

- ✓ Be honest and dependable – give people what they ask for
- ✓ Find good staff, invest in them and create a good working environment
- ✓ Be persistent with your dreams – persistence pays off in the end
- ✓ Tell workers clearly what is required of them and reward them generously for work well done
- ✓ Be considerate in dealings with employees – you will get more out of your staff
- ✓ Delegate
- ✓ Take responsibility for mistakes and correct them
- ✓ Train your staff to bring them up to standard and pay them well
- ✓ Focus on improving your business; never be satisfied with just making profits
- ✓ Keep records of everything and take time to analyse them
- ✓ Do not allow retailers to keep old stocks of products, replace them regularly
- ✓ Read Sections 4.1–4.7, 8.1–8.2, 10.1–10.5 in *Opportunities in Food Processing, Volume 1*.

Case study 6.1 A small-scale business owner

'Mr J is one of those businessmen who is involved in everything that goes on in his factory. He knows the staff, the systems and the sales. He is a man who started the business knowing exactly what he wanted to achieve, and although he has been faced with tough realities and challenges, and has had many disappointments, he is determined to win. He dares to dream and to set goals even in the midst of political uncertainty. As he speaks you see a man who did his calculations well and knows what should come out of his investment.'

Case study 6.2 Roles for staff

'The owner has the roles of sales and marketing, production and quality assurance. Although the financial records are kept by the owner, she is assisted by an accountant to do the accounting.

There are four staff: the secretary takes orders for products, the marketing person delivers products and checks on customers and products; the quality assurance person is responsible for testing, the accounting function is now contracted out by the company and all records are collected for the accountant. The production manager has responsibility for processing milk and other products.

The different roles are mostly done by the owner. He calls up customers and potential customers for orders and visits them to see the product on the shelves and get their comments on the product. He also checks incoming ingredients, materials, packaging and the finished product. He supervises the production, including weighing the ingredients and checking processing conditions. The owner also maintains the financial records and gets assistance to do his tax returns. He does an analysis of the financial records and pays attention to sales trends and production efficiency.'

Dairy owners at all scales of operation should constantly assess the strengths and weaknesses of their business in order to make positive changes to their operation and profitability.

Case study 6.3 Assessing business strengths and weaknesses

Our business strengths are:

1. The area is a good source of raw materials.
2. There is some good skilled local labour.
3. Our products are aimed up-market.
4. We offer fresh products.
5. We have been able to make cheaper equipment (especially moulds and presses) using a local Chinese carpenter.

Our main difficulties are:

1. Dependency on tourist customers.
2. Inconsistencies in the tax environment – our continuous complaints to the Revenue Authority have helped somewhat, and also lobbying through the Manufacturers Association for fairer government treatment has helped.
3. A politically uncertain environment has lost us 10% of the market and it is unpredictable, which hinders our expansion plans.
4. Bank rates are prohibitive and the bank loan policy is inconsistent.
5. Our products have a limited shelf-life.
6. We struggle with foreign products, such as imported cheeses from Europe, Kenya and South Africa.

6.2 Production planning

Planning is essential, both when a business is being set up (Chapter 2, Section 2), and also for the daily operation of the business. Good production planning makes the best use of people, materials and equipment, and also helps owners and managers to:

- think ahead about the business to prevent problems arising during operation
- avoid 'bottlenecks' in the process, or running out of an essential ingredient
- know if the business is going to make profits in the future
- get the necessary information for bank loans, suppliers' credit etc.
- predict growth of the business and what actions to take to achieve this growth.

A common failure of small-scale dairy owners is inadequate production planning, so that, for example, production ceases because there are no spare parts for a machine when it breaks down, an ingredient such as rennet is used up, or the stock of labels for the products is finished. In the authors' experience, these failures in production planning are the most important reason for a business to operate below its expected capacity. Low production rates or production stoppages mean that the fixed costs (Chapter 7) become a relatively large proportion of total costs. The business simply does not make enough products (and hence does not receive sufficient income) to make a profit or even to pay the bills. The products then become over-priced and uncompetitive. In extreme circumstances the producer reaches credit limits with suppliers, who eventually refuse to provide inputs and the business fails.

■ Remember: Failing to Plan is Planning to Fail

The following questions are examples of routine planning decisions taken in a dairy business:

- Is there enough milk available for tomorrow's production and is the quality satisfactory?
- Is the equipment ready for the expected production levels?
- Are there enough packaging materials available?
- Are trained workers going to be available, or should extra workers be hired for the week?

Case study 6.4 Production management

'Production is based on orders received from the sales and marketing section. This ensures all materials for the required amount of production are available. Quality and production are the responsibility of the same supervisor. An accountant handles all billings and follow-up, payments and bank accounts. He is responsible for transferring the information from the stock cards to the computer and checking on the balance of all supplies as reported by the computer.'

In order to make enough products to meet the expected demand, there are four factors that need to be taken into account. These are:

1. Expected sales
2. Raw materials, ingredients and packaging
3. Labour requirements
4. Machinery capacity and operation.

Each of these is discussed in more detail below.

Expected sales

A dairy manager should ensure that sales and marketing staff discuss with production staff the amounts of products required each week. There are two reasons for this: to plan production levels for the near future and to monitor long-term trends. Sales people gather orders from customers, and production staff then draw up a production plan for how much of each product to make during the next few days. The production manager can then arrange for the necessary amounts of ingredients, packaging and labour to be available to

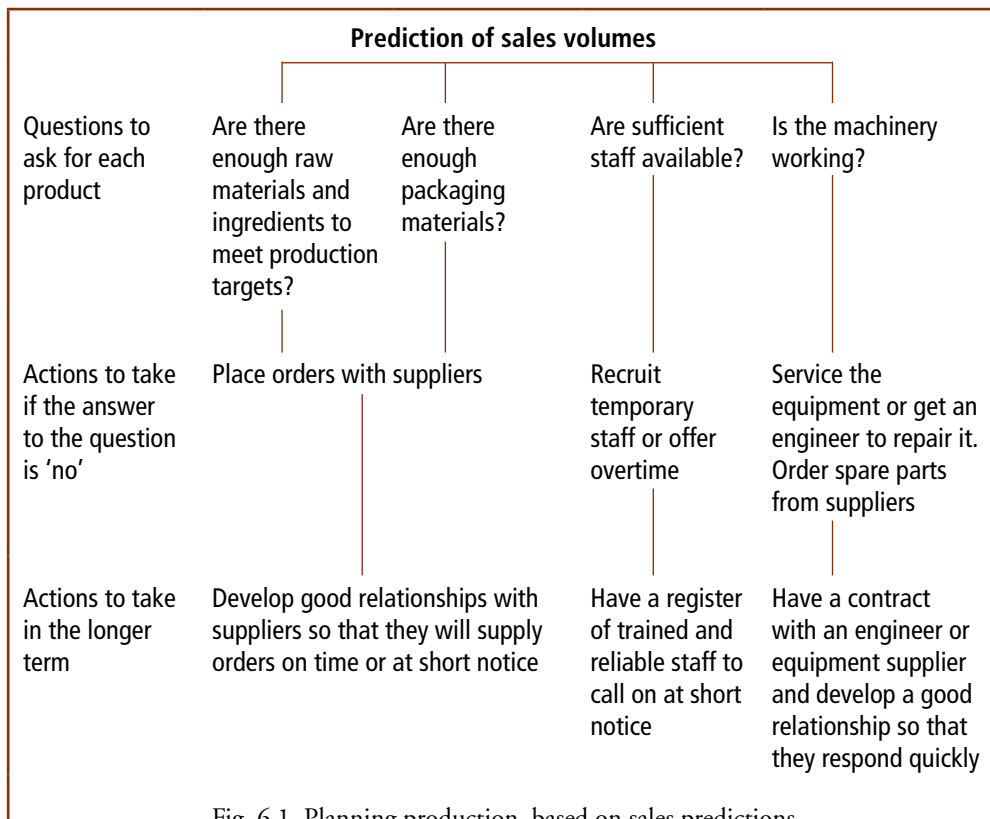


Fig. 6.1 Planning production, based on sales predictions

meet the orders (Figure 6.1). Clearly, the more notice that can be given of anticipated sales, the easier it is to plan production.

Sales staff should discuss the popularity of each product with retailers and customers, and find out whether demand is increasing or decreasing. By doing this, they can get an idea of future sales trends.

This type of information allows the owner or manager to draw up long-term plans to cope with expected changes in demand.

The first step in production planning is get up-to-date information from current sales. Among the records kept by a business, a sales book gives the amount of product sold each day. By adding the daily sales figures to form monthly totals, it is possible to produce a sales graph that shows the trends in sales for each type of product. These figures can then be used, for example, to plan for the purchase of additional equipment, training of new staff in time for the expected expansion, or development of alternative products. Figure 6.2 shows that sales of yoghurt are steadily increasing and provision for extra production capacity should be planned, whereas sales of butter are steadily declining and a future decision on whether to continue its production will be needed.

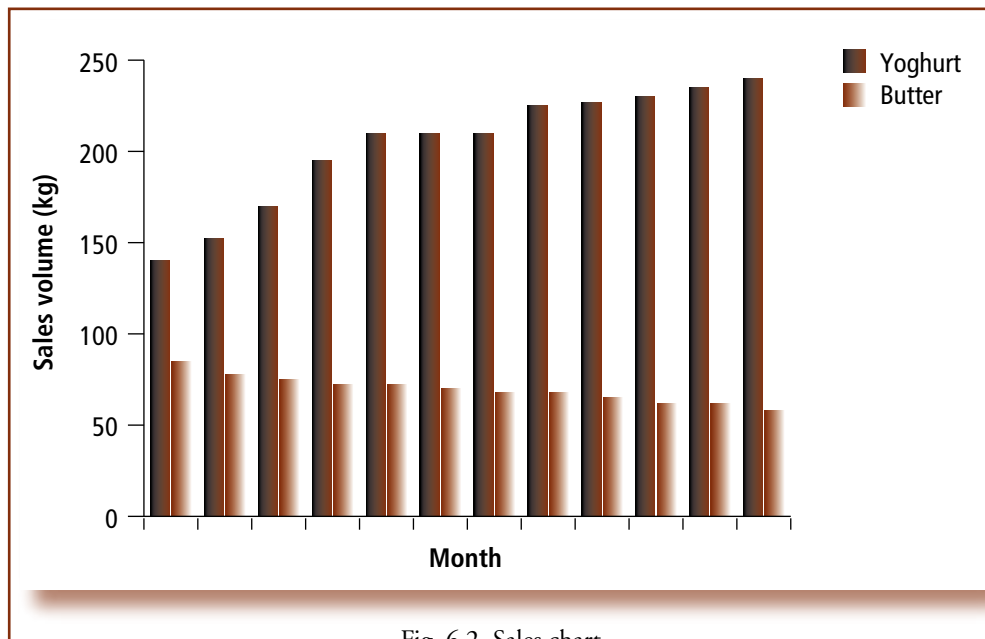


Fig. 6.2 Sales chart

Case studies 6.5 Analysing sales for production planning

'We analyse production, sales and expenses records to observe trends and to manage costs. These are used to check if operations are on track with plans and within budget.

We constantly analyse our sales and have a weekly meeting to decide our production strategy in response to the market. Our production targets are met, but marketing targets are not yet met. Our target is to produce 2 tons per month and our growth target is 20% per year.

We analyse our sales records constantly as it keeps us competitive, helps us determine production levels, see trends, decide to decrease/increase production, and gives us a breakdown of our clients. It is critical to check expenses regularly.

We analyse sales, production figures, expenses and overheads to get a sense of the state of the business.'

Planning raw materials, ingredients and packaging

In many ways production planning in a dairy business is more straightforward than some other types of food processing; the same equipment can be used for different products, there are few other ingredients, and packaging is relatively simple and usually available. However, a major constraint is the need to secure the supply of milk and this involves careful negotiations with farmers or other suppliers

Ideally, there should be strong, trusting relationships between farmers and dairy owners. The benefits of strong relationships are:

- reduced uncertainty, both in the costs to the dairy and income for farmers
- increased profitability from an assured supply of high-quality raw materials
- reduced costs arising from buying activities, better production planning and cash flow management because of guaranteed raw material supplies
- better understanding by farmers of quality requirements of dairies, and increased incomes to farmers from guaranteed sales of milk.

A key component of any agreement with farmers is the price offered by the dairy. A number of arrangements are possible to determine the prices that are paid for milk. In contract schemes, the dairy sets a fixed price and farmers have a guaranteed income, but do not benefit if the market price rises. They are more likely to renege on the agreement under these types of contract and sell their milk to the highest bidder. Also the dairy may lose out if market prices are depressed. In other contract schemes, the dairy buys a proportion of the milk at a fixed price and the remainder belongs to the farmer. This places the risk with the farmers, but also gives them the opportunity to get the full market price for some of their milk.

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.

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

1. Location of sufficient amounts of milk that has an acceptable quality
2. Maintenance of equipment to prevent breakdowns and ensure uninterrupted production
3. Proper staff training to ensure a uniformly high product quality
4. Full utilisation of staff and machinery to increase productivity and reduce costs
5. Minimising losses and wastage.

Each of these is described in more detail below.

Case study 6.6 Meeting production targets

'We have problems meeting the production targets in our plans. Both finance and poor milk production limit the attainment of targets.'

When a dairy owner has decided the amount of production needed each week to meet the expected demand, the weights of each ingredient can then be calculated using the recipe for each of the products to be made (Table 6.1). All of the other inputs needed to produce the required amount of product

Product: Ice cream
Ingredients: Butter 10%, dried milk 11%, sucrose 10%, corn syrup 5%, stabiliser 0.35%, emulsifier 0.15% and water 63.5%
Production target: 2000 packs @ 100 g each (200 kg total)

	Amount required for target production (kg)	Amount in stock (kg)	Amount to be ordered (kg)	
			For production	For stock
Butter	20.00	12	8	–
Dried milk	22.00	50	–	–
Sucrose	20.00	0	20	50
Corn syrup	10.00	50	–	–
Stabiliser	0.70	2	–	–
Emulsifier	0.30	0	0.3	5
Water	127.00	–	–	–
Total	200.00			

Table 6.1 Calculation of ingredients required for a day's ice cream production

(packaging, labels, distribution cartons etc.) can then be scheduled, and orders placed with suppliers to maintain the required stock levels.

Feedback from small-scale dairy processors revealed that milk and ingredient costs were between 20–60% of total production costs (average 40%). Because these are a significant proportion of total production costs, it is important to ensure that materials are correctly ordered and checked upon delivery, as this significantly affects the profitability of the business (details of quality assurance checks are given in Chapter 5, Section 5.1).

Similar considerations apply to ordering packaging materials, although because most dairy products do not need sophisticated packaging, this is less of a problem than in many other types of food processing. Costs of packaging vary from 10–65% (average 35%) among companies interviewed for this book. Most dairy processors that were interviewed find problems locating suitable local supplies of packaging materials (see also Chapter 3, Section 3.6). The need to order large amounts from overseas suppliers, together with the higher cost of packaging can have a substantial effect on the cash flow of a small dairy.

Planning work for staff

It is necessary to have correctly trained staff to effectively and efficiently operate the various stages in a process. An Activity Chart (Section 10.1 in *Opportunities in Food Processing, Volume 1*) can be used to plan the different jobs that each worker does during the day. It shows the type of work needed during the day, and the sequence of activities for each worker.

Case studies 6.7 Staff roles and responsibilities

'There are different roles and responsibilities within the business and there is a clear divide between the production manager and sales team. The Managing Director is in overall control and also guides and trains the marketing team.

When we want to recruit workers we sit down, develop selection criteria, and identify the points we want against each post. Then we also consider education, experience and gender – we thought we should give ladies equal chances for employment.'

There is divided opinion among small-scale dairy owners about whether it is better to employ friends and relatives or not. Although many small food businesses recruit friends, relations or neighbours to work in the business because they feel that they can be trusted, this may not get people with the best skills. Among the small businesses that were interviewed, a small majority thought it better not to employ family members, although significant numbers of businesses found that this was satisfactory.

Services

The cost of electricity, fuel and water was reported by most dairy owners to be 5–15% of their total production costs, although one owner reported a figure of 50%. Some had calculated the exact amounts and others estimated the costs, but their findings, averaging about 10%, were in very close agreement across the range of business types and sizes. The main problem is interrupted electricity supplies, which seriously affect the operation of cold stores and freezers.

6.3 Managing production

Staff

Labour (or 'Human Resource') planning involves deciding the present and future staffing needs of the enterprise. Larger companies have a more systematic approach to recruiting employees and training them, which brings substantial benefits. This is also likely to benefit small companies, but it requires the owner or manager to develop company policies and terms of employment, which in outline involve:

- preparing job descriptions and specifications
- developing a recruitment plan
- interviewing and selecting staff
- preparing employee training and development plans
- conducting training – either on-the-job or sending staff on training courses
- monitoring performance and giving additional training as required.

Depending on the particular ACP country, labour costs can be a relatively high proportion of total production costs. Dairy owners who were interviewed reported labour costs to be between 2% and 15% of their total costs, with an average of 10%. In view of these costs, together with additional costs of training, it is important to retain experienced staff.

However, many owners of small-scale businesses refuse to train staff because they think that this will either make them ask for higher pay, or they will move to a competitor to get a better job. Both attitudes are short-sighted and will eventually cause the business to fail.

As in other aspects of running a business, the owner or manager should have a wider view of where the business is heading, and what is needed to get it there. Staff development is one aspect of this and the business should be willing to invest in its employees to achieve success for both parties.

Recruiting and managing staff

Recruiting, training and retaining motivated staff with a genuine commitment to the company is a key factor to business success. De-motivated workers, on the other hand, can cause great damage by, for example:

- not carrying out their work with care

- causing deliberate sabotage
- spreading negative rumours about the enterprise and its products
- leaving, perhaps with company trade secrets, and joining a competitor.

Good staff management is less about telling staff what to do and more about building their feeling of belonging, worth and responsibility.

When hiring staff the owner of the enterprise should spend time considering the role of the worker and aspects such as:

- education and skills required
- additional training needed, either in house or external
- preparing a job description so that both parties understand their responsibilities.

Case study 6.8 Staff recruitment

‘Workers are recruited as needed. They must have completed primary school and be functionally literate to be able to keep records and follow instructions. On-the-job training is provided to new employees. Training in customer care is provided and workers are given opportunities to attend training seminars on various topics.’

Staff training

When developing training programmes it is very important to make sure that workers understand why they should behave in a certain way, or why certain jobs must be only carried out in a particular time. People need to understand the result of their actions.

There are different types of training (Table 6.2) but all should build up in a systematic way, to develop skills, knowledge and attitudes that are relevant to the job. On-the-job training involves either the new employee working immediately in his or her normal job under the supervision of more experienced workers, or it can be in different jobs to gain experience of the whole operation. This has advantages in that it results in greater flexibility to deal with absenteeism, holidays etc.

Any successful business of any size will have workers who are rewarded and willing to work for the company because they feel that they have a future with it.

Motivation is the part of staff development that encourages employees to achieve their highest level of performance. Some of the aspects that give staff job satisfaction are reasonable pay and working conditions, together with management methods to motivate them and allow them to enjoy their work. Well-motivated staff give limitless potential in their individual jobs, and hence improve the overall productivity of the enterprise. Managers should therefore devise ways of motivating staff and improving job performance.

Case study 6.9 Staff training

'We provide occasional local training programmes on food production and hygiene. Our production manager benefited from a 6-month training in cheese production in Holland, which was paid for by a development agency. We still need to generate better awareness of food quality and hygiene, and the sales team also needs better marketing insights.'

Get staff involved in decision making and planning, no matter how small the role.

On-the-job training is provided to employees. They are engaged in most aspects of the operation, but owner does not take any chances with weighing the ingredients, and does this himself.'

Staff benefits

Examples of staff benefits identified during interviews with dairy owners 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, assistance during bereavement, or with rent and other family needs
- meals provided, lunch allowance or food allowance
- sick pay and sick leave, hospital and health care benefits, paying medical bills, medical examinations or a proportion of salary held for medical support costs. In many ACP countries, staff are required to undergo a medical examination to obtain a health certificate for working with foods
- toilets and washing facilities with hot water
- transportation to work or transport allowance

- representation or attendance at staff meetings
- uniforms, aprons, head scarves and work clothes.

Even the lowest paid worker needs a sense of security, recognition and belonging.

Type of job	Training required
Production worker	<ul style="list-style-type: none"> • Accurately measure ingredients • Correct product preparation techniques • Safe operation of equipment • Machinery adjustment and maintenance skills • Operation of pot fillers or bag sealers • Monitoring product quality • Hygienic working • Examining raw materials for contamination • Ability to implement cleaning schedules to required standard • Personal hygiene • Product examination for sub-standard items
Sales staff	<ul style="list-style-type: none"> • Good knowledge of products • Skills to produce an attractive product display • Ability to collect money and give correct change for purchases • Personal appearance • Friendly manner with customers • Efficient service • Hygienic handling of products • Keeping the sales outlet clean • Telephone-answering skills

Table 6.2 Examples of training and skill development needed for dairy process workers and sales staff

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

Health and safety

Every entrepreneur has a responsibility to provide a safe and healthy working environment. Many, but not all, ACP countries have laws concerning 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.

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

Case studies 6.10 Staff benefits

'Staff benefits include a monthly package and bonus, lunch, work clothes (aprons and boots) and toilet and washroom facilities.

Staff are sent home when they are not healthy. Benefits include sickness, pension and other benefits. Workers get paid holidays, protective clothing and some get a transport allowance.

I provide benefits through the social security system – pension, sickness benefits and paid holidays. The workers are not in a labour union but are members of a credit union. This has produced benefits in that the staff have a sense of belonging and feel better about themselves.

Workers benefit from National Insurance Scheme. Benefits include sickness, pension, paid holidays, transport allowance, coat for use in processing area, warm clothing for entering the cold rooms.

I contribute to the National Insurance Scheme up to 5% of employee's earnings. This covers pension, sickness and other benefits. The employee is given paid holiday and a food allowance. The workers meet health requirements for working with food and they have not had any problems obtaining health certificates every 6 months.'

Case study 6.11 Safety measures

'Safety measures include a disinfecting wash dip for persons entering the processing plant; all electrical equipment is earthed; switches are waterproof; and there are signs to identify hot surfaces. We have comprehensive insurance covering fire, flood, earthquake (building and contents), and workers' compensation for injury sustained on the job. Loss of product is not covered. Public liability is being sought.'

It is very important that everyone in a dairy observes safety precautions to prevent accidents.

Most accidents occur due to:

- Familiarity: when a job is done often enough it tends to become boring, and this leads to carelessness (e.g. forgetting to switch off equipment before repairing it).
- Ignorance: most tasks look easy when done by an expert and accidents occur when inexperienced workers attempt difficult jobs without supervision.
- Playing around: young people in particular may not fully realise the hazards they are exposed to and playing around may cause a serious accident.

Simple safety precautions reduce the chances of accidents, and the good name of the company is enhanced. This increases 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. The manager should also prevent operators from wearing clothes or jewellery that could become entangled in moving equipment. Safety in dairies is described in Appendix II.

Production routines

Product storage and stock levels

Too much stock means that too much money is tied up and is not earning interest in the bank. Other disadvantages of keeping too much stock or not checking it regularly are that:

- if sales patterns change, the producer may be left with stock that is not useable
- if stock records are not checked it is possible to order the wrong quantities at the wrong time
- it is not possible to know if stock is missing, damaged or in poor condition or if the storage life is about to expire.

It is therefore important to do regular stocktaking and keep records of the stock to know when to re-order, what to order and how much to buy.

Case study 6.12 Stock control

'There is a packaging material stock control system done on a yearly basis. Checks include the amounts of milk and other ingredients used; record of in-coming material, finished product and deliveries of product to customers.

The stock control system uses stock cards. It records what comes in and what leaves the store. This information is entered into a computer, which gives information on the remaining stock of each ingredient.

A stock control system is in place. Records are kept of the quantities of each item entering the store, use of stock, production of product, finished product entering the store and the quantity of product delivered to customers.

Checks are made on materials and ingredients (amounts of milk and other ingredients used; record of in-coming material; finished product and deliveries of product to customers).'

Maintenance of equipment

A common reason for lost production is delays caused by equipment breakdowns and waiting for spare parts. Most small-scale producers do not keep a stock of spare parts because of the cost, but very few producers have compared the cost of a stock of spares with the cost of delayed production. For some it may be cheaper to keep a supply of spares.

In most enterprises, there are a few items of equipment that are likely to wear out more quickly than others (e.g. bearings on cream separators, heating elements etc.). The entrepreneur should therefore identify the specific parts of equipment that are likely to fail most often and ensure that spares are always kept in stock.

Machine breakdowns increase production costs and poorly maintained machines also produce substandard products and can contaminate products with metal fragments. Proper maintenance ensures that machinery operates correctly and safely and prolongs its life, thus reducing capital and operating expenditure. Most small-scale processors do not have a programme of planned maintenance, preferring instead to rely on the maxim 'if it is not broken, don't fix it'. Some engineers agree with this and regard planned maintenance as unnecessary. They believe that it is cheaper to allow equipment to break

down and then repair it. Others consider that it is cheaper to stop production on a regular basis and replace parts before they wear out. On balance, it is probable that the costs and benefits of planned maintenance depend on the speed at which repairs can be done and the value of the spares that have to be held in stock. As a minimum, managers should monitor the state of equipment and facilities that are likely to wear out. As experience of the rate of failure accumulates over the years, they should buy spare parts or send the machine for servicing at the time the next replacement is anticipated.

Improving productivity

Productivity can be improved by:

- improved efficiency, e.g. lowering operating costs, savings in idle machine time and reducing waste
- better procedures for buying materials
- improved decision making and communication
- raising performance by minimising equipment breakdowns, reducing other causes of lost time
- improved organisation, better staff morale and co-operation.

Improved process efficiency can be achieved by increasing the output of a processing plant without additional investment. To measure this an entrepreneur must calculate how much money it costs to produce one unit. If more units are produced at the same cost or within the same time frame without affecting quality, then productivity has increased. Productivity can also be improved by changing the product design or layout of the production facilities, changing raw materials suppliers or work organisation.

Improving efficiency in a process involves reducing wastage of time, materials and space, or unnecessary movement of foods, staff or equipment. Motivated staff will go a long way to increasing efficiency by reducing wastage. 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 (Chapter 3, Section 3.3). Care should also be taken when deciding on the movement of materials to increase efficiency and safety, reduce production delays, wastage, and contribute to safe working practices.

Avoiding waste

Ideally all dairy products that have a short shelf life should be sold on the day of production when they are at their freshest. This maximises income and avoids wastage, which has a serious effect on profitability. However, unsold products are still edible for a few days provided that they are stored correctly. They can be used for a variety of other purposes to generate an income and avoid wastage. Although it is possible to sell older products directly from the dairy, this is not advisable for a processor who wishes to maintain a reputation for only selling highest-quality products. Instead the owner should negotiate in advance with caterers, government institutions or cheaper retail outlets to purchase older products at short notice at a reduced price.

6.4 Contracts and agreements with customers

Having a formal contract with customers can be very useful to both parties. Such a contract might contain agreements on: the quantity and frequency of orders quality, price and any discounts available or terms of payment dealing with complaints or returns.

Formal agreements will allow better planning of production and provide a greater security on monthly sales. The shop or hotel, on the other hand, can feel sure that goods will always be in stock at the required level. The agreement should be clear and simple and legalistic language should be avoided as it may appear threatening. A specimen agreement is shown in Figure 6.3.

6.5 The use of records

Records are kept for a purpose, to be used and to assist in the legal, efficient and profitable running of an enterprise.

The planning and development of a useful record system is part of the planning process. Financial and production records are discussed in greater detail in Section 8.2 of *Opportunities in Food Processing, Volume 1*. Two types of records exist:

- Mandatory records that must be kept to comply with local legislation. These may include audited accounts, VAT returns, health screening reports for workers and pay-as-you-earn tax returns of staff.

Supply agreement between:

Happy Milk Products, PO Box 233, St Lucia

and

Sunset Hotel, PO Box 266, St Lucia

Happy Milk Products Ltd agrees to supply 25 litres of pasteurised milk @ US\$0.5 per litre,
0.5 kg of butter @ US\$1.75 per kg and 10 litres of yoghurt @ US\$0.63 per litre on Monday and Thursday of each week. The goods will be delivered in a refrigerated van. The product will be clearly coded with a batch number and use-by date.

Happy Milk Products Ltd will also check the temperatures in the hotel refrigerator on each visit. In the case of any complaints the company sales officer will visit the hotel and, if the complaint is justified, replace the goods.

Sunset Hotel agrees

To effect payment within 15 days

To purchase the goods listed above until this agreement is cancelled, having provided 1 month's notice.

Signed and dated.....

Signed and dated.....

Happy Milk Products Ltd

Sunset Hotel

Fig. 6.3 Example of a supply contract

- Internal records, which include material purchases, sales, quality assurance, cleaning schedules and maintenance records. These are used to manage the business.

The design of a basic record-keeping system should be part of the production planning process and include:

- records that must be kept for legal reasons
- records that will be useful to the enterprise and how they will be used
- the name of the person responsible for keeping records
- indication of the need for an external book keeper.

Case study 6.13 Successful business partnerships

'A few months ago, the owner entered into a business arrangement with an ice cream manufacturer. The owner will continue to make yoghurt with his own brand name but it will be marketed by the ice cream company, which has a larger network, refrigerated trucks to deliver the product, and sales persons who travel around the country selling the products. The ice cream company has also provided refrigerated cabinets to small shops, to be used only for the company's products. So the yoghurt will benefit from the larger network and better facilities. The ice cream company is better resourced and it will now import all raw materials, ingredients and packaging that is needed for producing yoghurt, and it will transport and store these at its storage facilities. The cost of these materials will be deducted from the value of yoghurt delivered to the company. In this arrangement the owner is still the manager of his company, but decisions about the business operation and development are made jointly with the ice cream maker. They are jointly developing a business and marketing plan for the yoghurt business, and have agreed to expand into new products including frozen icicles, yoghurts aimed at adults and children, and cheesecake. The cheesecake will be sold through supermarkets, fast food outlets and will be offered to the flight kitchen for inclusion in airline meals. The arrangement frees the owner to concentrate on production of his products, since the other areas of operation (procurement, transport and storage of materials, advertising and promotion, getting information on new sources of materials etc.) are handled by the associate as part of his own ice cream operations. Already the new arrangement has been fruitful and a new packaging supplier has been found, whose prices are significantly cheaper, and a more attractive and colourful label has been designed for the yoghurt at the same time that this exercise was done for the ice cream. The Associate now analyses the finances and has shown areas in which the yoghurt production could be more efficient, which product is the fastest seller and how production could be better scheduled for the different flavours. In addition, there have been promotions at various supermarkets and the price has been reduced. The marketing plan has projected sales of 8,000–9,000 4-oz containers of yoghurt per week'.

Summary of the chapter

- ✓ Carefully plan production to ensure adequate supplies of raw materials and packaging are available, that there are sufficient numbers of trained staff available, and all machinery is serviced and in working order.
- ✓ Use sales information to plan daily and weekly production as well as using it to inform long-term plans about changes in production levels
- ✓ Consider making formal agreements with both suppliers and buyers to assist production planning
- ✓ Carefully plan work for all staff to maximise their productivity
- ✓ Think carefully before employing friends and relatives
- ✓ Be active and innovative in managing the business
- ✓ Train staff so that they can work to a high standard without supervision
- ✓ Motivate and reward staff to gain their loyalty and reduce their chance of leaving
- ✓ Ensure that the factory is safe and does not damage workers' health
- ✓ Develop ways of improving the productivity of both staff and machines.

Entrepreneur's checklist

- Do you know how to properly plan your production to meet demand for each product by securing raw material/ingredient and packaging material supplies?

- Have you sufficient numbers of trained staff?

- Have you ensured that all equipment works properly?

- Have you taken steps to improve the productivity of your staff and equipment?

- Are you regularly on site to manage the factory? If not, do you have a trusted manager?

- Have you recently reviewed the benefits that you offer your staff?

- Have you made sure that all operations in the factory are safe?

7.1 Start-up costs

One of the first problems that face a small-scale dairy entrepreneur is getting enough money to start the business. Although it is possible to start at home if necessary using domestic-scale equipment, it is preferable to start with a separate facility (Chapter 3, Section 3.1). However, all types of business incur other start-up costs including:

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

The initial financing of a dairy business should therefore be based on a detailed feasibility study (Chapter 2, Section 2.4) that takes all costs into account. It is likely that funds will be required at different stages (Table 7.1) and this should be planned for when arranging a loan or discussing the business proposal with potential investors.

Many small-scale dairy processors do not wish to deal with banks because of the generally high interest rates in ACP

Tips for success

- ✓ Carefully consider your capital investment, the larger it is the more risky
- ✓ At start of the business do not overload yourself with unnecessary debt
- ✓ Keep credit at a low level
- ✓ Be in the good books of your bankers and be open to them, don't tell them half-truths
- ✓ Keep costs as low as possible but do not compromise the quality of the final product
- ✓ Don't go in for any loans unless you have another source of income to sustain you
- ✓ Don't try to undercut others by offering lower prices, this is very dangerous
- ✓ Make weekly deposits for utilities so that bills don't overwhelm you when they come in
- ✓ Pay your taxes
- ✓ Cost your products. Make sure that all products are profitable
- ✓ Bookkeeping should be done every day
- ✓ Read Sections 7.1–7.5 and 8.1–8.2 in *Opportunities in Food Processing, Volume 1*.

countries, but some positive experiences were reported by businesses during research for this book (Case study 7.2).

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

Table 7.1 Phases that require funding in a new business

Case study 7.1 Getting finance

‘The business was financed through his own funds, a bank loan and the equipment supplier. Repayment arrangements are monthly repayments to the bank as per loan agreement and repayment to the supplier of loan and interest.’

Case study 7.2 Dealing with banks

‘She has been very well assisted by her bank. On one occasion last year, there was a lengthy power stoppage, which resulted in the loss of a large stock of ice cream and popsicles. Part of this was for a wedding and for a hotel that was full of guests. She was insured for such events but the insurance would have to carry out investigations and the payment for the loss would take some time. The bank stepped in and provided the funds in the interim. It was paid back when the insurance paid for the loss.’

7.2 Production costs

Fixed costs (or 'overheads') including office costs, interest on loans, depreciation etc. are similar for all types of business.

Type of expenditure	Average (%) of total production costs
Labour	10
Raw materials/ingredients	40
Packaging	35
Services	10
Other (e.g.maintenance/ depreciation)	5

Table 7.2 Production costs in dairy businesses

7.3 Managing finances

Once a dairy becomes operational, its continued success depends on achieving a sufficient profit after all bills have been paid. There are three aspects to managing profitability:

1. Maintaining (or preferably increasing) income from sales
2. Controlling (or preferably reducing) costs
3. Maintaining a positive cash flow.

To achieve these it is necessary to have other aspects of the business operating successfully, such as marketing and sales (Chapter 2) and production planning (Chapter 6). Correct financial management involves:

- correctly setting product prices
- controlling costs
- managing cash flow
- book-keeping.

Pricing products

The simplest way to work out the price for a product is to calculate the production costs and add a percentage for profit. When a variety of products are produced, accurate costing enables the owner to find out which products

are most profitable and would benefit the business by expanding their production. Costing can also show which of the products is most expensive to produce and therefore identify where to cut costs. This method of calculating the cost of a product (based on production costs) is straightforward and suitable for most dairies. The profit margin that is added to the production costs is determined by the amount of competition, any government price controls and the demand for the product.

For some dairy products, there may be fewer competitors and hence a wider range of prices can be charged. In this situation, the processor should decide the price that the market will bear, based on among other factors, the quality of the products. Unique or unusual products are able to attract higher prices, provided that there are affluent people willing to buy the products and they have a consistently high quality. This is one of the benefits of product diversification and development (Chapter 4).

Controlling costs

The main costs in dairy processing are the milk, labour and power charges. Of these the milk costs are the most important and these can be controlled in a number of ways:

- making purchases directly from farmers rather than traders, preferably using a company-owned vehicle
- fixed prices for milk using contracts with farmers
- support or price incentives for farmers to supply high-quality milk with minimal contamination to reduce processing costs and wastage at the dairy.

Many dairy processing enterprises use a lot of energy for refrigeration. This energy must be used efficiently to minimise costs. Routinely checking temperatures, rules about leaving doors open and a general awareness about electricity use can help control costs. Details of the required quality of milk are given in Chapter 5 and about contract farming in Chapter 6. The effect on profitability of price variation in raw materials is shown in Table 7.3.

The profitability of a dairy also depends on the productivity of the workers and equipment. Wages and depreciation on machinery are fixed costs, and these cannot be covered by sales income if a dairy operates at a small percentage of its capacity. Proper production planning to maximise output for

a given number of workers and preventative maintenance to reduce machine downtime (Chapter 6, Section 6.2) can each reduce production costs. The effect of operating below planned capacity on the profitability of a dairy is shown in Table 7.3.

Cost (US\$)	Effect of milk price variation		Effect of plant utilisation	
	Dry season	Rainy season	Operating at 80% capacity	Operating at 50% capacity
Total fixed costs ¹	6,500	6,500	6,500	6,500
Variable costs				
Milk	11,000	9,000	8,800	6,500
Power	12,800	12,800	10,240	6,400
Total	30,300	28,300	25,540	19,400
Income	32,600	32,600	26,080	16,300
Profit	2,300	4,300	540	
Loss				3,100

¹ Rent, labour, utilities, taxes, maintenance etc.

Table 7.3 Effects on profitability of buying milk in wet and dry seasons or operating a dairy below capacity

The main methods of cost control include:

- Planning the work of production staff to ensure that they are fully occupied throughout the day, and training them to maximise their output and productivity.
- Creating or modifying recipes to reduce the amounts of expensive ingredients while maintaining the required quality.
- Reducing stocks of expensive ingredients or materials that are likely to deteriorate quickly and result in wastage.

Managing cash flow

Understanding how cash flows in and out of the business during a specified period (e.g. a month or a quarter) enables a dairy owner to ensure that there is always sufficient money to keep the business operating (i.e. maintain a positive cash flow). Cash flow can be managed by keeping control over the number of debtors and the amount of money that they owe a business, and arranging with suppliers to have a larger credit limit or a longer period before payment.

Case study 7.3 Getting paid and credit facilities

'To ensure payment by retailers/wholesalers, we send an invoice at the month end and follow it up with phone calls. Most customers pay by the 18th of the month. The others make a part-payment and leave the remainder lingering. We cut off delivering more products to those customers who do not pay. This is more effective with institutions like the hospital.

Know how the businesses you deal with actually work. We used to get payment problems from a hotel that always made the excuse that 'the cheque had not been prepared yet' or that 'the person to write it was not available'. On making inquiries, we discovered that there is a particular day when cheques are prepared, and so we now go on that day to ensure payment, even if it means we have to sit there for a while. It has worked every time since!

Business is conducted on cash basis for small shops and retailers, wholesalers are offered a 30-day credit and schools are offered a 7-day credit.

We developed a tiered system to ensure payment by retailers. The larger the order, the better the price. We blacklist retailers who do not pay and stop supplying until they pay cash. There is 2.5% interest on invoices outstanding after 30 days and no more credit sales for defaulters. We put pressure on them, call them regularly and then contact our lawyer after 90 days. We also levy a fee on cheques for small amounts.

We ensure payment by retailers by harassment, but being nice about it! Our experience is that if you do not constantly follow up for payment you will be overlooked. Depending on the customer, the terms are 7-, 14- or 30-day credits.'

Book-keeping

Accurate record keeping is necessary to successfully price a product and to keep control over production costs and cash flow. To calculate the profitability of the business, a dairy owner 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.). This is recorded using a Balance Sheet.

Common financial mistakes

Some of the areas where dairy owners tend to go wrong are:

- treating profits as their income, instead of paying themselves a salary (the profits belong to the business and should be used to develop it)
- incorrect costing and pricing of products so that 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 debts or creditors.

In too many cases businesses fail because the owners consider the profit to be theirs: perhaps to use for school fees, a new house etc.

■ The owner should take a set salary and any profit belongs to the business.

It should be used to develop the business by funding advertising or promotion, developing new products or increasing the skills of workers. While it is reasonable for the owners to increase their salaries if the business is doing well, this should be a carefully considered decision.

Case study 7.4 Taxes

'The taxes we have to pay include VAT, Income Tax, Trading Licence, Withholding Tax and PAYE.

A number of taxes are paid, including consumption tax on product (15%), an environmental levy, import duties and income tax. The consumption tax was imposed some time ago and was a hardship, but it has been eased by what is called a 'business retooling allowance' given each year and based on the cost of the finished product.

We pay company tax, consumption tax, environment levy and import duties (we get some waivers on import tax).

The business benefits from a 7-year waiver of import duties.'

Summary of the chapter

- ✓ Assess start-up costs and ensure that adequate finance is available before you start the business.
- ✓ Do not rely solely on loans, have your own money too.
- ✓ Assess all production costs (fixed and variable) and use them when calculating prices for your products.
- ✓ Manage your finances to ensure that you always have a positive cash flow.
- ✓ 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.
- ✓ Use every effort to get prompt payment from customers.
- ✓ Pay your taxes.

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 by backers?
.....
- If your business is operating, do you know all of your production costs?
.....
- Do you record and use financial information to plan your next steps to develop your business?
.....
- Have you examined ways to reduce costs?
.....
- Are the prices for your products competitive and 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?
.....

Appendix I

Understanding the products and processes – the science of milk processing

It is important that dairy processors have a basic understanding of the scientific principles that allow safe production of their products. Errors in processing and handling will not simply result in visible spoilage, but have the potential to cause consumers severe illness or even death. A proper understanding of the technical principles of the process assists the processor to plan and control production and distribution in a safe way.

Composition and properties of milk

The approximate composition of milk is:

- 87% water
- 4% milk fat
- 9% milk solids-not-fat (MSNF)
- 3% protein (three quarters of which is casein)
- 4% lactose
- 0.65% minerals
- 0.18% acids
- Vitamins (e.g. A, C, D, thiamine, riboflavin).
- Enzymes (e.g. peroxidase, catalase, phosphatase, lipase)

The composition is affected by many factors such as cattle breed variations, feed and seasonal and geographic variations.

Gel and curd formation

Most of the casein proteins exist in colloidal particles known as 'casein micelles'. When an acid is added to milk, or is produced by lactic acid bacteria, the casein micelles disintegrate at pH 4.6 and casein precipitates to form the characteristic gel of yoghurt. Heating to the boiling point of milk causes casein micelles to irreversibly clump together (aggregate) and form a curd.

Whey proteins (e.g. β -lactoglobulin, α -lactalbumin, serum albumin and immunoglobulins) are more water-soluble than casein and are denatured by heat, which increases their water-holding capacity. They also have good gelling and whipping properties.

Lactose

This is a sugar that is present at 4.8–5.2% in milk, or 52% of the MSNF and 70% of whey solids. It is not as sweet as sucrose and is relatively insoluble. Crystallisation of lactose results in the defect known as ‘sandiness’, which can cause problems in ice cream manufacture. Lactic acid bacteria produce lactic acid from lactose, which is the basis of many fermented dairy products. Some people who lack the enzyme needed to digest lactose suffer from ‘lactose intolerance’ and therefore cannot digest dairy products that contain lactose (milk, butter, buttermilk etc.) although they can digest yoghurt because the lactose it contains is largely removed by fermentation.

Enzymes

There are many enzymes in milk, including lipases (which break down fat) and alkaline phosphatase. This enzyme is denatured under similar heating conditions to those needed for adequate pasteurisation of milk.

Properties

The pH of milk at 25°C is 6.5–6.7 and its freezing point is approximately -0.5°C . The density of milk varies from 1.027–1.033 kg per litre at 20°C. Table A1 shows the density of dairy products that have different compositions of fat and MSNF.

Product	Product composition		Density (kg per l) at:			
	Fat (%)	MSNF (%)	4.4°C	10°C	20°C	38.9°C
Milk	4.00	8.95	1.035	1.033	1.030	1.023
Homogenised milk	3.60	8.60	1.033	1.032	1.029	1.022
Skimmed milk	0.02	8.90	1.036	1.035	1.033	1.026
Light cream	20.00	7.20	1.021	1.018	1.012	1.000
Heavy cream	36.60	5.55	1.008	1.005	0.994	0.978

Source: Bonfoh, 2005.

Table A1 Density and composition of milk products

Structure of milk and changes during processing

Milk can be described as:

1. An oil-in-water (O/W) emulsion with the fat globules dispersed in the continuous liquid phase.
2. A colloidal suspension of casein micelles and whey proteins.
3. A solution of lactose, soluble proteins, minerals, vitamins and other components.

Whipping and churning cream

When air is beaten into milk products it creates a foam. The foaming agents are proteins, but milk fat tends to spread over the air–water interface and destabilise the foam. When heavy cream is whipped, it becomes stiff due to changes to the milk fat structure. The fat droplets coalesce and surround air bubbles that are introduced by the whipping action. The structure of whipped cream is similar to the fat and air structure of ice cream. As the fat partially coalesces, it causes one fat-stabilised air bubble to be linked to the next, so that a network of air bubbles and fat globules form, trapping the liquid and producing a stable foam. This gives whipped cream its structure and firmness. The whipped cream becomes stiff and appears dry, with a smooth texture. Crystalline fat is essential and so the temperature for whipping cream is very important. Low temperatures cause the fat globules to partially coalesce into a 3-dimensional structure. At higher temperatures, they fully coalesce into larger globules that are not able to link together. If whipped cream is beaten too much, the fat clumps increase in size until they are too large and too few to enclose the air bubbles. Then the bubbles coalesce, the foam begins to leak the fat forms butter granules and buttermilk.

Butter making

In butter making, the process is designed to churn cream at a low temperature so that the solid fat globules clump together to form butter granules. Before churning, cream is cooled to control the crystallisation of milk fat and produce butter that has the correct consistency. At higher temperatures the milk fat softens and result in a soft, greasy butter, whereas butter from cooled milk fat will be hard and stiff.

If cooling is rapid, a large number of small fat crystals are formed, whereas slow cooling produces fewer, larger crystals. The crystals bind the liquid fat to

their surface, and because the total surface area is greater if there are a large number of small crystals, more liquid fat is adsorbed than if the crystals are larger and fewer. The more fat that crystallises, the less liquid fat globules are lost during churning and working, and hence the yield of butter is higher.

The method to achieve this is as follows:

1. Rapidly cool the cream to 8°C and store it for 2 hours. This causes the formation of a large number of small crystals that bind liquid fat to their surfaces.
2. Gently heat the cream to 20–21°C for at least 2 hours (water at 27–29°C is used for heating). Most of the crystals melt, leaving only the hard fat crystals, which grow larger.
3. Cool to 16°C. The high-melting fat collects in large crystals with little adsorption of the low-melting liquid fat.

Ice cream

Proteins act as emulsifiers and give stability to the fat emulsion. When the mix is agitated during freezing, the fat emulsion partially breaks down and the fat globules begin to flocculate, which improves the texture. Emulsifiers assist the fat globules to coalesce and stabilise the air bubbles to give a smooth texture. Commercial ice creams usually have a soft texture due in part to faster freezing, which produces smaller ice crystals. As a result, less heat is needed to melt the ice cream and it does not therefore feel excessively cold when eaten. Slow freezing creates larger ice crystals that give the product a gritty texture. Thus the structure of ice cream is a partially frozen foam with ice crystals and air bubbles occupying most of the space. The fat globules surround the air bubbles and also form a dispersed phase (see glossary in Appendix V).

During freezing of ice cream, the fat emulsion which exists in the mix will partially destabilise as a result of the air incorporation, ice crystallization and shearing forces of the mixer blades. This partial churning is necessary to set up the structure and texture in ice cream, which is very similar to the structure in whipped cream. The smaller the ice crystals in ice cream, the less detectable they are by the tongue. When ice cream is warmed (e.g. by opening a freezer door) some of the ice partially melts and then refreezes as the temperature is lowered. This causes the ice crystals to grow and the ice cream to taste icier. Stabilisers help to prevent this. Each of the stabilisers has different characteristics and two or more may be used in combination to improve their

overall performance. The traditional ice cream emulsifier was egg yolk, but now mono- and di-glycerides and Polysorbate 80 are used in most ice cream formulations.

Microbiology

Spoilage

A basic understanding of milk microbiology is important to enable processors to make safe products that have the required shelf life. Because milk is a low-acid food, bacteria are able to grow in it and to contaminate any products that are made from it. Different types of bacteria can cause food poisoning or they can change the flavour, texture or colour of dairy products, to spoil them and make them unacceptable for sale. To prevent this, processors must pay strict attention to hygiene and sanitation rules (Appendix II) throughout the process, from milking the animal to final sale of products.

In healthy animals the milk inside the udder is relatively free of micro-organisms, but if the animal is suffering from diseases such as mastitis, the bacteria that cause the disease pass into the milk and contaminate it before it leaves the udder. The surface of the udder is heavily contaminated with bacteria from mud, dung or hair. It is therefore important that dairy farmers are properly trained to ensure that udders are washed with clean water before milking. This is not always easy with some breeds of cattle that are less docile and resist having their udders washed. When animals on small farms are milked in the field there is often no source of clean water and the generally unhygienic conditions can easily contaminate the milk. In milking parlours, insects and dust can transfer bacteria to the milk. Other sources of infection include utensils and equipment or workers in the processing unit. Animal health and herd management are beyond the scope of this book, but details are given in references in Appendix III. Dairy processors should ideally buy their milk from farmers who have a dedicated milking area that is cleaned daily. Farmers should also be trained to wash their hands using clean water before milking animals, because any bacteria on their hands can contaminate the milk. They should also inspect animals each day to prevent bacteria from an infected animal being passed by their hands to healthy animals. All utensils, such as buckets, milk churns, separators, filters etc. should be thoroughly cleaned and disinfected after each use. Cloths should be boiled each day and

properly dried by hanging them on a line and not on the ground or other surfaces.

The types of micro-organisms that are present in milk can be used to assess the conditions under which it was produced and handled before it reaches the dairy processor. Coliforms are 'indicator' micro-organisms because they are closely associated with the presence of pathogens but not necessarily pathogenic themselves. They can cause spoilage of milk because they are able to ferment lactose and break down milk proteins. They are killed by the temperatures/times used for pasteurisation and their presence after pasteurisation therefore indicates either inadequate pasteurisation or re-contamination of the milk.

The micro-organisms that spoil milk are mostly psychrotrophic (cold-loving). Most are destroyed by pasteurisation temperatures, but some (e.g. *Pseudomonas fluorescens*, *Pseudomonas fragi*) can produce enzymes that are stable to heat and cause spoilage of milk products. Others (e.g. *Bacillus*, *Clostridium*, *Cornebacterium*, *Arthrobacter*, *Lactobacillus*, *Microbacterium*, *Micrococcus* and *Streptococcus* species) can cause spoilage because they survive pasteurisation and grow at refrigeration temperatures.

Viruses can contaminate milk, and in cheese-making they destroy lactic acid bacteria and prevent normal ripening. They are inactivated by heat treatments of 30 minutes at 63°–88°C, or by the use of chemical disinfectants.

Pathogens in milk

Illnesses such as tuberculosis, brucellosis and typhoid fever can result from drinking raw milk, or from eating dairy products made from milk that was either not properly pasteurised or contaminated after processing. The following pathogens are found in raw milk and dairy products: *Bacillus cereus*, *Listeria* sp., *Salmonella* sp., *Escherichia coli* O157:H7 and *Campylobacter* sp. Some moulds can also grow in milk and produce mycotoxins, which can be a health hazard.

Lactic acid bacteria

This group of bacteria are able to ferment lactose to lactic acid. They are normally present in milk and are also used as starter cultures in the production

of cultured dairy products such as yoghurt. The names of many lactic acid bacteria have been reclassified and the older names appear in brackets below.

Lactococci

Lactococcus lactis subsp. *cremoris* (*Streptococcus cremoris*)

L. delbrueckii subsp. *lactis* (*Streptococcus lactis*)

Lactobacilli

Lactobacillus casei

L. delbrueckii subsp. *lactis* (*L. lactis*)

L. delbrueckii subsp. *bulgaricus* (*L. bulgaricus*)

Leuconostoc sp.

Appendix II

Basic rules for hygiene, sanitation and safety in dairy processing

Facilities required in the processing room

- A changing room where clothing and shoes that are not worn for work can be stored
- Separate hand-washing facilities for staff, with soap, clean water, nail brushes and clean towels. These should not be used for processing
- Toilets, which should be separated from the processing room by two doors or located in a nearby building
- First aid materials
- Protective aprons or coats washed regularly, hats/hairnets, and if necessary, gloves and shoes/boots
- Cleaning chemicals, stored away from the processing room.

Hygiene and sanitation

- Clean the processing room, toilets and washing facilities, and storerooms every day
- Use the correct chemicals to clean equipment, make sure there are no food residues and rinse the equipment with clean water
- Make sure all cleaning cloths are washed and boiled each day. Do not hang them on equipment, products or window ledges to dry
- Do not leave dirty equipment until the end of the day before cleaning it
- Keep the area around the processing room clean and tidy, keep grass cut short
- Put all wastes into bins that are not used for anything else. Empty the bins periodically during the day away from the processing site
- Prevent all animals from entering the processing area or storerooms
- Visitors should only enter the processing room wearing protective clothing and under supervision
- Wear clothing or jewellery that cannot get caught in machinery

- Wear a hat/hairnet that completely covers the hair. Do not comb your hair in a processing room or storeroom
- Cover all cuts, burns, sores and abrasions with a clean, waterproof dressing
- Do not smoke or eat chewing gum in any room where there is open food because bacteria can be transferred from the mouth to the food
- Do not spit in a processing room or storeroom
- Wash hands and wrists thoroughly with soap after using the toilet, eating, smoking, coughing, blowing your nose, combing your hair, handling waste food, rubbish or cleaning chemicals. Dry them on a clean towel before handling food again
- Keep fingernails cut short
- Do not wear perfume or nail varnish as these can contaminate products
- Do not handle any food if you have sores, boils, septic spots, a bad cold, sore throat or a stomach upset. Report any of these to the manager and do alternative work
- Do not cough or sneeze over food
- Keep food covered wherever possible
- Keep all food, tools and equipment off the floor
- Keep ingredients in sealed containers
- Do not use broken or dirty equipment
- Report any signs of insects, rodents or birds to the manager.

Appendix III

Bibliography and further reading

References used in the text

Aguhob, S. and Axtell, B.L.A., 1996. *Dairy Processing – Food Cycle Technology Sourcebook*. IT Publications, London, UK.

Bonfoh, B., 2005. Institut du Sahel, Bamako, Mali. Personal communication.

Fellows, P.J. (ed.), 1997. *Traditional Foods, Processing and Preservation of Traditional Foods in Asia, Africa and Latin America*. IT Publications, London, UK.

Fellows, P.J., 2000. *Food Processing Technology*. 2nd Edition. Woodhead Publishing Ltd, Cambridge, UK.

Goff, D., 1995. *Dairy Science and Technology Education*. University of Guelph, Canada, available at: www.foodsci.uoguelph.ca/dairyedu/home.html

Hill, A.R., 1995. Chemical species in cheese and their origin in milk components. In: *Chemistry of Structure Function Relationships in Cheese* (Malin, E.L. and Tunick, M.H. eds). Plenum Press, New York, USA.

Sprenger, R.A., 2002. *The Food Hygiene Handbook*. Highfield Publications, Doncaster, UK.

Useful further reading on food science and technology, processing, quality assurance, marketing and management is provided in the bibliography in *Opportunities in Food Processing, Volume 1*.

Processing

Andreasen, T.G. and Nielsen, H., 1992. Ice cream and aerated desserts. Pages 197–220 In: *Technology of Dairy Products* (Early, R. ed.). Blackie, London, UK.

Anon., 1992. *Applications of Biotechnology to Traditional Fermented Foods*. National Academic Press, Washington DC, USA.

Anon., undated, *Dairy Handbook*. Alfa-Laval, Food Engineering, Lund, Sweden.

Battistotti, B., Bottazzi, V., Piccinardi, A. and Volpato, G., 1983. *Cheese: A Guide to the World of Cheese and Cheese Making*. Facts on File Publications, New York, USA.

- Berger, W., Klostermeyer, H., Merkenich, K. and Uhlmann, G., 1989. *Processed Cheese Manufacture, a JOHA Guide*. BK Ladenburg, Ladenburg, Germany.
- Brochu, E., Julien, J-P. and Dumais, R., 1985. *Dairy Science and Technology: Principles and Applications*. Les Presses de l'Université Laval, Quebec, Canada.
- Carroll, R. and Carroll, R., 1982. *Cheese Making Made Easy*. Storey Communications Inc., Ponnal, USA.
- Davis, J.G., 1965. *Cheese*. American Elsevier Publications Co., New York, USA.
- Fagard, P., 1980. *Guideline for Dairy Accounting*. FAO Animal Production and Health Paper No. 21. Food and Agriculture Organization of the United Nations, Rome, Italy.
- Fellows, P. and Axtell, B., 2003. *Appropriate Food Packaging*. 2nd edition. IT Publications, London, UK.
- Kosikowski, F.V. and Mistry, V.V., 1997. *Cheese and Fermented Milk Foods*. 3rd Edition. F.V. Kosikowski and Associates, Brooktondale, New York, USA.
- Lambert, J.C., 1988. *Village Milk Processing*. FAO Animal Production and Health Paper, No. 69. Food and Agriculture Organization of the United Nations, Rome, Italy.
- Law, B., 1999. *Technology of Cheese Making*. Sheffield Academic Press, Sheffield, UK.
- Masui, K. and Yamada, T., 1966. *French Cheeses: The Visual Guide to More Than 350 Cheeses from Every Region of France*. DK Publishing, New York, USA.
- Obi-Boatang, P. and Axtell, B., 1995. *Packaging, Food Cycle Technology Sourcebook*. IT Publications, London, UK.
- Rothwell, J., 1999. *Ice Cream Making, a Practical Booklet*. Ice Cream Alliance, Nottingham, UK.
- Roy, S.K. and Pal, R.L., 1994. Cooling without power. In: *Food Chain 12: 4-5 Practical Action*, Bourton-on-Dunsmore, UK.
- Scott, R., Robinson, R.K. and Wilbey, R.A., 1998. *Cheese Making Practice*. 3rd Edition. Applied Science Publications Ltd., London, UK.
- Tuszynski, W.B., 1978. *Packaging, Storage and Distribution of Processed Milk*. FAO Animal Production and Health Paper, No. 11. Food and Agriculture Organization of the United Nations, Rome, Italy
- Walstra, P., Geurts, T.J., Noomen, A., Jellema, A. and van Boekel, M.A., 1998. *Dairy Technology*. Marcel Dekker Inc. New York, USA.

Quality assurance and science

- Anon., 1992. *World Directory of Standardisation and Quality Assurance Related Institutions, Export Quality*. ITC/UNCTAD/GATT, Geneva, Switzerland.
- Bryan, F.I., 1992. *Hazard Analysis: Critical Control Point Evaluations*. World Health Organization, Geneva, Switzerland.
- Caplen, R.H., 1982. *A Practical Approach to Quality Control*. Hutchinson Publishing Group, London, UK.
- Cunniff, P. (ed.), 1999. *Official Methods of Analysis of AOAC*. 16th Edition, 5th Revision. International Association of Official Agricultural Chemists International, Maryland, USA.
- Dillon, M. and Griffith, C., 1999. *How to Clean*. M.D.Associates, Grimsby, UK.
- Eck, A. and Gillis, J-C., 2000. *Cheesemaking from Science to Quality Assurance*. Lavoisier Publishing, Paris, France.
- Fellows, P. and Hidellage, V., 1992. *Making Safe Food*. IT Publications, London, UK.
- Fox, P.F., Guinee, T.P., Cogan, T.M. and McSweeney, P.L.H., 2000. *Fundamentals of Cheese Science*. Aspen Publishers Inc. Gaithersburg, Maryland, USA.
- Hobbs, B.C. and Roberts, D., 1987. *Food Poisoning and Food Hygiene*. Edward Arnold, London, UK.
- Kramer, A. and Twigg, B.A., 1962. *Fundamentals of Quality Control for the Food Industry*. AVI Publishing Co., Westport, USA.
- Robinson, R.K. (ed.), 1990. *Dairy Microbiology, Volumes 1 and 2*. Elsevier Applied Science, New York, USA.
- Shapton, D.A., and Shapton, N.F., 1993. *Safe Processing of Foods*. Butterworth-Heinemann, Oxford, UK.
- Troller, J.A., 1993. *Sanitation in Food Processing*. 2nd Edition. Academic Press, New York, USA.
- Wehr, M., 2004. *Standard Methods for the Examination of Dairy Products*. American Public Health Association, Washington, DC, USA.
- Wong, N.P., Jenness, R., Keeney, M. and Marth, E.H., 1988. *Fundamentals of Dairy Chemistry*. Van Nostrand Reinhold Company, New York, USA.

Websites

The Basics of Making Cheese. Frank Kosikowski:
www.cip.ukcentre.com/cheese.htm

CODEX Alimentarius: www.codexalimentarius.net/index

Centre for Dairy Research, Madison, Wisconsin: www.cdr.wisc.edu

Dairy Science and Technology Education website, University of Guelph:
www.foodsci.uoguelph.ca/dairyedu

FAO: www.fao.org

and specifically information published by FAO at the following sites:

www.fao.org/DOCREP/004/T0045E/T0045E04.htm

www.fao.org/DOCREP/003/X6511E/X6511E00.htm

www.fao.org/DOCREP/003/X6523E/X6523E00.htm

Processing information:

www.helene.users2.50megs.com/various_manufacturing_methods.htm

Strengthening African Food Processing: www.safpp.net

Appendix IV

Institutions that support small-scale dairy processing

The following institutions in ACP countries are able to provide advice and assistance dairy processing enterprises. These are in addition to those described in Appendix III of *Opportunities in Food Processing, Volume 1*.

Africa

Botswana. Botswana Technology Centre, PO 0082, Gaborone
www.botec.bw

Burkina Faso. Table Filière Laitière, Bobo Dioulasso
e-mail: agrozootech@fasonet.bf

The Gambia. International Trypano-tolerance Centre, PMB 14, Banjul
Tel: +220-446-2928
Fax: +220-446-2924
Email: itc@itc.gm

Mali. Institut d'Economie Rurale, Rue Mohamed V, BP 258, Bamako
Tel: +223-222-26-06/223-19-05
Fax: +223-222-37-75
e-mail: info@ier.ml

Mali. Institut du Sahel, BP 1530, Bamako
Tel: +223-222-2148/222-2337/222-8086
Fax: +223-222-5980/222-7831
e-mail: administration@insah.org

Mali. Laboratoire Central Vétérinaire BP 2295, Km 8, Rte Koulikoro, Bamako
Tel: +223-24-3344
Fax: +223-24-9809

Niger. Karkara, Cellule d'Appui à la Promotion de l'Elevage au Niger (CAPEN)
e-mail: camelin@intenet.ne

Senegal. Institut Sénégalais de Recherche Agronomique/BAME (Bureau d'analyses macro-économiques), BP 3120, Dakar
Tel: +221-832-2313
e-mail: bam@syfed.sn

Tanzania. Confederation of Tanzania Industries, 10th Floor, NIC Investment House, Samora Avenue, PO Box 71783, Dar es Salaam
Tel: +255-22-211-4954/212-3802
Fax: +255-22-211-5414.
e-mail: cti@cats-net.com

Tanzania. Department of Food Science and Technology, Sokoine University of Agriculture, PO Box 3006, Morogoro
Tel: +255-23-4402
Fax: +255-23-4562/3259

Tanzania. Government Chemist Laboratory, PO Box 164, Dar es Salaam
Tel: +255-22-211-3383/4
Fax: +255-22-211-33320

Tanzania. Ministry of Agriculture and Food Security, Kilimo House, PO Box 9192, Dar es Salaam
Tel: +255-22-286-2064/286-2480/1
e-mail: psk@kilimo.go/tz

Tanzania. Ministry of Industry and Trade, PO Box 9503, Dar es Salaam
Tel: +255-22-218-0075

Tanzania. Ministry of Water and Livestock Development, PO Box 9153, Dar es Salaam
Tel: +255-22-117-153/9

Tanzania. National Food Control Commission, Ministry of Health, PO Box 7601, Dar es Salaam
Tel: +255-22-211-4039/211-4060

Tanzania. Tanzania Bureau of Standards, PO Box 9524, Dar es Salaam
Tel: +255-22-245-0298
Fax: +255-22-245-0959
e-mail: standards@twiga.com

Uganda. National Agricultural Research Organisation (NARO), PO Box 7852, Plot M217, Nakawa Ind. Area, Kampala
Tel: +256-41-567-708
Fax: +256-41-567-649
e-mail: karihave@starcom.co.ug

Uganda. Department of Food Science and Technology, Makerere University, PO Box 7062, Kampala
e-mail: foodtech@infocom.co.ug

Caribbean

Antigua. Antigua and Barbuda Bureau of Standards (ABBS), PO Box 110, St. John's
Tel: +1-268-462-1542/2424
Fax: +1-268-462-1625
e-mail: abbs@candw.ag

Antigua. Chemistry and Food Technology Division, Ministry of Agriculture, Fisheries and Lands, Dunbars
Tel: +1-268-462-4502/1213
Fax: +1-268-462-6281/6104
e-mail: moa@candw.ag

Barbados. Barbados National Bureau of Standards (BNSI), Flodden, Calloden Road, St. Michael
Tel: +1-246-426-3870
Fax: +1-246-436-1495
e-mail: dbr@bnsi.com.bb

Barbados. Export Business Adviser, Caribbean Export Development Agency, PO Box 34B, Brittons Hill, St. Michael
Tel: +1-246-436-0578
Fax: +1-246-436-9999
e-mail: lseon@carib-export.com

Barbados. Project Officer, Technological Services, Caribbean Development Bank, PO Box 408, Wildey, St. Michael
Tel: +1-246-431-1690
Fax: +1-246-426-7269
e-mail: harvey@caribank.org

Dominica. Business Development Officer, OECS/EDADU, PO Box 961, Roseau
Tel: +1-767-448-2240
Fax: +1-767-448-5554
e-mail: csthilaire_edadu@yahoo.com

Dominica. Dominica Bureau of Standards, 28 Kennedy Drive, 1st Floor, Roseau
Tel: +1-767-448-1685
Fax: +1-767-449-9217
e-mail: standards@cwdom.du

Grenada. Grenada Bureau of Standards (GDBS), Lagoon Road, St Georges
Tel: +1-473-440-5886/6783
Fax: +1-473-440-5554
e-mail: gdbs@caribsurf.com

Guyana. Guyana National Bureau of Standards (GNBS), Flat 15, Sophia Exhibition Complex, Sophia, Greater Georgetown
Tel: +592-2-59041
Fax: + 592-2-57455
e-mail: gnbs@sdpn.org.gy

Jamaica. Jamaica Bureau of Standards (JBS), 86 Winchester Road, PO Box 113, Kingston 10
Tel: +1-876-926-3140-6
Fax: +1-876-929-4736
e-mail: othomas@jbs.org.jm

Jamaica. Food Technology Institute, Scientific research Council, Hope Gardens, PO Box 350, Kingston 6
Tel: +1-876-977-9316
Fax: +1-876-977-2194
e-mail: ftihead@cwjamaica.com

Saint Kitts. St Kitts-Nevis Multipurpose Laboratory, PO Box 39, Department of Agriculture
Tel: +1-869-465-5279
Fax: +1-869-465-3852
e-mail: mplbos@caribsurf.com

Saint Lucia. Saint Lucia Bureau of Standards (SLBS), Heraldine Rock Building, Block B, 4th Floor, Waterfront, Castries
Tel: +1-758-453-0049/456-0546
Fax: +1-758-452-3561
e-mail: slbs@candw.lc

Saint Vincent. St Vincent and the Grenadines Bureau of Standards (SVGBS), Ministry of Trade and Industry, Kingstown

Tel: +1-784-457-8092/456-1223
Fax: +1-784-457-8175
e-mail: svgbs@caribsurf.com

Trinidad. Trinidad and Tobago Bureau of Standards (TTBS), Century Drive, Trinicity Industrial Estate, PO Box 467, Port of Spain
Tel: +1-868-662-4482/8827
Fax: +1-868-663-4335
e-mail: ttbs@carib-link.net

Trinidad. Caribbean Industrial Research Institute (CARIRI), Tunapuna Post Office
Tel: +1-868-662-7161/3
Fax: +1-868-662-7177
e-mail: cariri@tstt.net.tt

Trinidad. Chemistry, Food and Drugs Division, 92 Frederick Street, Port of Spain
Tel: +1-868-623-5242
Fax: +1-868-623-2477
e-mail: cfdd@carib-link.net

Europe

France. Agronomes et Vétérinaires sans frontières (VSF-CICDA) rue Raulin 69361, Lyon Cedex 07
Tel: +33-478-697959
Fax: +33-478-69795645

Switzerland. VSF-Suisse, Optingenstrasse 14, PO Box 479, CH-3000 Bern 25
Tel: +41-31-332-7765
Fax: +41-31-332-7766
Email: info@vsf-suisse.ch

UK. Ice Cream Alliance, 3 Melbourne Court, Pride Park, Derby, DE24 8LZ
Tel: +44-1332-203333
Fax: +44-1332-203420
e-mail: info@alice-cream.org
www.ice-cream.org

Some examples of small-scale dairy equipment suppliers

Company	Country	
APV	Denmark	Tel: +45-8922-8922 Fax: +45-8922-8901
Actini	France	Tel: +33-450-707474 Fax: +33-450-707475
Charles Wait Ltd sales@cwpp.co.uk	UK	Tel: +44-1704-211273 Fax: +44-1704-225875
C van't Riet Zuiveltechnologie info@rietdairy.nl/www.rietdairy.nl	The Netherlands	Tel: +31-172-571304 Fax: +31-172-573406
Dairy Udyog jipun@vsnl.com	India	Tel: +91-22-517-1636/1960 Fax: +91-22-517-0878
Elecrem	France	Tel: +33-146-421414
Elimeca	France	Tel: +33-474-697690 Fax: +33-474-697275
Fullwood Ltd	UK	Tel: +44-1691-622391 Fax: +44-1691-622355
Geere SA	France	Tel: +33-388-04480
Lehman getlehman@aol.com	USA	Tel: +1-330-857-5757 Fax: +1-330-857-5785
Small-scale Dairy Technology Group	The Netherlands	Tel +31 838 024235

Glossary and acronyms

Abomasum	The fourth stomach of a calf
ACP	African, Caribbean and Pacific
Additives	Any small amount of a recipe other than the main ingredients
a_w	Water activity – a measure of the amount of water in a food that is available for micro-organisms to use
BOD	Biological Oxidation Demand – a measure of the polluting potential of waste water
Breakeven point	The level of turnover at which all costs are covered
Brining	Submerging cheese in weak brine for a short time
Burette	A graduated glass cylinder used to titrate liquids
Buttermilk	The liquid remaining after butter making
Carboxymethyl cellulose	A synthetic cellulose gum used as a stabiliser and thickener
Celsius	Centigrade scale of temperature measurement
Churning	Agitation of cream to make butter
Coagulate	Making a suspension of proteins solid or partially solid
COD	Chemical Oxidation Demand – a measure of the polluting potential of waste water
CODEX	<i>Codex Alimentarius</i> – an internationally agreed protocol of food standards
Cold chain	A system that maintains a food at the correct temperature from production to consumption
<i>E.coli</i>	<i>Escherichia coli</i> – an organism whose presence indicates that faecal contamination has taken place
Emulsifying agent	A chemical that stabilises an emulsion and prevents it from separating into its component parts
Enzymes	Natural proteins that cause changes in food colours and flavour
FAO	Food and Agricultural Organization of the United Nations

Fixed costs	Costs of production that do not depend on the quantity of goods produced.
HACCP	Hazard Analysis and Critical Control Point system of quality assurance
Insectocutor	Equipment which attracts flying insects to an ultra-violet light and then kills them by electrical discharge.
<i>Lactobacillus</i> sp.	A harmless organism that produces lactic acid from carbohydrates
Lactodensimeter (or densitometer)	A type of hydrometer used to measure the density of milk
Lactose	Milk sugar
Large-scale processing	A business having more than 50 employees, and capital in excess of US\$1,000,000
Lecithin	A type of emulsifying agent extracted from soybeans and other plants
Market segment	A group of similar consumers
Marketing mix	The combination of where a product is sold, its price, its characteristics and its promotion
Medium-scale processing	A business having 16–50 employees, and capital of US\$50,000–1,000,000
Micro scale processing	A business having fewer than 5 employees and capital of less than US\$1000
MSNF	Milk Solids Not Fat
Niche market	A small specialised section of a market
Overrun	A measure of the amount of air incorporated into ice cream
Pathogens	Micro-organisms that can cause sickness if consumed in foods
pH	A scale from 1–14 that is used to measure acidity
ppm	Parts per million (mg per kg)
Process control point	A point in a process where lack of control can affect the quality and safety of a product
Rancidity	Development of off-flavours due to the oxidation of fats
Rennet	An enzyme used to coagulate milk in cheese making

Risk analysis	A system that examines the risks faced by a food as it moves through the chain from producer to consumer
Ropiness	A fault in milk in which strings of gel are formed by micro-organisms
<i>Salmonella</i> sp.	A dangerous food poisoning micro-organism
Shelf life	The time that a product is fit to eat
Small-scale processing	A business having 5–15 employees, and capital of US\$1000–50,000
Soil	A term used to describe all types of contamination of equipment
sp.	Species (of micro-organism)
<i>Staphylococcus</i> sp.	A food poisoning micro-organism commonly found in the throat or nose
subsp.	Sub-species (of micro-organism)
Syneresis	Leakage of liquid (e.g. from cheese or yoghurt curd)
Titrate	To add one liquid to another in a controlled way using a burette
Total viable count	A measure of the total number of organisms present
UHT	Ultra-high temperature heat treatment
UNESCO	United Nations Educational, Scientific and Cultural Organization
USP	Unique Selling Point
Variable costs	Production costs that depend on the amount of goods produced
Whey	The liquid remaining after cheese making
WHO	World Health Organization
wt / wt	Amount of a substance (in weight) in a given weight of product (i.e. g/100g)

Index

A

- Acid coagulation, see Coagulation of milk
- Acidophilus milk 87
- Additives, see Ingredients

B

- Bacteria in milk, see Food spoilage
- Boiling pans 51
- Book-keeping 156, see *also* Finance
- Buildings 28, 40–44
 - floors 43
 - layout 44
 - location 39–40
 - roofs and ceilings 41
 - setup costs 56, 152
 - walls, windows and doors 42
 - water and sanitation 46–49
- Business plan 28
- Butter 75–76, 117–118, 163–164
 - cultured butter 75–76
 - equipment 53, 72, 74
 - markets 20, 22
 - types 71
 - yield 73, 74, 164

C

- Cash flow 155
- Cheese 77–86, 118–119
 - buildings 41, 42, 49
 - coagulants 78–79
 - equipment 53, 79, 80
 - markets 20
 - properties 84
 - quality testing 109
 - types 77–78, 80–83
- Chhana* 84, 97, 98
- Chlorine, see Cleaning

- Cleaning 43, 48, 112, 114
 - equipment 48, 55, 112
 - schedules 113
- Coagulation of milk 78, 97, 161
- Cold chain 18, 109, 111
- Competitors 19, 32–33
- Confectionery 96–99
- Contracts 145–147
- Controlling costs, see Costs
- Cost of services, see Costs
- Costs 136, 142, 151–153, 154–155
- Cream 69–71, 120, 163
 - additives 121
 - markets 20
 - equipment 53
 - separators 53, 69
- Cultured milks 87–88
- Curd cutters 79
- Customers 20
 - care 24
 - complaints 26
 - types 20, 21–22

D

- Dairy buildings, see Buildings
- Demand for dairy products 13, 19
- Density of milk 105, 162

E

- Efficiency 127, 144
 - butter churning 73, 74
 - cream separation 69–70
- Effluent treatment and disposal, see Waste treatment and disposal
- Energy conservation 45
- Environmental impact of effluents 49–50
- Equipment 28, 44, 50–56
 - maintenance 55, 142–144

F

Fat content 65–67, 74, 78, 106, 120, 122
Feasibility studies 27
Fill weights 114
Finance 28, 151, 157
Fixed costs 42
Food poisoning 26, 103, 111, 166
Food spoilage 90, 103, 107, 111, 165
Form-fill-seal 54

G

Ghee 71, 76–77
Gulab jamun 96, 97, 99

H

Hygiene 46, 49, 111, 139, 169–170

I

Ice cream 92–96, 120–121, 135, 164–165
 markets 20
 equipment 53
 ingredients and mix 93–96
 production 92
Ingredients 57–59, 133–135
 suppliers 57
Inspection of equipment 112

K

Khova 96–99

L

Labelling 116
Lactic acid bacteria 166–167
Lactose 87, 162
 intolerance 19, 162
Legislation 116–123
 butter 117
 cheese 118
 cream 120
 ice cream 120
 labelling 116
 product composition 117
 yoghurt 122
Lighting and power 45
Location for dairy 39, 40

M

Maintenance of equipment 52, 55, 113, 142–144
Management 127
 contracts and records 145–147
 of finances 131–132, 151, 153
 of production 129–131, 133–136, 142–145
 roles 127
 of staff 136, 137–142
Marketing 28, 131
 mix 29
 strategy 28–32
Markets for dairy products 17, 20
Mass balances 70
Methylene blue test 107
Microbiological tests 107
Microbiology 165–166
Micro-organisms, see Food spoilage
Milk 18, 66, 103, 161
 confectionery 20, 96–99
 composition 161
 deliveries 18, 103
 density 105, 162
 pasteurising 53, 65–69
 quality 18, 103–108, 111, 112
 standardisation 66
 supply chain 18, 133
 untreated 17, 19

O

Overrun 92

P

Packaging 31, 57, 133, 135
 equipment 54–59
Pasteurisation 65–69, 107, 115, 121
 testing effectiveness 108
Pasteurised milk 65–69, see also Milk
Pasteurisers 67
Pathogens, see Food poisoning
Planning 151–157
 finances 151
 production 127, 136, 144
Plate heat exchanger 68
Pot sealers 54
Pricing products 29, 32, 153

- Process control 114–116
 - Processed cheese 86
 - Processing 63–99
 - Product development 33
 - Product diversification 19, 90, 95
 - Product testing, see Quality assurance
 - Production 39–59, 127–147
 - costs, 135 136, 137, 153
 - methods 65–99
 - planning 129–136
 - Productivity improvement 144, 154
 - Promotion 21, 29, 30–31
- Q**
- Quality assurance 18, 64, 103–116
 - cheese 109–112
 - milk 103–108
 - process control 114–115
 - yoghurt 109–112
- R**
- Rasagolla* 96–98
 - Record keeping 145
 - Records 115, 145–147
 - sales 132
 - stock 142
 - Refrigeration 25, 64, 75, 110, 154
 - Rennet 78, 81, 85, 109
 - production 86
 - Risk analysis 109–112
- S**
- Safety in dairies 140–142, 144, 169
 - Sales 28, 131
 - outlets 20
 - Sanitation 46, 112, 169
 - Science of dairy processing 161–167
 - Sealers 54
 - Selling strategy 28
 - Services, see Utility services
 - Set-up 39, 56, 151–152
 - costs 56, 151–152
 - hygiene 40–43, 46–49
 - location 39–40
 - production 39
 - Shelf life 64
 - Sour cream 71
 - Soured milk 87
 - Spoilage, see Food spoilage
 - Staff 28, 128, 131, 137–142
 - accidents 140–142
 - benefits 139
 - recruiting 137–138
 - training 138, 140
 - Standardisation of milk 66–67
 - Starter cultures 83–86
 - Start-up, see Set-up
 - Support institutions 175
- T**
- Testing milk, see Quality assurance
 - Training staff 138
- U**
- Utility services 45, 136
- V**
- Vacuum sealer 54
 - Variable costs 142
- W**
- Wastage 145
 - Waste treatment and disposal 48, 49–50, 112, 169–170
 - Water
 - supplies 40, 46, 49–50
 - treatment 47
 - Whey 77, 90
 - Whipped cream 70, 163
- Y**
- Yoghurt 21, 87, 109, 115, 122
 - composition 122
 - equipment 53
 - incubators 89
 - markets 20 21
 - packaging 57
 - processing 87, 88–91, 115
 - quality 109

Readers' questionnaire

Please help us to improve future books by completing this questionnaire and sending it by post to CTA, Postbus 380, 6700 AJ, Wageningen, The Netherlands (Fax +31-317-460067).

Name Position/Profession.....
Address.....

Are you?

An individual entrepreneur , in an academic institution , government organisation , a local NGO/CBO , an international NGO , a commercial company , another organisation (please specify)

How did you hear about this book?

Word of mouth , an advertisement , a publications list , another way (please specify)

Why did you buy this book?

To learn about food processing , to improve my existing business , to help in training programmes , another reason (please give details)
.....

Has the book given you the information you needed?

Yes , No , Some of it

Which information was most useful to you?

.....
.....

What information was missing that you feel should be included?

.....
.....

Do you like the layout and style of presentation? Yes , No , Other comments:

What would you like to see included in future books that is missing from this one?

.....

Please continue overleaf with any other comments you would like to make.

