SEAM Programme

Cleaner Production in the Dairy Sector, Egypt

Ministry of State for Environmental Affairs
Egyptian Environmental Affairs Agency

Entec UK Ltd., ERM
UK Department for International Development

SEAM Programme

DAIRY SECTOR REPORT, EGYPT

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Implemented by:

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Egyptian Environmental Affairs Agency
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ERM
UK Department for International Development

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1

1.0 Background

1.0 BACKGROUND

1.1 SEAM Programme

Support for Environmental Assessment and Management (SEAM) is a major environmental programme implemented by the Egyptian Environmental Affairs Agency (EEAA), Entec UK Ltd and ERM with support from the UK Department for International Development (DfID).

The SEAM Programme is made up of four components focussing on environmental management issues. These include developing Governorate Environmental Action Plans (GEAPs) in five Governorates in Egypt (Sohag, Dakahleya, Qena, Damietta and South Sinai), delivering community environmental projects (CEPs) that benefit the poor, improving solid waste management (SWM), and implementing cleaner production (CP) projects in industry to enhance competitiveness and reduce pollution. SEAM I (1994-1999) developed GEAPs for Sohag and Dakahleya, built environmental capacity and demonstrated the tangible benefits of improved environmental management. SEAM II (2000-2004) will build on SEAM I successes by improving environmental planning and services for the poor and strengthening decentralized environmental management.

1.1.1 The Cleaner Production Component

The main goal of the Cleaner Production component is to show that significant financial savings and environmental improvements can be made by relatively low-cost and straight-forward interventions, such as good housekeeping, waste minimization, process modification and technology changes. This approach was recognized as having two benefits – valuable materials can be recovered and reused, rather than being wasted, and industries move towards environmental (legislative) compliance.

<u>1994-99</u> - Cleaner Production initiatives were successfully undertaken in medium to large scale Egyptian industrial units in the textiles, food processing and edible oil and soap sectors. 32 factories were audited and 21 Demonstration Projects implemented at a cost of LE 16 million, with an average pay back of 6 months. Examples of interventions included water and energy conservation, ecolabelling for textile exports, oil and fats recovery, Hazard Analysis Critical Control Point (HACCP), and recovery of cheese whey, etc.

<u>2000-2005</u> – The programme focused on micro, small and medium size enterprises (MSMEs) in Egypt. It focused on 4-5 main priority sectors in five governorates which are the food, metal foundries, textiles, furniture and other miscellaneous small industries. About 100 audits and 30 demonstration projects have been undertaken in MSME priority sectors including food processing, metal foundries, furniture, textiles, and other miscellaneous projects. The aim here is to enhance efficiency, reduce pollution, yield financial savings and improve the environment for surrounding communities.

Within the dairy sector, five demonstration projects have been implemented in eighteen sites as follows:

1. Improved Cheese Recovery in Curd-Whey Separation (2 factories)
2. Practising Hygienic Milk Collection and Processing Pays! (2 factories)
3. Strategic Modernisation of Traditional Small and Medium Scale Dairy Factories
4. Profiting from Pollution: Recovering Ricotta Cheese from Whey
5. Whey from Cheese Making: A Resource for Bakeries

6. Cleaner Production Clinics to Promote Cleaner Production (CP) in Dairy Sector, Dakahleya, Egypt.
7. CP Clinics Help Dairy Factories in Dakahleya to Improve Productivity and Reduce Discharge of Pollution (11 factories).

More information on various sector ,manuals and case studies may be procured from http://www.seamegypt.org

1.2 About This Sector Report

The Dairy Sector Report collates baseline information on the dairy industry in Egypt, including statistical data, current manufacturing practices, technology inputs, environmental issues, regulatory, institutional and policy frameworks. The focus throughout is to enhance and improve the quality of production in MSMEs in order that they may perform a vital role in supporting the economic success of the dairy industry in Egypt through both domestic and overseas sales.

1.3 The Structure of the Sector Report

The Dairy Sector Report is divided into 7 sections a brief summary of each section is provided below.

- **Section 1.0** provides background information.
- **Section 2.0** presents a profile of the dairy sector. It includes an overview of dairy production activities , the product range, the dairy cycle at the MSME scale, policy, regulatory and institutional framework, and concludes with a discussion as to why MSMEs are critical to the dairy sector.
- **Section 3.0** provides information on dairy processing procedures and waste generation. Process descriptions are presented for typical MSME-scale dairy products.
- **Section 4.0** covers environmental standards, regulations relevant to the dairy sector, institutional framework for environmental management and their application to MSMEs.
- **Section 5.0** introduces the concept of Cleaner Production, why MSMEs should adopt Cleaner Production, barriers faced and issues for sustaining Cleaner Production in MSMEs.
- **Section 6.0** analyses Cleaner Production opportunities using selected case studies from around the world, provides a short overview of the status of MSMEs in Egypt with respect to each stage of the dairy cycle, and summarises Cleaner Production interventions implemented by SEAM.
- **Section 7.0** provides a summary of the key issues and recommendations towards enabling and sustaining Cleaner Production across MSMEs in the dairy sector in Egypt.

The Report is accompanied by a number of Annexes, which include statistical information and recommended reading material.

Some of the material researched for the Report was obtained from the World Wide Web; it should be noted that such information can change, given the dynamic nature of the Internet.

Chapter

2

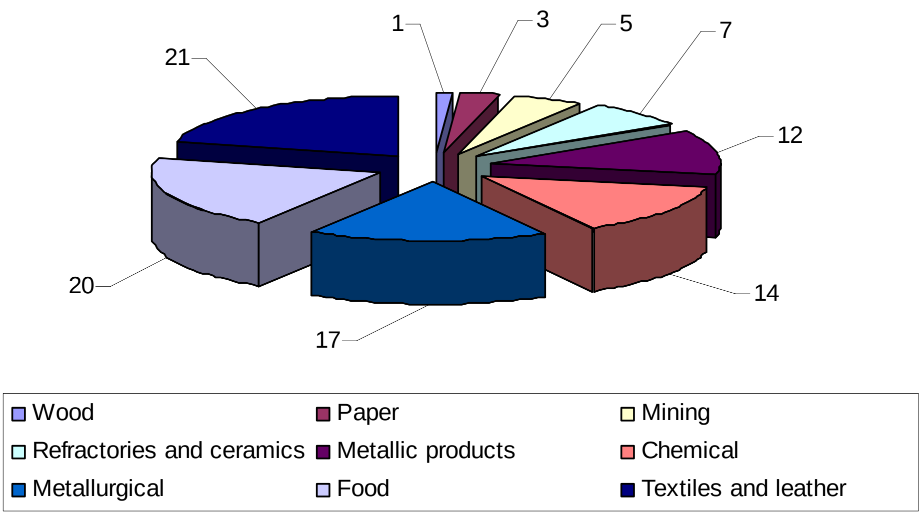
2.0 A Profile of the Dairy Sector Report in Egypt

2.0 A PROFILE OF THE DAIRY SECTOR IN EGYPT

2.1 Introduction

The food processing sector has one of the highest production values of any industrial sector in Egypt. In 1995, the production of medium and large establishments (those with 200 or more employees) in the sector accounted for 20% of the total production value of the country, second only to the textiles and leather sector (21%). Figure 2.1 illustrates this distribution.

Figure 2.1: Production Values in Egypt [1]



The dairy sector is one of the sub-sectors of the food processing sector. According to data from the Bureau of Statistics, dairy product facilities represent about 9% of the number of facilities and 15.9% of the total manpower within the food sector. The term "dairy" refers to milk and milk products (e.g. cheeses, yoghurt, butter, cream, etc.). The Standard Industrial Classification (SIC) sub-sector Code for the dairy sector is 152.

2.2 An Overview of Dairy Production Activities

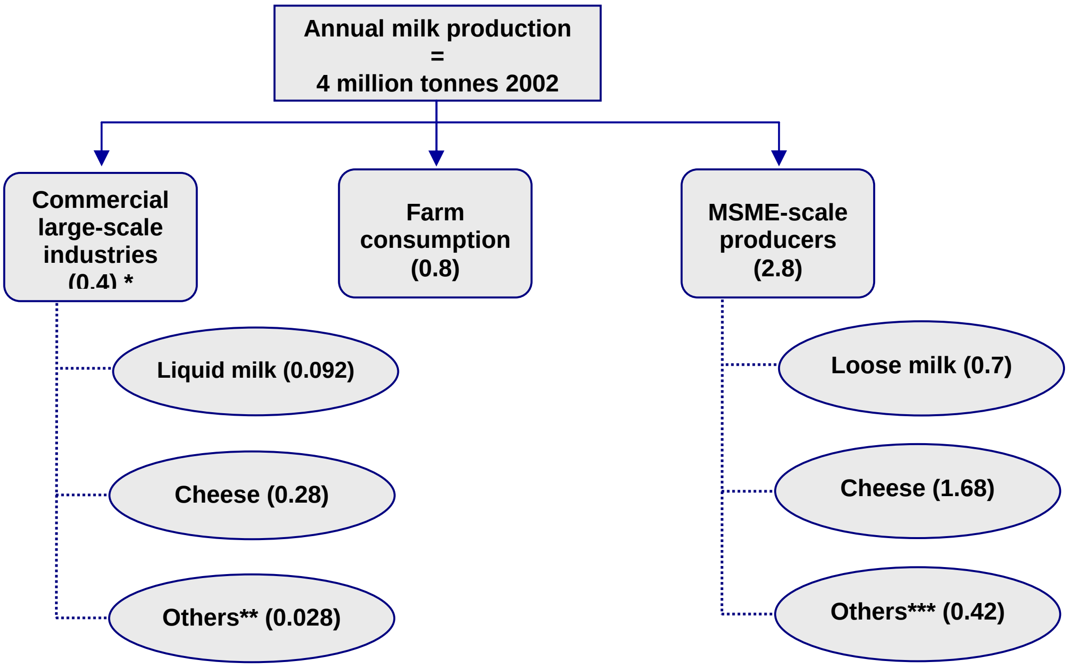
Modern dairy production can be traced to the 1920s, when the first private sector factory producing Domiaty (white) cheese was set up in Damietta. In 1945, Astra Company began producing pasteurized milk, to be followed in 1956 by another factory in Kafr El Sheikh Governorate specializing in milk powder production. That year, *Misr* Dairy (the largest dairy producer during the 1960s and 1970s) was established.

Today, there are over 3,334[2] factories ranging between the micro-small-medium scale enterprises (MSMEs)[3] to the large-scale undertakings It is the MSMEs that capture the major (around 70%) share of the market though some sources report this number to be even higher at around 80 – 90%).[4] The high demand for dairy products by the low and middle-income strata continues to create a flourishing market for low-cost, small and informal dairy producers (i.e. MSMEs) especially in the rural areas.

1 Food Processing Sector, Egypt – Cleaner Production Opportunities, SEAM (1999).
2 CAPMAS, 2001.
3 The Egyptian Ministry of Foreign Trade defines micro-enterprises as those operating with between 1 to 4 workers, small enterprises as those operating with between 5 to 14 workers and medium enterprises as those operating with between 15 to 49 workers. Source: www.sme.gov.eg/sme_statistical_information.htm.
4 The Dairy Sector Report by Business Studies and Analysis Center, American Chamber of Commerce in Egypt, 1999.

In 2002, production of raw milk by the MSMEs and the larger commercial producers, was 4 million tonnes, up from the 2.4 million tonnes in 1998. Total annual milk production value is estimated at about LE 4.4 billion, which represents 25.5% of the total animal production, and 7.4% of agricultural production.[5] Around 20% (i.e. 0.8 million tonnes) of raw milk is consumed on the farm itself. Of the remaining 80%, 70% (i.e. 2.8 million tonnes) is distributed and processed through MSME-scale producers to supply milk, cheese, and home-made butter. 10% (i.e. 0.4 million tonnes) is consumed by the modern commercial large-scale sector with cheese production accounting for the major activity at both the MSME and the larger scale dairy operations. Figure 2.2 shows the breakdown of raw milk usage by the dairy industry and the relative importance of MSMEs within the sector.

Figure 2.2: Proportion of Raw Milk Usage[6]



* All figures in brackets in million tonnes

** At the commercial large-scale, 'Others' refers to items such as butter, yogurt, ice cream, milk powder, processed cheese and mish.

*** At the MSME scale 'Others' refers to mish, butter, cream, etc.

It is clear that the dairy sector relies on MSME scale industries for raw milk sales, as well as cheese production..

2.2.1 SIZE DISTRIBUTION

Based on the data from the 1996 census, the Central Agency for Public Mobilization and Statistics (CAPMAS) shows that the total number of dairy product processing facilities is 3,334. Table 2.1 shows a classification of the facilities by manpower (manpower is an indicator of facility size, although modern facilities employ fewer workers for the same production rate).

It is clear that 75% of the facilities operate with less than 4 workers and less than 1% employ more than 40 , thus underlying the importance of MSMEs within this sector.

5 Kamal, Aly (2003). Economics of milk production in small farms, Ph. D thesis. Faculty of Agriculture, Al Azhar University, Egypt.

6 The Dairy Sector Report by Business Studies and Analysis Center, American Chamber of Commerce in Egypt, 1999.

Table 2.1: Classification of Facilities by Manpower [7]

Manpower	1	2	3	4	5	6 - 10	11 - 15	16 - 20	21 - 25	26 - 30	31 - 40	41 - 50	51 - 100	101 - 500	501 - 1000
Number of facilities	1,419	603	494	312	362	57	21	20	10	6	4	11	12	3	-
%	42.5	18	15	9	11	2	0.6	0.6	0.3	0.2	0.1	0.3	0.4	0.1	-

2.2.2 GEOGRAPHIC DISTRIBUTION

Figures 2.3a and 2.3b show the distribution of dairy facilities throughout Egypt. (Beni Suef for example produces 5.61% of the total milk production or some 224,400 tonnes of milk per annum).

7 Self Monitoring Manual: Dairy Industry, 2003 by Ministry of State for Environmental Affairs [Egyptian Environmental Affairs Agency (EEAA) and Egyptian Pollution Abatement Project (EPAP)].

Figure 2.3a: Geographic Distribution of Milk Production 2001

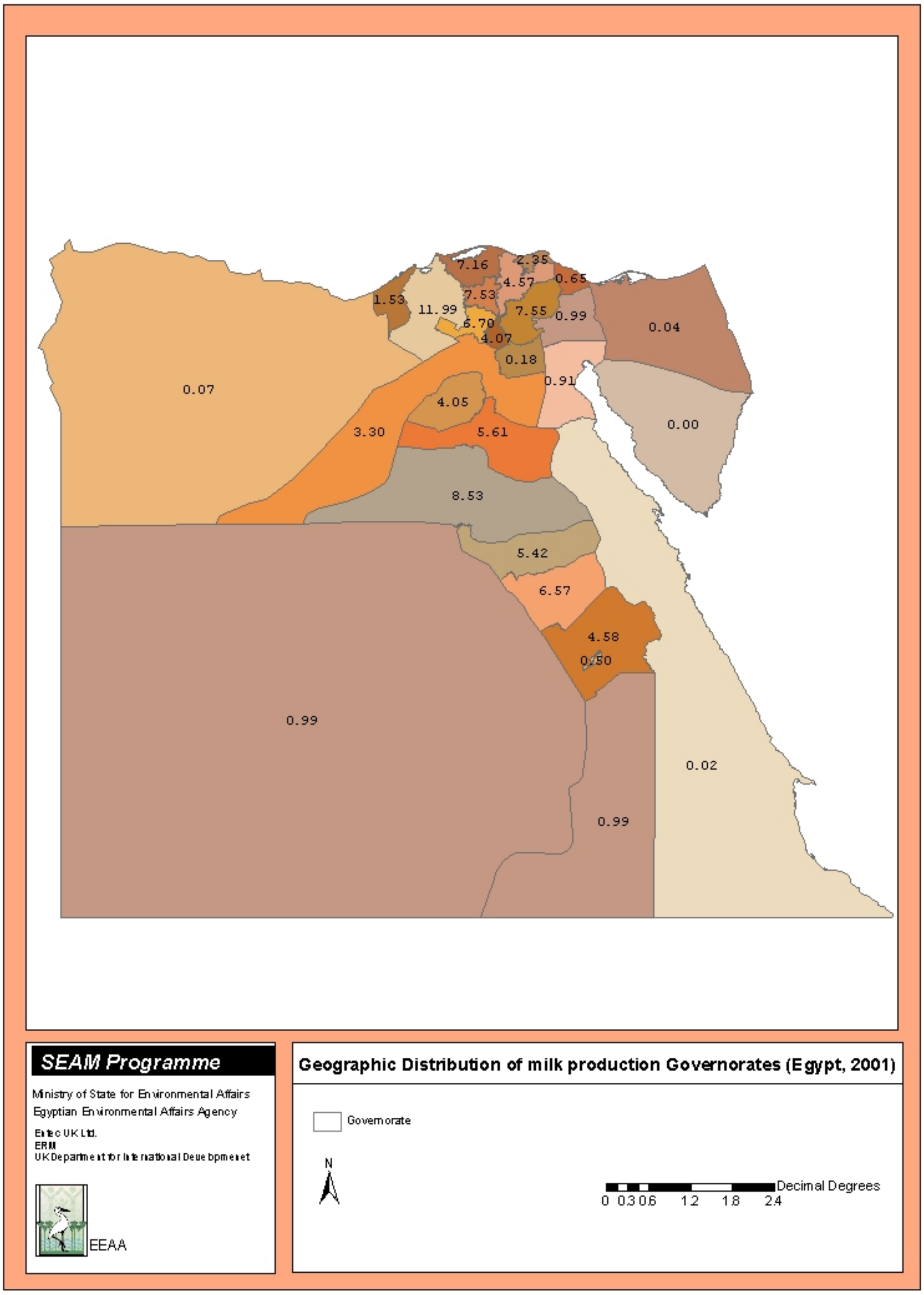
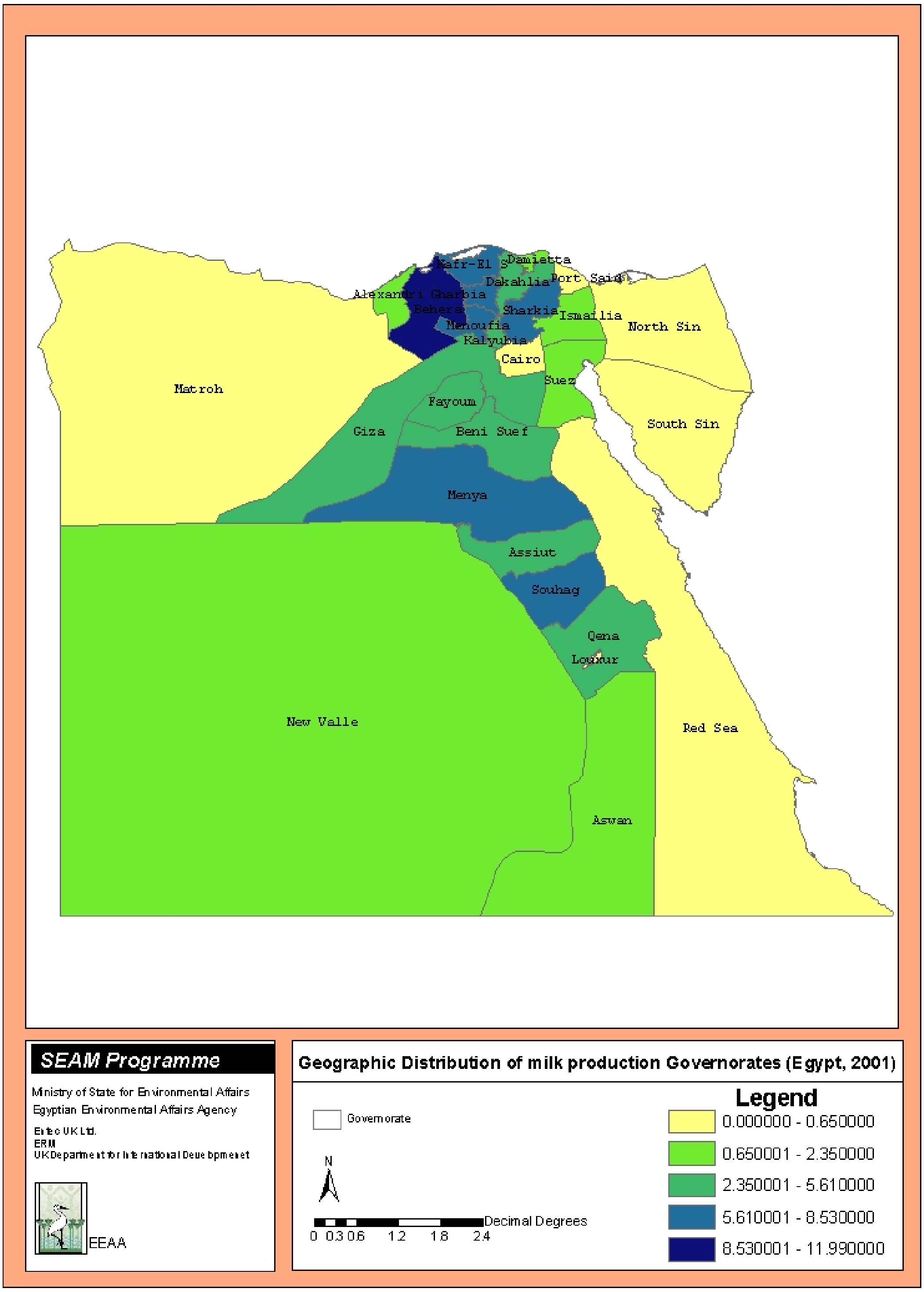


Figure 2.3b: Geographic Distribution of Milk Production 2001



Note: for abbreviations and expanded forms of Egyptian Governorates Refer to Annex 2.1

2.2.3 Type of Ownership

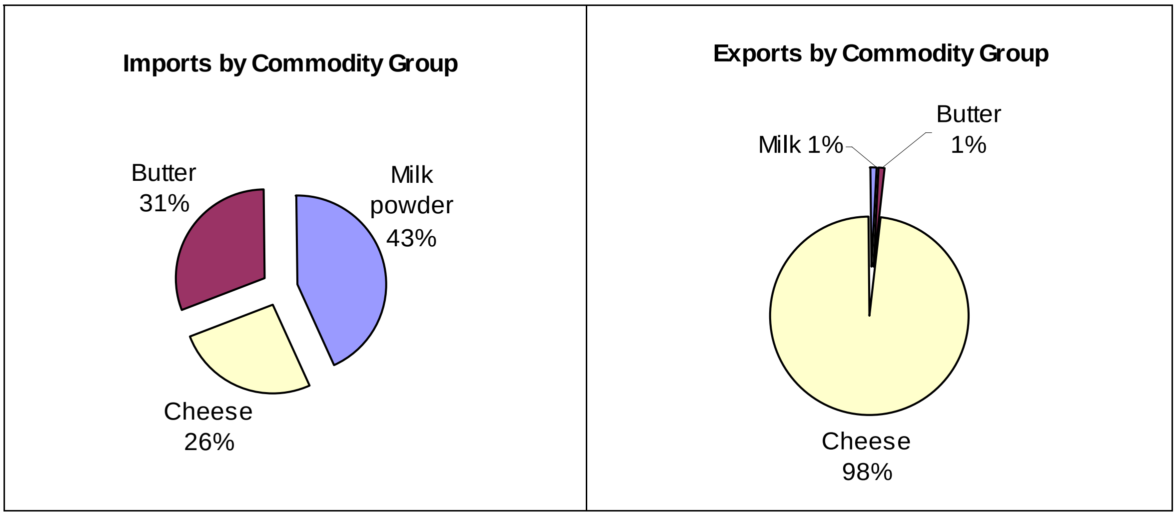
Following the nationalisation of leading private dairies in the early 1960s, production of dairy products was in the hands of the state-owned *Misr* Food & Dairy, with 8 factories. In 1974, the dairy industry was opened to private sector investment. In the next 10 years, about 150 licences for private dairy operations were issued and 20 new dairy factories opened. *Misr* Food & Dairy lost market share to more dynamic private companies and in 1997 it accounted for less than 5% of total commercial milk volume. In 1997, there were reportedly close to a dozen significant local industrial producers of dairy products besides *Misr* Dairy, which is itself now due for privatization.

2.2.4 Demand for Dairy Products: The Local Market, Exports and Imports

In terms of the local market, there is an increasing demand for dairy products in urban centres and a growing number of consumers put quality before price considerations. The growth in urban populations, increased levels of education, and income growth have resulted in a massive increase in demand for dairy products. According to FAO statistics, in 2001 every Egyptian consumed 51 kg of milk and milk products (excluding butter) and demand for dairy products and milk outstrips home grown supply. To cover expected demand, Egypt will need to produce 5.6 million tonnes of milk by the year 2020.[8]

Figures 2.4 and 2.5 show dairy exports and imports by commodity group in 1998, and the world-wide distribution of imports and exports (in terms of US$ value, 1998) respectively. [9]

Figure 2.4: Imports and Exports by Commodity Group (January 1998 – December 1998)



Egypt is a net importer of butter and ghee and milk powder. Butter and ghee is produced in Egypt by farmers in the rural areas and by a few select modern large-scale producers at an estimated capacity of 96,700 tonnes annually. Milk production in Egypt is seasonal with around 80% produced between January and June (see Figure 2.7, Section 2.2.5), after which production levels decline and imports of milk powder increase to compensate.

Cheese constitutes 26% of the total imports. However, in contrast to butter and milk powder, Egypt's self-sufficiency in cheese manufacturing is impressive – almost 97% of its demand is met through domestic means.

Cheese consumption in 1998 totalled 393,000 tonnes, of which only 13,000 tonnes were imported.

The upward trend in local dairy production is supported by an increase in domestic resources, which are gradually replacing imports. The self-sufficiency ratio of the primary

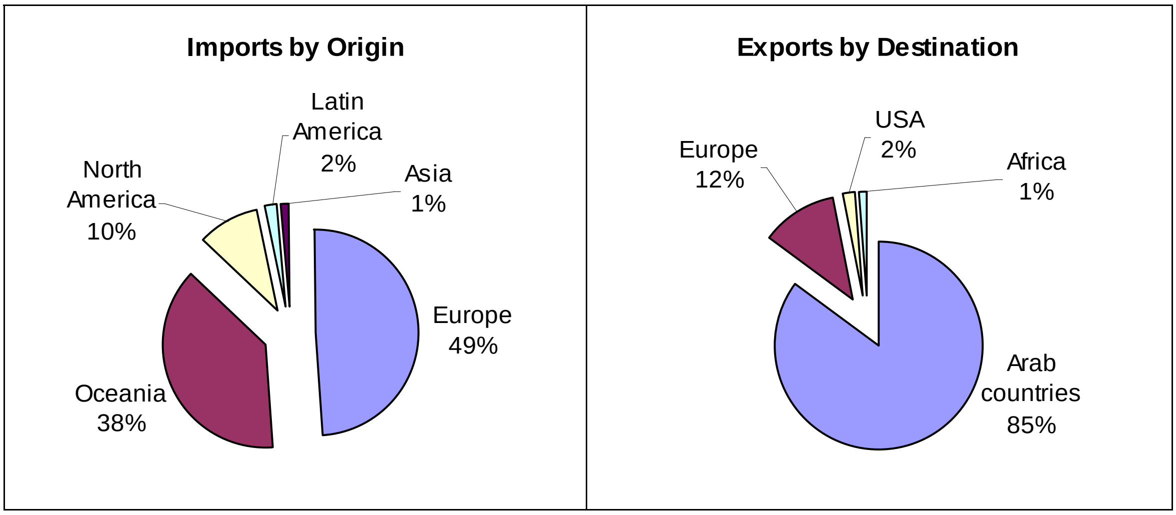
8 Agricultural Production, FAOSTAT Agricultural Database, FAO 2003 (www.fao.org). See Annex 2.2 for a table on statistics for livestock.

9 The Dairy Sector Report by Business Studies and Analysis Center, American Chamber of Commerce in Egypt, 1999.

local resource (i.e. raw milk) was 67% in 1992-1993. By 1997-1998, this had risen to 72%, and continues to increase. The reduction in production and export subsidies in exporting nations, led by the General Agreement on Tariffs and Trade (GATT), is expected to further enhance price competitiveness of local dairy products in the domestic market, thus strongly indicating the scope for growth throughout the Egyptian dairy industry.

As can be seen from Figure 2.5, Europe provides 49% of dairy product imports to Egypt, followed by Oceania (38%) and North America (10%). In terms of exports, 85% of Egyptian dairy exports are to Arab countries, followed by 12% to European countries.

Figure 2.5: World-Wide Distribution of Egyptian Imports and Exports (January 1998 – December 1998)



Egypt's exports of dairy products are product-specific as well as region-specific. Saudi Arabia is ranked first among Egypt's export destinations for dairy products, in terms of volume and value. In 1998, Egyptian dairy exports to Saudi Arabia exceeded US$ 1 million, comprising of about 30% of the total. Although constituting less than 3% of Saudi Arabia's total imports of dairy products, demand for Egyptian products is reported to be relatively high, especially amongst Egyptian expatriates.

However, certain problems have been reported concerning hygiene, packaging and overall quality of cheese exports to Saudi Arabia from MSME-Scale Producers in Egypt. Metallic cheese packs are frequently found to be defective due to corrosion and the quality of cheeses generally violates Saudi standards due to:

- Harmful microbes detected in the cheeses.
- Rust from white cheese metallic containers is frequently recorded.
- Excessively salty flavour and low fat content do not conform to Saudi tastes.

The second and third biggest importers of Egyptian dairy products are Jordan (18%) and Iraq (14%), with cheese (Roumy, Tallaga and Istanbully) being the only item imported by these countries.

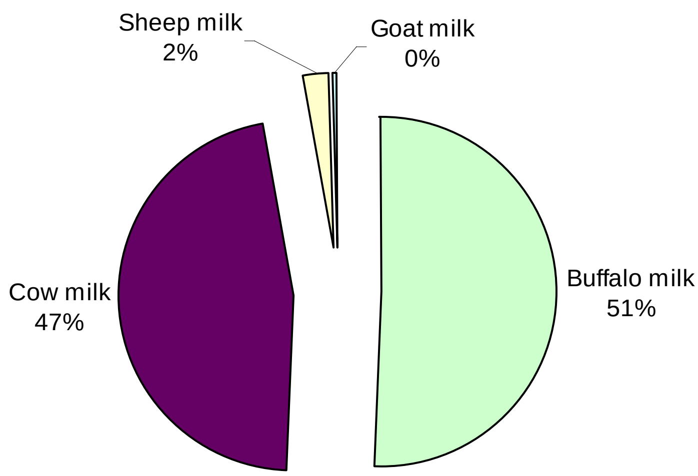
Clearly therefore, while a substantial export market exists for MSME cheese products, limitations concerning hygiene, packaging and overall product quality must be addressed so that the market share can grow and benefit the local MSME-scale producers.

One area of dairy sector reforms in Egypt could focus on these aspects.

2.2.5 Resource Base[10]

Buffaloes and local baladi cows are the main dairy animals and are found in almost equal numbers (3.3 million buffaloes and 3.1 million cows, statistics being indicative of 2002[11]). The buffalo is preferred due to its greater resistance to disease, higher milk productivity, whiter milk colour, its distinctive flavour and higher fat content. Figure 2.6 presents milk production as per the type of milking animal for the year 2002 (a table on geographical distribution of milk production can also be in Annex 2.2).

Figure 2.6: Total Milk Production in Egypt (2002)



Livestock may fit into one of the following two categories:

- "traditional" or small- scale dairy farms and
- large-scale "modern" or "specialized" dairy farms.

Traditional Small-Scale Dairy Farms

This type of milk production system is practiced in the rural areas of Egypt. Here the production of milk is not considered as the primary objective of the farm but is one of a number of objectives, including meat production and raising crops. The livestock are not bred specially for the purpose of milk production and the animals are therefore prone to low productivity.

Like many other Middle Eastern countries, Egypt has a tradition of family ownership of small herds of milk producing animals. Even today, almost 90% of milking animals are kept on farms with an average size of one feddan and no more than three to five animals, mostly providing draught power as well as milk.

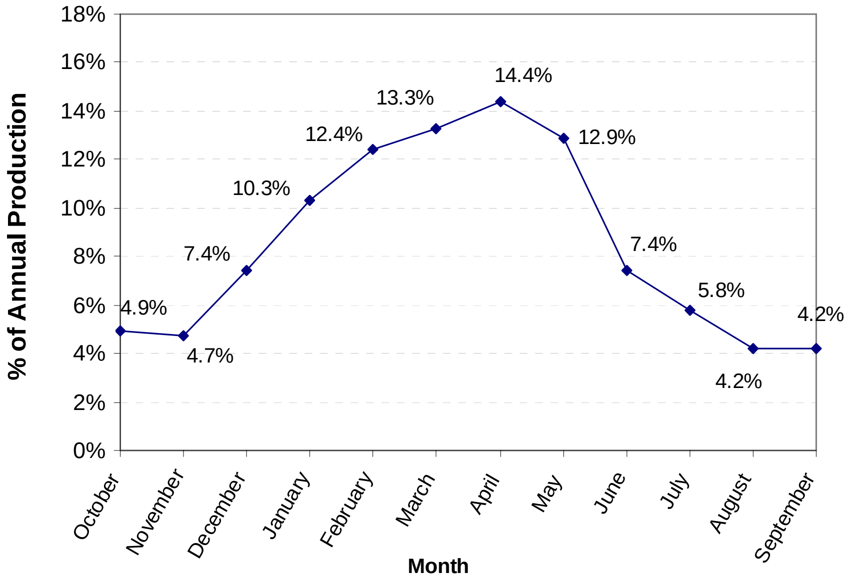
Currently, the traditional small scale dairy farm system accounts for an estimated 72% of total milk production.

10 A major portion of the information provided in this sub-section (unless stated otherwise) is adapted from The Egyptian Dairy Market, 1997 by IMES Consulting, UK. Source: www.imes.co.uk/pages/egyptart.html.

11 Agricultural Production (Live animals) FAOSTAT Agricultural Database, FAO 2003 (www.fao.org). See Annex 2.2 for a table on statistics for livestock.

The average milk production per animal is low at 0.66 tonnes per year, far below the corresponding levels in developed countries. For example, milk productivity reaches 2.7 tonnes per year in the USA and around 5.5 tonnes per year in the EU, and the world average is some 2 tonnes per year.[12] This low productivity has been attributed to the varying levels of feed. Indeed, it has been said that "Egyptian cows are possibly the world's best fed during winter, but the worst fed during summer". Milk production in Egypt is linked to the availability of a weed known locally as 'green clover' or 'berseem' (*Trifolium Alexandrinum*).

Figure 2.7: Breakdown of Milk Production per Month as a Percentage of Annual Milk Production



During the summer season, the shortage of the green clover results in a decrease in the quantity and quality of milk. Indeed, as seen in Figure 2.7[13], about 80% of raw milk is produced in the winter season from December to June. A report from 1999[14] cites the major factor in this cycle as the country's limited land base, which is devoid of permanent pastures.

The shortage of good quality feed has thus been considered as one of the constraints to the development of traditional small-scale dairy farms. Additional constraints include lack of know-how and access to veterinary services, elementary hygiene practices at the milk production stage and essential equipment for milk handling

Therefore, one area of dairy sector reforms in Egypt could focus on removing these constraints by improving year round access to food and enabling such facilities.

Large-Scale Specialized Dairy Farms

The production of milk on large-scale specialized dairy farms is the main objective of such facilities. Livestock is specially bred for higher milk productivity and each farm may have hundreds or thousands of animals. The number of such dairy farms is currently estimated at

12 The Dairy Sector Report by Business Studies and Analysis Center, American Chamber of Commerce in Egypt, 1999.

13 Source: Hanna, W. Z. Economic Study on the Production of Hard Cheese in U. A. R., Master's Thesis, 1968. Faculty of Agriculture, Ain Shams University, Egypt.

14 Food Processing Sector, Egypt – Cleaner Production Opportunities, SEAM (1999).

35, with a total of about 220,500 high yield cows specially bred for milking (some have been imported, mainly from the United States of America).[15]

The Zerba or flying (buffalo) herd system is also practiced on these farms. It is characterized by relatively short term intensive feeding and milking. Under this system, between 25 and 30 lactating buffaloes are selected and fed on high quality rations. Milk produced by the *Zerba* herds is generally sold as liquid milk.

Reportedly, more such large scale farms are being established for their higher milk yield. The commercial farm system currently accounts for an estimated 28% of total milk production. Numbers may swell in the coming years, given the apparent shift towards procuring cheaper locally produced milk (see Section 2.3.2 below). These dairy farms tend to sell their milk to the commercial large-scale dairy industries and are much better equipped than the traditional MSME scale dairy farms as they have access to veterinary services and modern equipment. Such dairy farms are supported by the Ministry of Agriculture in activities concerning veterinary supervision.

2.3 Product Range

2.3.1 Milk

About 90% of the raw milk consumed in Egypt is sold loose by MSME scale producers (see Figure 2.2).

Most MSME scale producers do not have the capacity to pasteurize the raw milk they sell despite Government directives on compulsory pasteurization and raw milk supplied by MSMEs is treated by the consumer by traditional stove-top boiling.

Commercial large-scale producers have tried to capitalize on this weakness, thus posing a threat to MSME Dairy Producers.

- The Egyptian Dairy Association (EDA) was officially established in April 1999. The association represents the interests of the commercial (modern) large-scale producers. As of June 1999, there were 15 members in the EDA, 14 private sector companies and the *Misr* Dairy Public Company.
- The EDA sponsors awareness campaigns to pinpoint the dangers of consuming unpasteurized milk and milk products made from the same (commonly sold by most MSMEs) to encourage the public to shift voluntarily to consuming their products.
- The EDA offers members a quality stamp on their products. Members are also entitled to a 36% reduction in taxes paid on television awareness advertisements, which will indirectly promote overall demand for large-scale dairy sector products.

Since the late 1990s, commercial large-scale producers have been actively campaigning to enhance public awareness of the health hazards posed by “loose milk and dairy products” (a term describing milk and other products made by MSME-scale units), in a bid to expand their share of the market. The television and press campaign targeting the urban and rural market spread the message that the milk sold by street vendors, is unhygienic, neither chilled nor laboratory tested for bacteria. The campaign also extolled the virtues of packaged milk produced by commercial large scale dairy producers. It is reported that “the campaign

15 Livestock and Products – Annual Report (Egypt, 2002). Foreign Agricultural Service / USDA.

succeeded in raising consumer awareness and causing demand for packaged products to rise faster than companies could respond. Those suppliers would not quantify the increased demand, but insiders in the industry put it at close to a full percentage point."[16]

Liquid Ultra High Temperature (UHT) milk is produced at the large scale only. Liquid milk is the primary resource used in the production of UHT milk. The share of processed milk, dominated by UHT is growing slowly, but as yet remains of "secondary importance".[17]

In spite of market support, MSME-scale producers are exposed to constant pressures and threats from commercial large-scale dairy producers in Egypt. Therefore, unless active efforts are taken to ensure hygienic practices are followed and sustained in their day-to-day operations, MSME producers may find their market share slipping considerably in the coming years. Lack of awareness concerning hygienic practices, absence of a cold channel (e.g. adequate refrigeration facilities) due to financial and/or technological constraints, etc., are some of the factors influencing the MSME scale producers in this area. One area of dairy sector reforms in Egypt could focus on these aspects.

2.3.2 Milk Powder

Egypt is a net importer of milk powder. Non-fat milk powder (NFDM) constitutes the bulk of imports to be reused in dairy production, whereas full cream milk powder is imported for direct consumption. Milk powder imports reached 12,000 tonnes in 1998, showing a steady decline from the recorded levels in 1996 and 1997, while the domestic industry is reportedly catching up rapidly with an annual growth rate of about 27% (this includes dairy products and associated industrial equipment). The decrease in milk powder imports is primarily attributed to a safeguard duty of 45% which was imposed by the Egyptian Government on milk powder imports (see Section 2.4.1).[18] It is expected that large-scale Egyptian dairy production will gradually reduce reliance on imports through ongoing and proposed improvements in livestock productivity and reductions in production costs. It has also been reported that the commercial large-scale dairy producers are seeking to secure regular supplies of raw milk through the establishment of local milk collection centres.[19]

Such an activity is bound to have serious repercussions on the MSME scale producers, since the commercial large-scale producers will be able to edge the MSME scale producers out of the market for raw milk production.

To date, the use of milk powder is limited to large-scale producers. MSME units do not use milk powder for their primary activity; i.e. cheese manufacturing. However, there have been reports of some MSME units mixing milk powder with palm or coconut oil to produce an imitation of the more popular low salt Ultra Filtration cheese, which is preferred by consumers due to its superior qualities. This practice is considered illegal.

2.3.3 Cheese

Consumption of milk derivatives in Egypt, particularly locally produced cheeses, is high. Cheese may be eaten on its own or with other dishes and many Egyptians eat cheese with at least one meal every day.

16 Market Assessment by Industrie Canada. Available at: www.strategis.ic.gc.ca/SSG.
17 The Dairy Sector Report by Business Studies and Analysis Center, American Chamber of Commerce in Egypt, 1999.
18 The Dairy Sector Report by Business Studies and Analysis Center, American Chamber of Commerce in Egypt, 1999.
19 Food Sector Development Programme, Egypt. Available at: www.aht-inter.com/html/egypt_fsdp.html.

Annual per capita consumption of cheese is estimated at around 6 kilograms, which is lower than in some developed countries (e.g. Australia at 8.8) but higher than in most developing countries (e.g. Brazil at 2.66 and Venezuela at 3.29). [20]

Cheese production constitutes the primary activity at the MSME-scale. MSMEs produce Roumy, Tallaga, Baramely, Domiaty, Karish and Istanbully cheeses. The commercial, large-scale dairy plants do not produce these cheeses.

Typically, the amount of milk processed by a MSME dairy unit is 6 to 12 tonnes per day in the winter season and 2 to 7 tonnes in the summer season. Hard cheese[21] is produced for 5 months of the year (i.e. during the winter) and soft white cheese during the remaining 7 months of the year. In general, the quantity of hard cheese produced per day is in the range of 0.6 to 1.2 tonnes, and for soft cheese around 0.5 to 2 tonnes per day. Around 30 to 60 kg per day of whey cream is produced as a by-product of hard cheese manufacture. Once again, MSME-scale production makes up the bulk of the total quantity – about 85% - of cheese produced in Egypt.

Production of soft white cheese (Domiaty) and hard cheese (Roumy) is dominated in northern Governorates, such as Damietta, Dakahleya and Behera. The balance of local production (i.e. from large-scale producers) is spread among other cheese types, such as feta, processed cheese, and a small amount of Gouda and blue cheese.[22]

In spite of these impressive numbers, MSMEs face potential threats here too. Some consumers have started preferring the low-salt soft cheese produced through ultrafiltration technology used by the commercial large scale units, compared to the highly salted fresh soft cheese produced by traditional plants. Many MSMEs tend to use excessive amounts of salt during the cheese making operations, to compensate for the high bacterial activity in the raw milk and the unhygienic practices followed during milking and cheese processing activities.

2.3.4 Butter

In most Governorates, butter making is performed by farmhouse women. It is also done at the MSME scale, with units manufacturing Roumy cheese also producing butter as a by-product of whey cream.

During 1998, the total consumption of butter reached 49,000 tonnes, of which only 18% was manufactured locally by commercial large-scale dairy producers. The reason for such small local production is the "lack of adequate refrigeration throughout the country"[23], which makes the conversion of butter to samna (i.e. clarified butter or ghee) a necessity. Also, the rapid increase in availability of lower-priced shortening, which is manufactured from palm oil, has decreased the local production of butter. Butter is used in cooking and baking rather than as a spread on bread. The local butter industry is expected to grow by 23% during the coming 5 years and imports have been declining gradually (by about 20% annually).

20 Cheese Consumption per Capita (Selected Countries). Figures indicative for the year 1998. Available at: www.fas.usda.gov/dlp2/circular/1998/98-01Dairy/percaps.pd.

21 Usually, local names are assigned to each type of cheese; hard cheese tends to be known as Ras or Roumy cheese, while soft white cheese is referred to as Domiaty cheese.

22 Market Assessment, Egypt by Industrie Canada. Available at: www.strategis.ic.gc.ca/SSG.

23 Market Assessment, Egypt by Industrie Canada. Available at: www.strategis.ic.gc.ca/SSG.

2.3.5 Other Dairy Products

Other dairy products consumed in Egypt prepared by large-scale producers[24] include milk powder, processed cheese[25], butter, yoghurt, and ice cream. Other products at the farmhouse scale (primarily for on-farm consumption) include Samna, Raibb (a fermented skimmed milk), Kishk (a dried powder made from acidified milk and ground wheat), Zabady (an acidified milk, somewhat like yoghurt), and Keshda Laff (cooked cream).

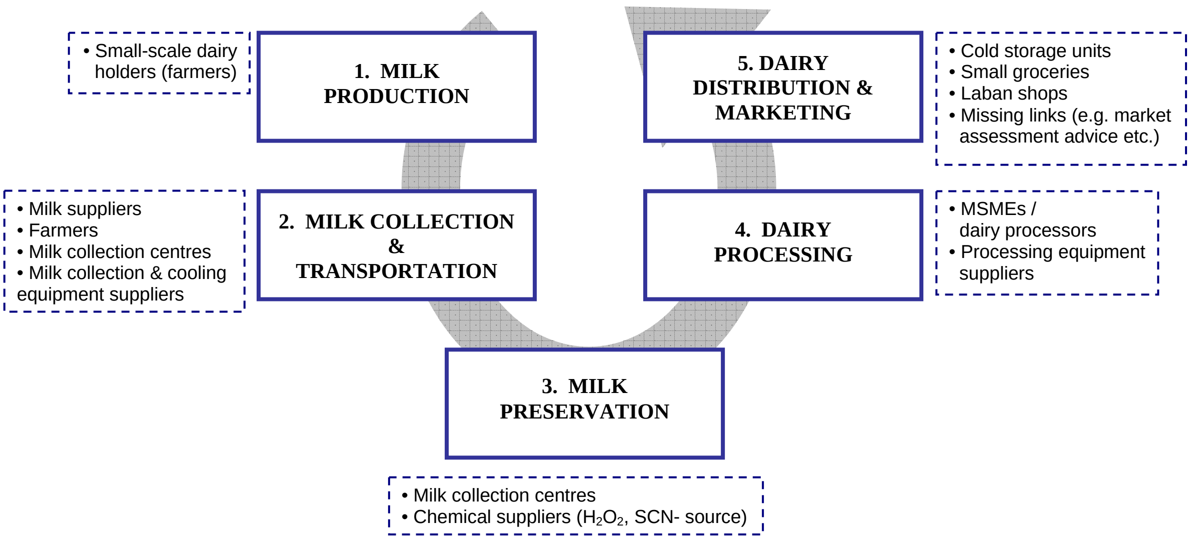
2.4 The Dairy Cycle

Having seen the significance and extent of involvement of the MSME scale within the dairy sector in Egypt, it becomes essential to study the dairy cycle, which is largely informal, and identify the factors which affect it. Such an undertaking will facilitate:

- An understanding of the different stakeholders within the dairy cycle,
- Provide indications as to the nature of interactions amongst them,
- Identify the stronger and weaker links within the cycle and
- Generate a list of options and improvements that may then be used to identify dairy sector reforms, which could ultimately strengthen the economic, environmental and social benefits at the MSME scale.

Figure 2.8 shows the various stages within the dairy cycle and the key players for each stage.

Figure 2.8: A Snapshot of the Various Stages within the Dairy Cycle at the MSME Scale and the Key Players for Each Stage[26]



2.4.1 Milk Production

Selling of liquid milk by small scale farmers is an important source of daily income.

24 Since the scope of this report is limited to MSME-scale producers within the dairy sector in Egypt, the dairy products enumerated for the larger-scale commercial sector in this sub-section will not be elaborated on in this report.

25 Processed cheese in Egypt is made from a number of ingredients, mainly palm oil, cheese curd, Roquefort cheese, skimmed milk, protein whey, emulsifying salts and preservatives.

26 "H_2O_2" stands for hydrogen peroxide and "SCN-" stands for thiocyanate ion. These chemicals are required for preservation of raw milk by the lactoperoxidase system. For further details, see Section 7.0 of this report.

As noted earlier higher quantities of better quality milk is obtained in the winter season as compared to the summer season, projects such as the Food Sector Development Programme (FSDP), launched at the request of the European Union (EU) and managed by the Egyptian Ministry of Agriculture, aimed to address this issue by adopting "an integrated development approach aimed at improving livestock feeding, animal health and breeding". This was to be done by providing about LE 300 million as loans at low interest rates of 7%, 9% and 11% for 1 year, 2 years and loans exceeding 2 years respectively.[27] However, this credit policy has been taken up by larger scale livestock production projects, and is not helpful to the traditional small-scale dairy farms and overall MSME-scale dairy production.

Further, the lack of crucial support services – veterinary services, awareness and training in the general care of livestock and hygienic milking practices, and their availability to the farmers - has also negatively affected milk production.

In terms of the quality of raw milk produced in Egypt, Egyptian standards mandate certain quality and safety criteria for food and dairy products. Raw milk Standard Number 154/2001 sets limits for composition, microbiological and contaminant levels. Raw milk must be free from Salmonella, Listeria and Brucella. Staphylococcus Aureus must not exceed 100 cfu/ml. The maximum limit mandated for Bacillus cererus is 1 cfu/ml, while the maximum somatic cell count is 750,000/ml. Additionally, raw milk should be free from any additives, preservatives, antibiotics, drugs and disinfectants. The levels of pesticide residuals, mycotoxins and radiation must comply with the international standards (Codex Alimentarius Commission Standards). (Refer also to Annex 2.3 for a list of Egyptian Standards for Milk and Milk Products). However, testing milk for quality is largely unheard of for small-scale milk production. As a general practice, the raw milk may undergo a sensory evaluation (i.e. by smell and sight for acidity and spoilage) to judge its quality. The supervisor at the concerned MSME conducts these tests in the milk reception area of the unit as per his/her judgement and experience. One of the other traits by which the raw milk may be judged is its acidity. Bacteriological tests are mostly unheard of.

The price for the raw milk is fixed regardless of its quality. Thus, at the present time, the small-scale farmer does not have any incentive in ensuring the production of hygienic raw milk is of good quality.

Interestingly, Government policy has served to play a highly important role in the aspect of milk production at the MSME scale. In October 2000, the Egyptian Government imposed a safeguard duty of 45% on milk powder imports, as a means of protecting the dairy farms from the unrestricted use of milk powder and to give them time to implement the relevant Government directives in their day-to-day activities. This safeguard made milk production a highly profitable industry so that existing farms could see incentives to improve and expand their operations. Some producers also established milk collection centres to expand milk purchases from small farmers. However, the Government has gradually reduced this safeguard duty[28] and by April 2003 the duty on milk powder imports stood at 3%, . Following this, it was reported[29] that the usual price for one kilogram of liquid cow milk was around LE 1 at the time, but larger milk factories refused to pay more than LE 0.5 (substituting raw cow milk with reconstituted imported powder milk) this resulted in huge losses for small-scale milk producers, and led to the closure of many farms.

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27 This particular programme was started in 1991 and has been extended to the year 2004.

28 The safeguard duty stood at 15% in April 2001 and at 7% in April 2002.

29 Sources: 3.1.3 Comments (on) Topic 1 (comment by K. A. Soryal, Egypt), Chapter 3 - Summary of Proceedings, pp. 11; Annex 5: Introductory Paper, Discussion Papers, Poster Papers and Comments Received on Topic 1 (comment by K. A. Soryal, Egypt), pp. 83 in Report on the FAO E-mail Conference on Small-scale Milk Collection and Processing in Developing Countries (29 May to 28 July 2000). Available at: www.fao.org.

Thus, in the case of milk production at the MSME scale, the absence of awareness, training, implementation of crucial aspects such as raw milk hygiene and quality, incentives for the production of hygienic raw milk of a good quality, misdirection of Government policies, pressures from the international market and globalization can put significant, barriers to the entire dairy cycle. One area of dairy sector reforms could focus on these aspects.

2.4.2 Milk Collection and Transportation

Milk is collected once or twice a day, usually twice a day because farms lack refrigeration systems. In cases where the raw milk is to be consumed as liquid milk the farmer may sell the milk directly to the local market or to intermediate milk suppliers.

Small-scale milk producers generally receive lower prices for liquid milk, compared to large scale dairy farms. This is mainly due to the longer distances the raw milk has to travel from the farm to the market place. Moreover, it has also been reported that some factories refuse to accept raw milk if its temperature exceeds 5-7°C,. This underlines the requirement for a "cold channel" (e.g. adequate refrigeration facilities), which is lacking at the traditional small-scale dairy farms.

Milk may be taken by farmers directly to the MSME processing site, or may be collected by the MSMEs or by a third party. Lax hygiene practices during milking and transport often lead to milk contamination.

2.4.3 Milk Preservation

The use of plastic and/or aluminium cans for milking and milk transport leads to significant bacterial contamination, this is exacerbated during transport of milk in un-refrigerated vehicles and often leads to milk spoilage and rejection. Depending upon local transport arrangements, this spoilage leads to economic loss for the farmer, third party or MSME unit. According to FAO 2001, annual milk losses of about 201,430 tonnes of milk (over LE 201.43 million) can be attributed to improper handling and raw milk spoilage.[30]

In some instances, preservatives (hydrogen peroxide) are added to the raw milk in order to suppress the bacterial activity. In the past (and the practice may continue in certain areas), farmers have used formalin as a preservative for raw milk, this poses a significant health risk to the consumer as formalin is a carcinogen.

Spoilt raw milk is either used to make 'mish' or low grade products, or is discharged directly to the sewer or drain.

It is estimated that in the winter months, 5-10% of the collected raw milk is spoilt; this climbs to as much as 30% during the summer season.

2.4.4 Dairy Processing

The milk is then processed into cheese. Unhygienic practices during cheese making often lead to the production of contaminated product that is likely to be rejected by the consumer.

To compensate for the high bacterial activity of raw milk and the poor hygiene practices, much larger amounts of salt than are needed during the cheese making operations are used.

30 Agricultural Production, FAOSTAT Agricultural Database, FAO 2003. Retrieved from the World Wide Web on July 29, 2003.

For example, Domiaty cheeses should require 7% salt, but some MSMEs use as much as 15%. This leads to a very salty product that may fetch a reduced price at market. It has been estimated that for a unit of 10 tonnes/day capacity, the production of excessively salty cheese will result in losses of LE40,000 per year, (2002 prices).

Salty cheese production results in the production of salty whey.

Depending on the type of cheese manufactured and practices followed during the cheese-making process, the whey by-product may be characterized as sweet, acidic or salty. It is important to note that salty whey is the least preferable since its downstream utilization potential is severely limited. Such a limitation would mean not only the loss of revenue from sales of whey derived product but also increased waste treatment costs.

2.4.5 Dairy Distribution and Marketing[31]

The retail distribution of dairy products is fragmented. The range of dairy products available is basic – mostly consisting of milk and cheese, and at times, samna and yoghurt.

Dairy products may be found for sale at supermarkets, small groceries and at laban shops. In the private sector, there is a top strata of less than 50 supermarkets concentrated in the upper class areas of Cairo and Alexandria. There are an estimated 180,000 small groceries, but only 5-10% of these stock a full range of dairy products. There are also some 1,800 laban shops. These are generally situated in urban residential areas and at prominent locations most have refrigerated display facilities.

At least 80% of fresh dairy products made at MSME dairy units are sold through laban shops.

These shops are independently owned and it is not unusual for a milk trader (or intermediary) who collects fresh milk from farms to own a laban shop. Fresh white cheese and mature natural cheeses are bought directly from MSME manufacturers or cheese wholesalers. Other products typically on sale include loose fresh milk, plain yoghurt and rice pudding, all made at the shop. In general, there are no large-scale made, frozen or imported products on sale in the laban shops.

At the present time there is an absence of a body representing the interests of MSMEs either in milk production, collection, processing, distribution or marketing of products. While institutions such as the Egyptian Exporters Association (EEA) and Agriculture-Led Export Businesses (ALEB) do exist, their activities are primarily to address export activities; they do not extend throughout the entire dairy cycle and do not orient themselves towards MSMEs.[32]

As a result, it is difficult (if not impossible) for MSME scale dairy farmers and/or units to:

- Get the best possible price for their milk. The small-scale dairy farmer with a few litres of good quality fresh milk may be forced to sell the milk to the first milk trader he encounters, who may or may not offer him the best price for his

31 Adapted largely from The Egyptian Dairy Market, 1997 by IMES Consulting, UK. Source: www.imes.co.uk/pages/egyptart.html.

32 The goal of the Egyptian Exporters Association (EEA) is to develop Egyptian non-traditional exports and increase Egyptian exporters' competitive advantage, helping them reach and compete in targeted markets with sophisticated and enhanced products or services matching international market demands. EEA offers a comprehensive service package from information, market research, technology transfer, export promotion, to market entry.

Agriculture-Led Export Businesses (ALEB) was established and funded by USAID to support Egypt's private sector. ALEB provides assistance in collecting and utilizing market information, integrating new food processing technologies, improving adherence to international food quality and safety standards, enhancing marketing and business skills, strengthening associations; and forming strategic alliances.

produce. This not only adversely affects the farmer economically as he depends on milk sales as part of his daily livelihood but there is no incentive for hygienic milk production as he is liable to get paid for his produce depending on chance rather than quality.

- Make strategic decisions about new product lines; gather news about market assessments vis-à-vis pricing of products in the markets, the supply and demand situation, etc. This means that decisions to upgrade or modernise the facility cannot be made on the basis of demand or informed judgement. This may lead to losses on investments, no upgrading or modernisation and the concomitant loss of markets.

The establishment of a suitable institution which can help the MSME scale processor with such matters could be an important area of focus for dairy sector reforms.

2.5 Policy, Regulatory and Institutional Framework

Local dairy production is not subject to any subsidies or any other form of special government assistance. Investment projects in the dairy business are eligible to the preferential terms of Investment Law No. 8/97. Investment projects in the field of livestock (cattle) raising for dairy production purposes are also covered by Investment Law No. 8/97.

The dairy industry must comply with the specifications laid down by Egyptian standard definitions. The Egyptian Organization for Standardization and Quality Control[33], under the Ministry of Industry, is responsible for issuing food standards and quality control certificates, and approving quality certification bodies in Egypt.

Dairy units are also required to label their products with the product specific Egyptian standard. They are required to indicate whether the product is produced from fresh milk or powdered milk or both and the labelling law requires processors to indicate the percentage of powdered milk in the mixture, calculated on the basis of its weight after restoration. This law applies to pasteurized milk, UHT milk, ice cream, cheese and yoghurt.

The Ministry of Health and the Ministry of Home Trade and Supplies apply shelf life standards and product specifications to dairy products. Any product that exceeds its established shelf life is considered no longer fit for human consumption and is subject to confiscation.

In order to address hygiene related issues in the dairy sector, the Government issued a decree to pasteurize all locally produced milk (2001). However, it has been reported that MSMEs are having problems in responding to this directive due to:

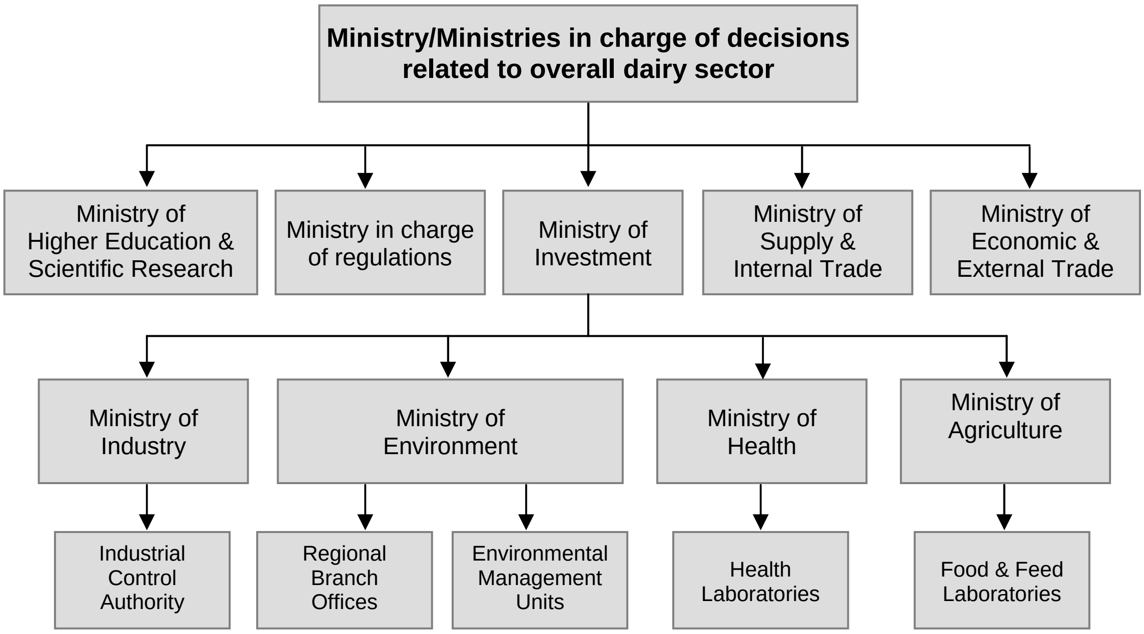
- Financial constraints,
- Lack of understanding of additional benefits that pasteurization can provide to the MSME unit,
- Difficulties in accessing the appropriate technology at the right scale,
- Lack of skills in operating such equipment,
- High acidity levels in raw milk in the summer making the raw milk unfit for pasteurization,

33 The Ministries of Health, Agriculture, Home Trade and Supplies, Economy and Foreign Trade, along with various experts in the field, provide recommendations to the all–encompassing General Authority for Standardization and Quality Control.

- ❑ Perceived reduction in taste, especially for Roumy cheese due to the effect of pasteurization on natural micro flora associated with raw milk.

Figure 2.9 presents an organization chart depicting the policy and regulatory framework applicable to the dairy sector in Egypt.

Figure 2.9: Policy and Regulatory Framework Applicable to the Dairy Sector



The following areas may provide a focus for dairy sector reforms from the policy, regulatory and institutional framework point of view:

- ❑ Addressing requirements for micro-finance in the areas of milk production and dairy product processing (i.e. technological improvements) in particular,
- ❑ Envisioning a more pliable, easier to understand and implement environmental regulatory framework (for further details see Section 4.0),
- ❑ Allowing for the use of novel and appropriate waste utilization techniques, e.g. reuse of whey generated as a by-product of cheese processing operations for baked goods manufactured in bakeries (for further details see Figure 6.6, Section 6.0)
- ❑ Establishing regulations governing limits on salt usage in all dairy products in order to protect consumer health and also as a means of ensuring that the product meets criteria for export (such a regulation already exists for Domiaty cheese (to a maximum limit of 9%),
- ❑ Allowing for reductions or exemptions on any government duty charged for MSME scale processing equipment, etc.

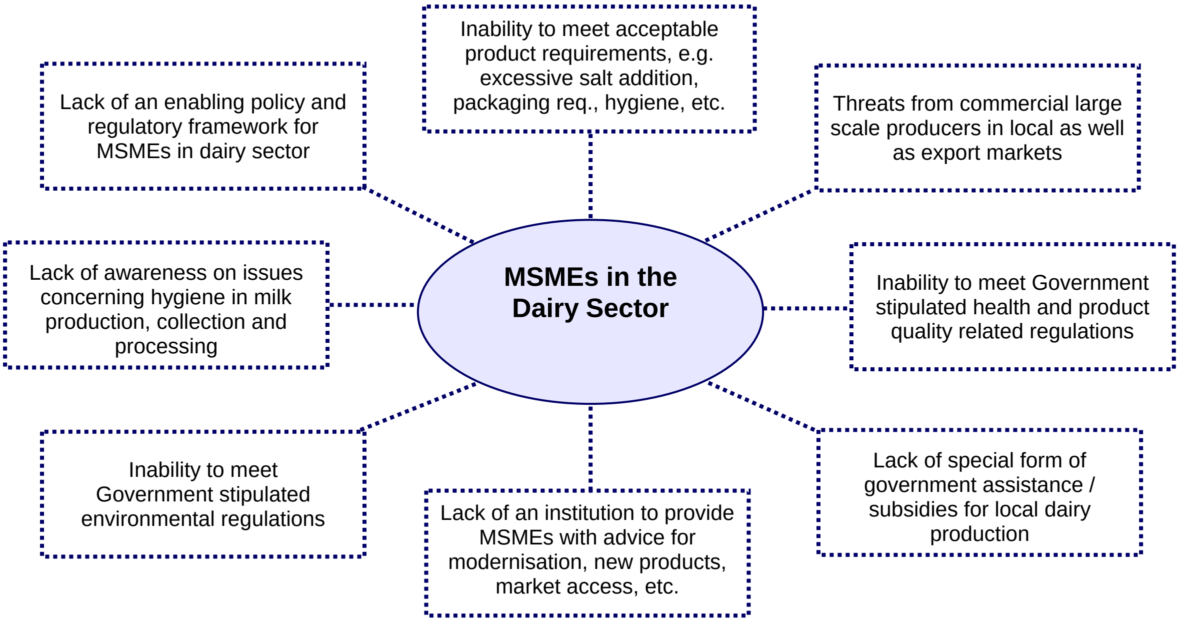
2.6 Issues Facing MSMEs

A general summary is presented the below.

- About 70% of Egypt's dairy production occurs in the MSME-scale production segment.
- A major share of the total cheese production (about 85%) and sale of milk (about 90%) for local consumption is at the MSME-scale.
- Large–scale dairy producers make multiple products, while MSME-scale units make only one or two products, comprising primarily of cheese(s). MSMEs produce Roumy, Tallaga, Baramely, Domiaty and Istanbully cheeses, which are not produced by the modern larger-scale plants. This production tends to be seasonal.
- While a substantial export market exists for MSME cheese products, a number of issues must be addressed before this market share can grow. These issues include quality concerns, excessive salt addition, hygiene concerns and packaging concerns.
- Increasingly stringent environmental and health-related legislations pose a threat to the survival of MSME dairy units, and hence a threat to the income and employment of a large segment of the public. Such regulations cannot be met, because of high capital and operating costs, space constraints and/or lack of adequate skills for operating the facilities.
- Additionally MSME units face severe competition from large scale producers, both in the domestic and export markets. To fight this competition process and product improvements, adoption of new technologies and building of new skills are required.

Figure 2.10 sums up the various threats facing MSMEs in the dairy sector.

Figure 2.10: Threats Facing MSMEs



This unique set of circumstances has led to both challenges and opportunities for MSME units.

The principal challenge is to organise the collection of safe, good quality milk and provide a constant supply of quality milk and dairy products to meet market demands. At the same time, the market demand for value added products for a range of income levels should be met. The Egyptian Government is also looking to find ways to reduce imports of food and food products that are a major burden on the national budget and especially on hard earned foreign currency.

However, strategies and policies to promote dairy sector activities at the MSME scale often do not address the key issues of small-scale dairy cycle. This acts as a limiting factor in the success of many programmes and projects.

The main driving force to attract MSME-scale producers into a profitable dairy cycle is to provide increased incentives to undertake hygienic practices, stimulate production and encourage improved technologies. Efforts in dairy sector development at the MSME scale should therefore be directed toward integrating milk production, processing, distribution and marketing, to ensure that valuable resources are not wasted, whilst pursuing appropriate returns to MSME producers, and improving the quantity and quality of dairy products for urban and rural consumers.

The concept of Cleaner Production can serve this purpose very well with practical, cost-effective and sustainable solutions to address environmental, health and productivity concerns of the MSMEs.

Chapter

3

What will we learn from Chapter 3?

3.0 Process Description and Waste Generation in Milk Product Processing Operations

3.0 PROCESS DESCRIPTION AND WASTE GENERATION IN MILK PRODUCT PROCESSING OPERATIONS

3.1 Introduction

Dairy production is a global activity that relies on relatively primitive technology, more so in the developing world and plants such as those in the category of MSMEs.

In order to effectively understand the problems facing the dairy sector, and in particular the problems facing MSMEs, we need to understand the day-to-day functioning of MSME operations, this will allow:

- The identification of pollution hazards,
- Expected violations to allied regulatory framework[34],
- Economic, social and environmental damages and scope for improvement.

This will help to determine avenues for implementing the concept of Cleaner Production[35].

3.2 Process Overview

The process overview for each dairy product includes a brief introduction about the dairy product, a flow diagram showing how it is produced and the process description. The flow diagram pinpoints activities during the process for which some waste generation occurs, including air emissions, liquid waste or wastewater and solid waste.

It should be noted that while the process overviews given here are typical for MSMEs in the dairy sector, some variation across units and Governorates is possible.

3.2.1 *Roumy* cheese

Roumy cheese falls under the category of hard cheese. Depending on the fat content of raw milk used in the cheese making operation, it has a moisture content of 35 to 40% and a fat content of 30 to 35%.[36] Egyptian Standards require that Roumy cheese moisture content should not exceed 40%. A minimum limit of 45% is prescribed for Fat Dry Matter (FDM). Additionally, the cheese should meet the Egyptian Standards for absence of pathogens and harmful additives.

Figure 3.1 outlines the basic process of making Roumy cheese along with the required material / energy inputs and expected outputs.

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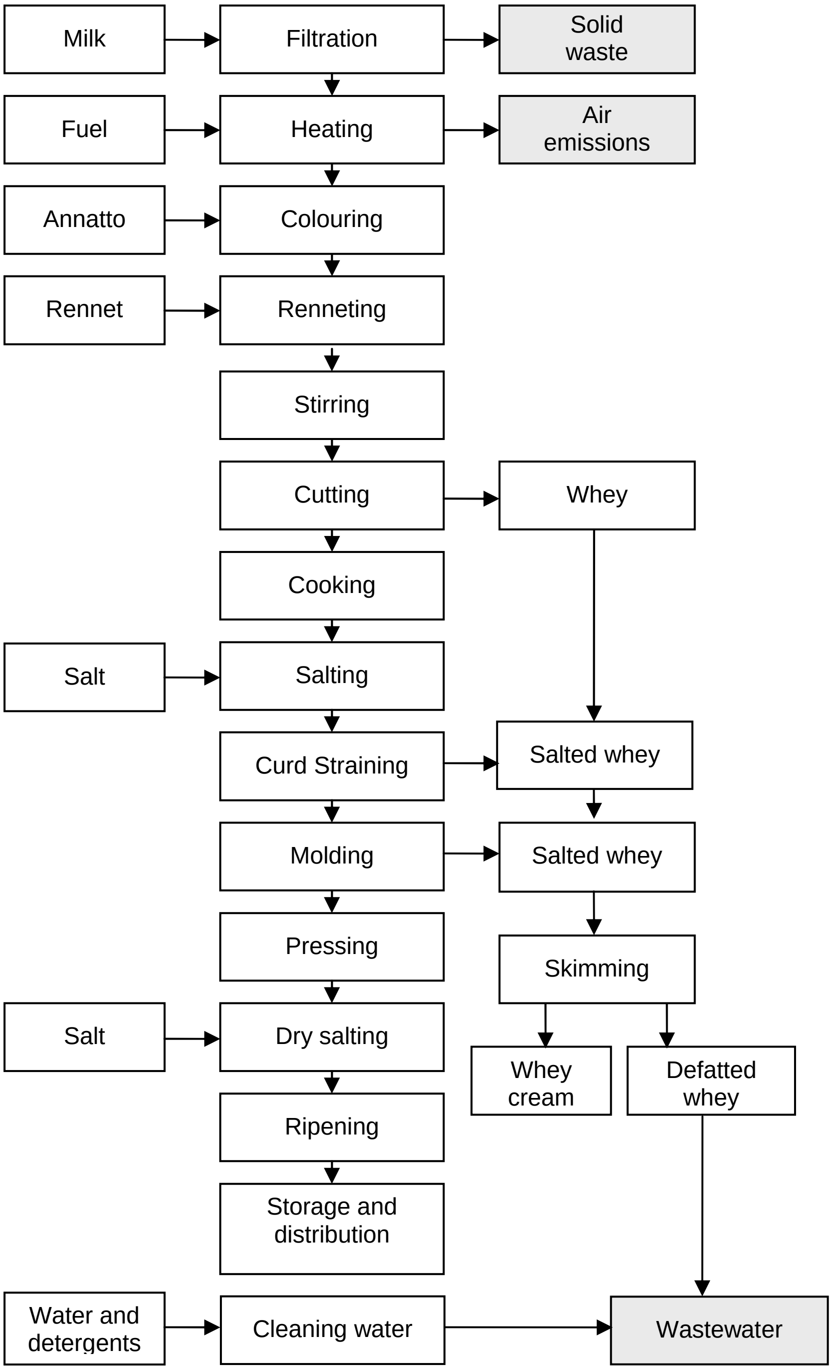
34 This aspect is dealt with in more detail in Section 4.0 of this report.
35 This aspect is dealt with in more detail in Sections 5.0 and 6.0 of this report.
36 Source: *Characteristics and Manufacturing Techniques of Traditional Milk Products - FAO Animal Production and Health Paper – 85* by the Food and Agriculture Organization (FAO). Available at: www.fao.org.

Figure 3.1: Flow Diagram for the Production of *Roumy* Cheese



At the pre-treatment stage, the raw milk is filtered with cheesecloth so as to remove any debris (such as plant material, hair, etc.) before filling the cheese vats. (Other pre-treatment techniques i.e. clarification, standardization and homogenisation, are generally not applied at the MSME scale. The reasons for such omissions generally include lack of awareness and technical know-how, and financial constraints).

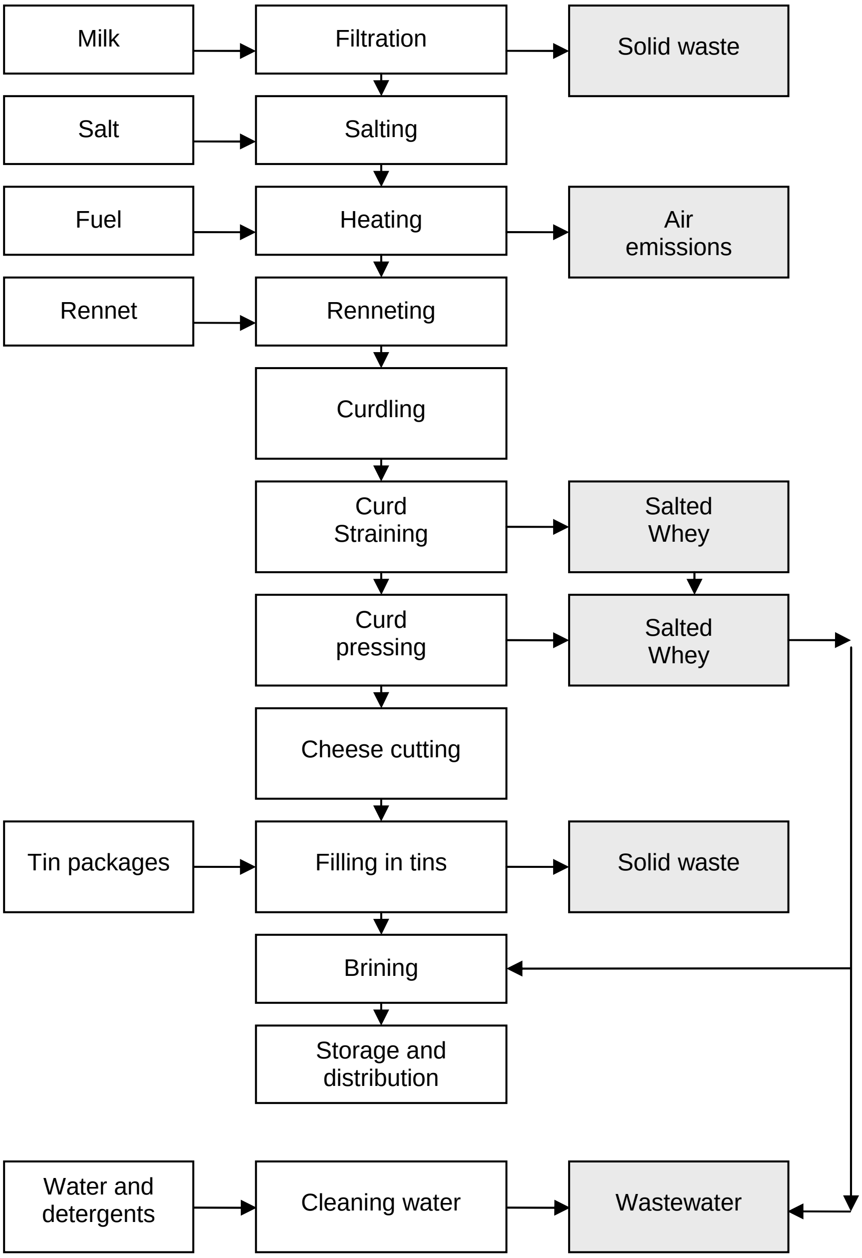
Raw milk is not subjected to any heat treatment. No starter cultures are added for this particular type of cheese. Coagulation is obtained with liquid rennet, which takes 20 to 30 minutes at 30 to 33°C. The curd is stirred with a wooden paddle until the curd size reaches the size of maize grains and then the curds are stirred and heated up to 45°C in 45 minutes. Salt is added in a concentration of about 4 to 6%. The curd is moulded and pressed for 12 to 16 hours. After removal from the moulds, the cheese is dry salted and then ripened in a room at 15 to 20°C for at least 90 days.

3.2.2 *Domiaty* Cheese

Domiaty cheese is known locally as Gibbneh Beda (white cheese), it is very popular and is consumed fresh or ripened by pickling after 3 months of storage. It is considered as the highest salted cheese among world cheese varieties with up to 10% salt added. Salt is added directly to the milk before renneting. The curd is white and has a very salty taste and it has a homogeneous texture with small eyeholes. It is usually shaped into rectangles and is packaged to weigh between 0.4 to 1 kg. Its composition according to the Egyptian Standards should not exceed 60% for moisture content and 9% for salt content. A minimum limit of 40% is prescribed for Fat Dry Matter (FDM). Additionally, the cheese should meet the Egyptian Standards for absence of pathogens and harmful additives.

Figure 3.2 outlines the basic process of making Domiaty cheese along with the required material and energy inputs and expected outputs.

Figure 3.2: Flow Diagram for the Production of *Domiaty* Cheese



In MSMEs Domiaty cheese is manufactured from raw cow and buffalo milk with a high level of salt addition (up to 15%). In contrast, modern large-scale dairies use pasteurized cow milk with a lower level of salt addition (6 to 8%). Recently, all modern dairies have started using ultrafiltration (UF) technology for Domiaty cheese manufacturing. Accordingly, Domiaty cheese made by UF is quite different from that made in MSME dairies. It has a much lower salt content (3%) and is also referred to as fresh spreadable soft cheese.

For the processing of Domiaty cheese in MSME dairies, salt is added directly to the milk. In case of pasteurized milk, calcium chloride is added. Coagulation is obtained mainly by means of liquid calf rennet in traditional dairies, while microbial rennet is widely used in modern large-scale dairies. The coagulation takes 2 to 3 hours at 38 to 40°C. Subsequently, the curdled milk is ladled into large wooden frames lined with cheesecloth. The curd is pressed for 12 to 24 hours. After pressing, the block of cheese is cut into pieces of a suitable size, these are arranged in tins and covered with salted whey (brining). Green pepper is usually used for flavouring. Then tins are closed and cheese is kept for up to 9 months at room temperature (20 to 25° C°).[37]

There are also other types of soft white cheese produced with slight modifications to the production process of Domiaty cheese. For example, Tallaga is a fresh low salt high moisture cheese that is kept and sold refrigerated. Baramely cheese is a ripened low salt low moisture cheese.

3.2.3 Fatty and Fermented Dairy Products

The following dairy products fall under the category of fatty and fermented dairy products – Raibb, butter, Samna (or ghee), Morta and Karish cheese.

Figure 3.3 outlines the basic process of making of fatty and fermented dairy products, along with the required material and energy inputs and expected outputs. The process steps for each product are as described below.

Raibb

Raibb is a fermented skimmed milk (less than 1% fat content) obtained by spontaneous acidification of raw buffalo milk during separation of cream by gravity. It is consumed as a refreshing beverage.

In modern large-scale dairies, stirred yoghurt made from full cream cow milk in a controlled fermentation process is labelled as Raibb.

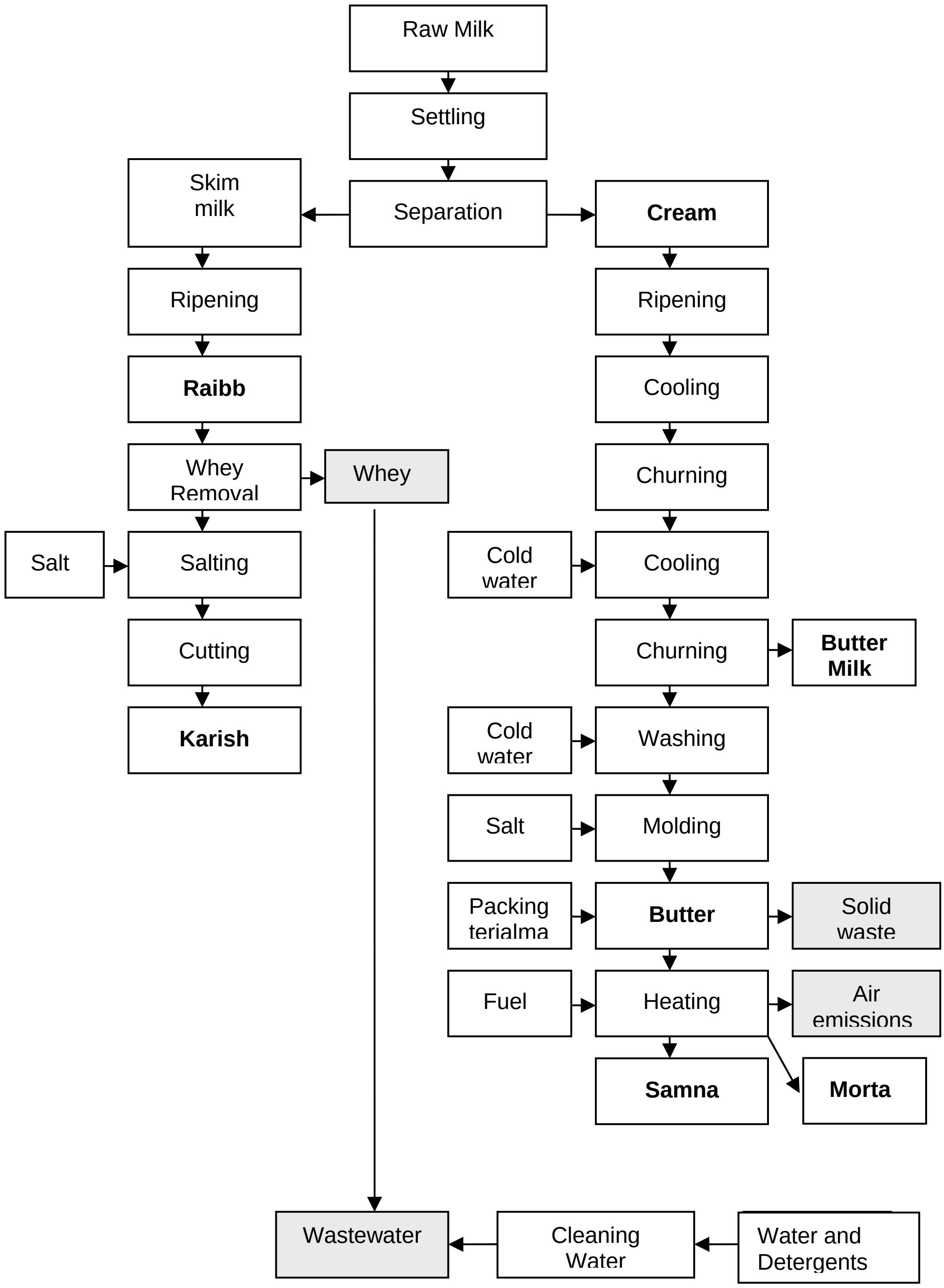
Butter

Butter (also known locally as Zebdah) is the fatty product derived from milk cream or whey cream. Apart from milk fat, it contains milk solids, water and occasionally, additives. It has a mild to slightly acidic taste. The average fat content of butter is 80%.

Cream is usually obtained by natural separation from whole milk, where cream floats to the milk surface. When the amount of cream produced on a daily basis is very small, it may be stored for a number of days in a vessel until enough is accumulated for churning. In this case, butter will almost certainly have an acid taste due to the spontaneous acidification of raw cream. The collected (sour) cream is poured into a churn, which is properly plugged and then shaken usually for several hours until butter grains appear. Buttermilk is drained off and butter grains are washed, with fresh cold water in order to remove the rest of the buttermilk. This washing stage also improves butter firmness. Subsequently, the butter is worked by hand to give it a homogeneous and even texture, and to exclude air or water from between the butter grains. The finished butter may be packed into glass jars or wrapped in special plastic or paper depending on its consistency.

37Source: *Characteristics and Manufacturing Techniques of Traditional Milk Products - FAO Animal Production and Health Paper – 85* by the Food and Agriculture Organization (FAO). Available at: www.fao.org.

Figure 3.3: Flow Diagram for the Production of Fatty and Fermented Dairy Products



Samna

Samna (also known as ghee) is the milk fat (or butter oil) obtained by removal of water from butter by heating. The minimum limit of fat content is 99.5%. It has a white colour if manufactured from buffalo milk and a yellow colour if made from cow milk, the former being preferred by Egyptian consumers. Samna is used for cooking purposes and sweet manufacture.

Samna is traditionally made from butter and sometimes from cream. After adding a small amount of salt, the butter/cream is subjected to direct heating and stirring until the cooked flavour typical to Samna is observed. At the end of the process, the milk protein turns yellow in colour, forming a by-product called Morta. It has a salty taste and is used as supplement in Mish production (see below).

Karish Cheese[38]

Karish cheese is mainly manufactured on farms by women and is sold at the local markets by them. It is consumed as a staple food and may also be ripened by pickling for not less than 1 year (in this case, it is called Mish cheese).

Karish cheese is an acid coagulated fresh cheese. It has a white curd texture, is slightly salty and has an acidic taste. The average composition is 70% by moisture and about 10 to 25% FDM.

Karish is made from buffalo milk. The milk is subjected to gravity or mechanical separation. However, it does not undergo any heat treatment. The acidification develops from the natural flora present in the raw milk. Coagulation is solely obtained by acidification over 1 to 3 days. After coagulation, the curd is ladled into a special cheese mat called Hosor made from the Sammar (*Cyperus alopecuroides*) plant. The curd is left to drain properly for several hours. A small amount of salt is sprinkled on when it is firm enough. Subsequently, the Hosor containing the salted curd is rolled to facilitate the removal of whey for 1 to 3 days. The cheese is not pressed. The long cylindrically shaped cheese in the Hosor is removed and cut into equal parts. This cheese may be kept for 7 to 15 days.

Mish

Mish is a soft pickled cheese without rind. Its body is yellowish to brown and has a close texture without eyeholes. It has a sharp and salty taste. The average composition of this cheese is 60% by moisture, 40% dry matter and 20% FDM.

On a traditional scale, women prepare Mish for family consumption. It is sold in the local markets directly by the women and also through retail shops. It is consumed as a staple food by farmers and as appetizer by the rest of the population.

The manufacturing process for Mish cheese is the same as that of Karish cheese. Karish cheese is usually left for several days in a dry place to drain as much as possible. Then, the cheese is rinsed with water and put in layers in earthenware jars called zalaa or ballas. Salt is sprinkled over each cheese layer in the container, which is then filled up with a pickling solution. The pickling solution consists of buttermilk, sour skim milk (Raibb), whey and Morta (the remaining precipitate after the preparation of Samna by boiling of butter) in variable proportions. Red and green pepper, and some old Mish as a natural starter are added. The container is sealed and placed at ambient temperature for not less than one year.[39]

In both traditional and modern cheese dairies, low-grade cheeses (defective in structure, but acceptable otherwise) are also used for Mish production. Such cheeses are subjected to severe heat treatment, blended, salted and supplemented with some ripened Mish as flavouring material.[40]

38See Footnote 39.

39Source: *Characteristics and Manufacturing Techniques of Traditional Milk Products - FAO Animal Production and Health Paper – 85* by the Food and Agriculture Organization (FAO). Available at: www.fao.org.

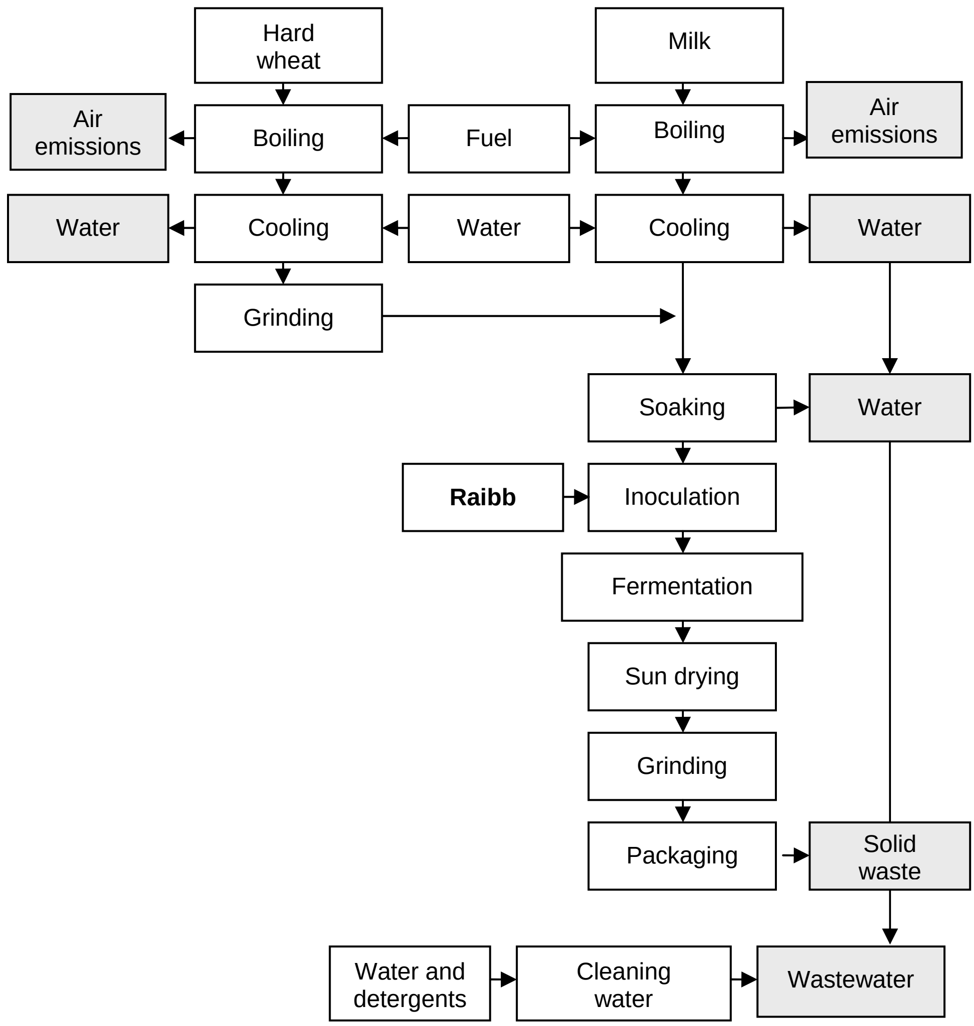
40 Pers. communications from Dr. Osman Aita.

***Kishk*[41]**

Kishk is a dried powder made from acidified milk mixed with ground wheat and then sun dried. It is yellowish, and has an acidic and yeast fermented taste. The average composition of Kishk is 10 to 15% by moisture, 85 to 90% dry matter and 8 to 10% fat content. Dried Kishk is mixed with water, salt, garlic, and then boiled and is consumed like a hot soup.

Figure 3.4 outlines the basic process of making Kishk along with the required material/energy inputs and expected outputs. The process steps are as described below.

Figure 3.4: Flow Diagram for the Production of *Kishk*



Hard wheat is half boiled, cooled and subsequently ground into pieces. The milk is heated to 70°C for 30 minutes. The ground wheat is added to the milk in an earthenware jar. The jar is then covered and the mix is allowed to settle for 24 hours at room temperature. Next, some of previously prepared Raibb is added as a starter culture to the settled mixture, which is then mixed by hand. Once more, the mix is left to ferment for 24 hours. After three days, the mix turns into a pale white paste. It is then spread in a thin layer and sun dried. When the product has dried, it is ground and packed in cloth bags. It can be kept for one year.

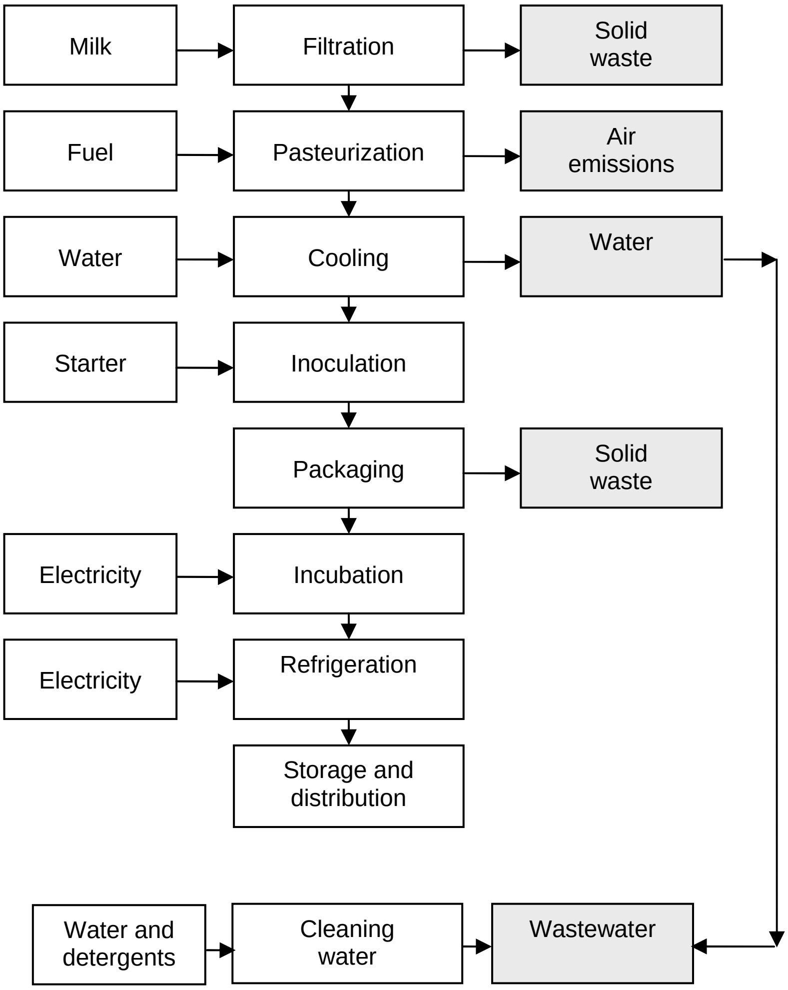
41Source: *Characteristics and Manufacturing Techniques of Traditional Dairy Products – FAO Animal Production and Health Paper – 85* by the Food and Agriculture Organization (FAO). Available at: www.fao.org.

***Zabady*[42]**

Zabady is acidified milk obtained by the fermentation of lactose by means of lactic acid producing bacteria. It is white with a mild to sour taste.

Figure 3.5 outlines the basic process of making Zabady along with the required material and energy inputs and expected outputs. The process steps are as described below.

Figure 3.5: Flow Diagram for the Production of *Zabady*



Buffalo milk is usually heated to 80 to 90°C for 10 minutes. The milk is then inoculated with some yoghurt from the previous day. This mixture is allowed to acidify overnight (6 to 8 hours) at 42 to 45°C, after which the Zabady is ready. The end product is refrigerated. Its acidity usually reaches 0.8 to 0.9% of lactic acid.

In modern large-scale dairies, Zabady is manufactured using the standard procedure for yoghurt making, using homogenized pasteurized cow milk inoculated with starter cultures.

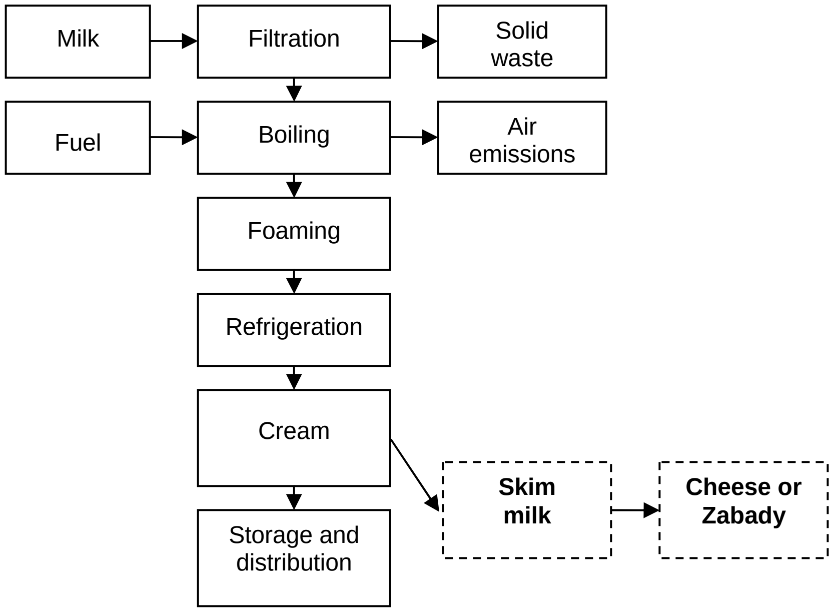
42Source: *Characteristics and Manufacturing Techniques of Traditional Dairy Products – FAO Animal Production and Health Paper – 85* by the Food and Agriculture Organization (FAO). Available at: www.fao.org.

Cooked Cream[43]

Cooked cream (also known locally as Keshda Laff) is a heated fresh cream characterized by its spongy structure and cooked flavour. It has a rich sweet taste and is usually shaped in the form of a cylinder. It is used as a topping for oriental pastries. It is manufactured and marketed in small shops selling dairy products in urban areas.

Figure 3.6 outlines the basic process of making cooked cream along with the required material and energy inputs and expected outputs. The process steps are as described below.

Figure 3.6: Flow Diagram for the Production of Cooked Cream



Keshda Laff is made from buffalo milk. The milk is boiled for 30 minutes and then poured hot into a shallow container from a height so as to generate foam. This step is repeated several times until thick foam is formed on the surface of the milk. Then, the foamed milk is cooled in refrigerators. It is left overnight until a thick layer of cream has formed on the surface. The layer is then manually removed and rolled and shaped into a cylinder for packing purposes. The cooked cream is kept and sold refrigerated.

3.3 Waste generation from processing operations[44]

Waste generation from dairy processing operations at the MSME scale includes liquid waste, solid waste and air emissions. The generation of liquid wastes constitute the major environmental concern. Wastewater discharged from the MSME dairy operations consists of spoilt milk, whey and wash water, it is normally discharged to the sewer without any treatment.

Solid waste is generated as a result of packaging operations for all dairy products and small quantities of waste arise from the filtering raw milk. While air emissions are generated by the use of boilers for heating purposes. Quantification of waste generation in the Egyptian dairy sector at the MSME scale exists only for wastewater at the present time.

43 Source: *Characteristics and Manufacturing Techniques of Traditional Dairy Products – FAO Animal Production and Health Paper – 85* by the Food and Agriculture Organization (FAO). Available at: www.fao.org.
44 *Best Available Techniques (BAT) for the Nordic Dairy industry*. Available at: www.norden.org/pub.

The following sub-sections present an overview of the various activities in dairy processing that are liable to bring about some form of waste generation.

3.3.1 Milk Reception

Water is used for rinsing of the inside of the milk cans and plastic barrels, and the reception area. Some milk spillage is also to be expected.

3.3.2 Heat Treatments

The practice of heat treatment has started recently as a means of complying with food safety regulations. The main environmental issues of such treatments are related to the high levels of energy consumed in heating and cooling of the raw milk, and the electricity consumed by the separator and the pumps.

Water is consumed for rinsing and cleaning of the equipment, which in turn results in the generation of wastewater containing milk solids and cleaning agents (detergents). Water and milk mixtures are also generated at the start-up of the production line, when the water in the pipes is replaced by milk.

3.3.3 Fermented Milk Production

The production of fermented dairy products involves several heating and cooling steps, which in turn result in high consumption of cooling and heating energy (cooling water and hot water streams). There is also milk spillage throughout the process, particularly during start-up and equipment rinsing.

3.3.4 Butter Production

The churning step produces buttermilk, which represents a potential environmental loading unless carefully collected and segregated. The buttermilk usually amounts to approximately 50% of the original cream volume, and can be used as an ingredient in other products. Sour buttermilk is more difficult to use for purposes other than animal feed.

Additionally, after the process is completed, the residual fat remaining in the equipment has to be rinsed out before the equipment is cleaned. The rinsing and cleaning steps result in high organic loads in the generated wastewater.

3.3.5 *Samna* Production

A large amount of energy is consumed in the steps involving heating and melting of the butter. The process also produces a by-product in the form of Morta, which may be used as supplement for Mish production.

3.3.6 Cheese Production

The environmental impacts of cheese production include the generation of whey and energy consumption required for cooking of the curd.

Whey is the liquid remaining after the recovery of the curds formed by adding rennet or starters to milk. It comprises 80 to 90% of the total volume of milk used in the cheese making process and contains more than half the solids from the original whole milk, including 20% of the protein and most of the lactose. The disposal of whey produced during cheese production has always been a major problem in the dairy sector. Only in the past two decades have technological advances made it economically possible to recover soluble proteins from cheese whey and, to some extent, to recover value from the lactose. However, MSMEs have been slow to catch up with such technological advances mainly due to financial constraints, lack of awareness, technological know-how, etc.

It is important to understand the different types of whey that arise as by-products in cheese making operations.

Box 3.1: Types Of Whey Resulting From Cheese Making Operations

The following are the different types of whey resulting from cheese making operations:

- ***Sweet whey:*** This type of whey is generated when rennet is used to coagulate the milk. Sweet whey typically contains 0.6–0.9% soluble protein, up to 0.3% fat and large quantities of lactose (up to 5%). The pH value of sweet whey falls between 5 to 5.5.
- ***Acid whey:*** This type of whey is generated when acid is used to coagulate the milk. Acid whey typically contains the same proportion of soluble proteins as sweet whey, but less fat and somewhat less lactose (4.5%), since some of the lactose is converted to lactic acid. It has a low pH value of about 4.5 to 4.7.
- ***Salty whey:*** This type of whey is produced during the pressing of salted cheese curd, such as in the manufacture of Domiaty cheese. Due to the presence of salt, it is important that this whey should be collected separately from other types of whey.

Whey constitutes the dominant pollution load as it contains a high percentage of milk components[45] and may contain high salt concentrations. The BOD of whey is extremely high at around 40,000 to 50,000 milligrams per litre (mg/l). Depending on the size of operations, some 8 to 18 cubic metres per day (m^3 /d) of whey are produced by the manufacture of cheese at MSME units. After dilution by washwater, the resultant wastewater corresponds to about 4,000 to 5,000 mg/l of BOD, which is still significantly higher than that permitted for sewer discharge (i.e. 600 mg/l[46]). Discharge of untreated whey and/or washwater containing whey to sewers/drain can lead to dangerous falls in levels of dissolved oxygen in the receiving water body, thus leading to loss of aquatic life. Uncontrolled disposal of untreated whey on land can lead to high salinity and septicity issues in the soil.

The pressing of cheese produces more whey. Curd grains are often spilt on the floor during moulding and are usually flushed into the sewer by water at the end of the processing operation. Rinsing of cheese vats generates wastewater containing cheese fines and traces of fat. Water and cleaning chemicals are used for cleaning of the moulds and pressing equipment, which in turn contribute to the wastewater stream.

The temperatures in the ripening rooms should be strictly maintained, thus requiring large quantities of energy. Cold storage units use refrigerants, which might accidentally leak into the air. Refrigerants utilise chlorofluorocarbons that are known to adversely affect the ozone layer.

45 Comprising of lactose (5%), protein (1.25%) and fat (1.55%).
46 As per Law 93/62 (as Decree 44/2000).

3.3.7 Packaging

The major wastes from the packing of cheese are solid wastes in the form of discarded cuts and small pieces of cheese, as well as spent ripening bags and wax residues. In addition, there are liquid discharges from cleaning of surfaces, packaging machines and conveyors.

Most packaging materials end up as solid waste at the household level (i.e. waste disposed of by consumers of the dairy products). Empty packages and rejected material, as well as packages from rejected dairy products represent the major proportion of solid waste from dairy processing units.

3.3.8 Cleaning and Disinfection

Cleaning represents an essential activity of the operations in any dairy plant.

Chemicals used during the cleaning process may be hazardous, and could be subject to handling, storage and management procedures required by law.[47] The chemicals used for this purpose are acidic such as hydrochloric acid and nitric acid, and caustic such as sodium hydroxide and sodium hypochlorite. While the organic load caused by the cleaning chemicals is minor, the fluctuation of the pH of wastewater represents the main problem.

Cleaning may be done manually or automatically, cleaning activities tend to be manual at MSMEs while cleaning in place (CIP) practices are common in modern large-scale dairies.

Manual cleaning

Floors of the production facilities are cleaned and any product spills on the floor or on the outside of equipment are manually flushed to drains.

Manual cleaning consumes a great deal of water particularly in the absence of pressurized hot water. Water containing detergents and product residues, usually flows directly to the drain.

Cleaning of milk tanks and vats

Tanks and vats are cleaned every day at the end of each collection round. The outside of the vessels should also cleaned daily which may result in waste water containing sand, heavy metals, and lubricants in addition to detergents used for the cleaning. The cleaning takes place in the reception area and generates large quantities of waste water.

CIP Equipment

The design of modern dairy equipment allows cleaning and disinfecting to take place without dismantling of the equipment. Rinsing water and cleaning solutions are pumped through all the components that are in contact with product. Some equipment has built-in cleaning nozzles to improve the distribution of the cleaning solution.

Again, the pollution load of the resultant wastewater is high due to the mixture of residual milk fat and proteins, and cleaning chemicals.

47 *Self Monitoring Manual: Dairy Industry*, 2003 by Ministry of State for Environmental Affairs [Egyptian Environmental Affairs Agency (EEAA) and Egyptian Pollution Abatement Project (EPAP)].

3.4 Utilities – Description and Potential Sources of Waste Generation

The commonly occurring utilities or service units in MSME plants are boilers and refrigeration systems and storage facilities. Utilities also contribute to environmental pollution.

3.4.1 Boilers

Boilers are used to produce hot water in order to supply heat to the processes. The gaseous emissions generated by boilers are typical of those generated from combustion processes. The types of fuel used are fuel oil (mazout), gas oil (solar), gasoline and natural gas. The exhaust gases from burning fuel contain particulate matter (PM), heavy metals (if they are present in significant concentration in the fuel), carbon monoxide (CO), carbon dioxide (CO_2), sulphur oxides and nitrogen oxides (SO_x and NO_x), and volatile organic compounds (VOCs). The concentrations of these pollutants are a function of the firing configuration (i.e. nozzle design), operating practices and fuel composition. Gas-fired boilers generally produce the smallest quantities of particulates and other pollutants.

Box 3.2 provides information on health impacts associated with the various pollutants associated with combustion of fuel.

Box 3.2: Health Impacts of Air Pollutants

- ***Particulate matter (PM):*** PM are particles found in the air, including soot, dust, smoke, and liquid droplets. In the case of industrial operations, incomplete fuel combustion is a significant source of PM emissions. In humans, PM can cause coughing, painful breathing, can aggravate asthma, and increase the risk of premature death. Those at risk are workers exposed to PM on a daily basis, the elderly, children, and people with existing lung disease. Recent medical studies suggest that much of the health damage caused by exposure to particulates is associated with PM smaller than 10 microns in diameter. PM can cause damage to the environment by making rivers, lakes and streams acidic, changing the nutrient balance in coastal waters and large river basins, depleting nutrients in soil, damaging sensitive forests and farm crops, and affecting the diversity of ecosystems.

- ***Sulphur oxides and nitrogen oxides (SOx and NOx):*** Air pollution by these pollutants is a major environmental problem world-wide. In humans and animals, they can irritate the respiratory tract and may give rise to disease, especially in children and asthmatics. They also cause premature long-term damage to building materials due to their highly corrosive nature. Acid rain is another problem of great concern arising as a result of excessive SOx and NOx emissions. It is caused by the dissolution of these compounds in atmospheric water droplets to form acidic solutions, which are very damaging when distributed in the form of rain, since it is corrosive to metals, limestone and many other materials. Excessive quantities of these compounds cause long-term damage to the environment.

- ***Volatile Organic Compounds (VOCs):*** VOCs are compounds that contain carbon and evaporate easily from water into air at normal air temperatures. This is why the distinctive odour of gasoline and many solvents can easily be detected. VOCs are contained in a wide variety of commercial, industrial and residential products including fuel oils used for industrial purposes, gasoline, solvents, cleaners and degreasers, paints, refrigerants, etc. They vary considerably in their toxic (or harmful) effects. VOCs at levels higher than the health risk limits may be harmful to the central nervous system, the kidneys and the liver. They may also cause irritation when they contact the skin or may irritate mucous membranes if they are inhaled. Some VOCs are known or suspected cancer-causing substances.

3.4.2 Refrigeration Systems and Storage Facilities

The term 'refrigeration' usually applies to cooling below the ambient temperature. Refrigeration operations involve a change in the phase of the substance (i.e. the refrigerant), so that heat is extracted. The refrigerant absorbs the heat at a low temperature by vaporisation and gives it up at the condenser. Compressors are used for increasing the pressure of the vaporised refrigerant. The increase in pressure is accompanied by an increase in temperature that enables cooling water to condense the vapour and the cycle is repeated.

The major pollutants from this operation can be:

- Noise from the compressor operation, which can be a violating parameter in the work and ambient environment,
- Waste cooling water, which could be contaminated with lube oil,
- Ozone Depleting Susbstances (ODSs) such as freon[48], if used as refrigerants.

The specifications for the storage facilities depend on the stored materials. Generally speaking, the products are packaged either in hard or soft plastic containers and then stored in refrigerators (6 to 8^{o}C).

Damaged and discarded packaging containers contribute to the waste material stream.

48 Freon is a trade name for a specific chlorofluorocarbon (CFC). CFCs are ozone destroying substances (ODSs). ODSs are undergoing phased replacement in manufacturing activities throughout the world as they cause ozone destruction and global warming.

Chapter 4

4.0 Environmental Management and Allied Regulatory Framework

4.1 Regulatory Framework for Environmental Management

4.2 Waste Treatment Practices for Dairy Sector Operations

4.3 Response of MSMEs to the Environmental and Allied Regulatory Framework

4.4 The Status of Environmental Standards and Strategies for Filling in the Gaps

4.0 ENVIRONMENTAL MANAGEMENT AND ALLIED REGULATORY FRAMEWORK

4.1 Regulatory Framework for Environmental Management

4.1.1 Environmental Standards

Environmental standards extend across the following 5 categories (see Figure 4.1),:[49]

1. **Occupational health and safety standards:** are applied to the work place and are intended to protect the well-being of the workers within the workplace. Occupational health and safety standards are generally specified as maximum limits of emissions in the work place in terms of pollutant concentration. The limits are further broken down into two sub-categories - exposure limits for short periods and those over an 8-hour worker shift.

2. **Disposal/emission/effluent standards:** are applied to solid wastes, liquid wastes and air emissions after they have been generated and undergone treatment. As the name suggests, disposal standards are intended to protect the quality of soil, water bodies and air into which the wastes are discharged by limiting releases.

   Disposal standards tend to be dictated by techno-economic feasibility; i.e. the combination of the “best available technology” and the “best practical means” is the deciding factor during the establishment of disposal standards.

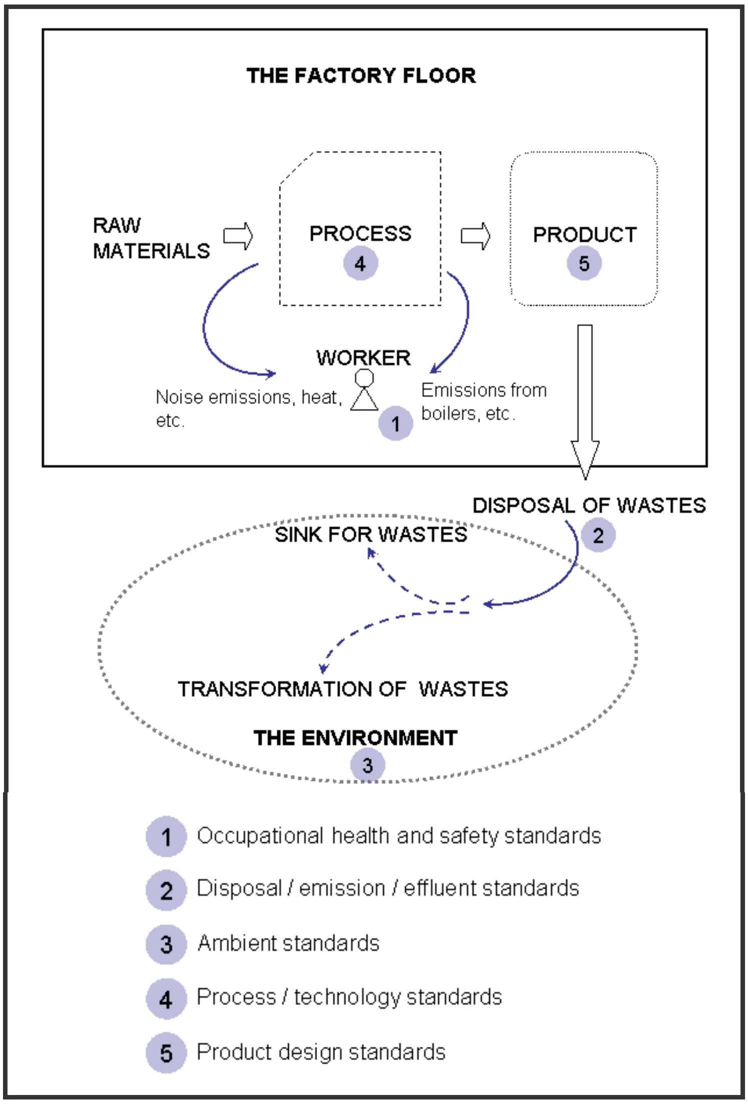
   Disposal standards may even extend to specify the types of treatment technologies to be used to ensure adequate treatment of wastes before they are disposed, and also the modes of disposal of the wastes so generated.

   Disposal standards may be concentration based or load based. For example a load based standard could have the units cubic metre of wastewater generated per tonne of finished product while a concentration based standard would have the unit milligram of pollutant per litre of water. Load based standards are often considered preferable to concentration based standards, since in the latter case, the industry can "meet" the standard by diluting the effluent. Since load based standards place limits on the quantity of wastewater generated in relation to the amount of finished product, they help the industry move progressively towards cleaner practices and technology.

   In some countries, disposal standards vary as per the age and size of the industry, wherein newer and bigger industrial units are required to comply with more stringent disposal standards in comparison to their older and smaller counterparts.

49 Additional standards include standards for hazardous material and hazardous wastes. However, since the dairy industry does not produce any hazardous wastes, we shall exclude any reference to the same here.

Figure 4.1: The Different Categories of Environmental Regulations



3. **Ambient standards:** are concentration-based cumulative standards and are intended to ensure the upkeep of environmental quality goals for a particular region after effluent dilution/dispersion/mixing phenomena have been achieved. Ambient standards tend to be dictated by the assimilative capacity of the environment.

   Location-specific standards are one form of ambient standard. In this case, the regulations prohibit the establishment of industrial units in locations other than the ones specified. Some countries employ this tactic to apply more stringent environmental standards to locations deemed as "sensitive". Examples include locations close to sites designated as ecologically protected areas, or sites where ambient air and quality standards have not been met consistently, etc. Ambient standards may also differ depending on the prevailing land zoning classifications so that the standards in residential zones are stricter than those in industrial zones.

4. **Process/technology standards:** include restrictions and/or mandates on manufacturing processes in terms of manufacturing process technology and operating practices. These standards are intended to limit the generation of

wastes as far as possible. These standards are dependent on the prevailing manufacturing technology and operating practices in place at a particular time, they tend to be revised with advances in technology and/or operating practices.

Process/technology standards tend to be sector dependent. Process standards may extend so far as to specify bans against the use of certain substances during the manufacturing process.

Resource consumption standards are a variation of process standards. Here, limits are placed on the consumption of water and / or energy.

5. **Product design standards:** mandate that the product be designed keeping in mind ecological criteria. Such standards require manufacturers to assess and take into account environmental attributes at each stage of a product's life cycle during its design process, in order to be able to market the product within the country/region that the standards are applied in. Therefore, product design standards mandate life cycle assessment of the product before its manufacture.

Product design standards are intended to minimize or eliminate anticipated waste generation and resource consumption in all the phases of the life cycle; viz raw material sourcing, production, product distribution, use, and disposal. They are a recent addition to the family of environmental standards. Due to their focus on life cycle assessment (LCA), they are also the most stringent of the prevailing environmental standards. Additionally, it is significant to note that adherence to product design standards is mandatory for export requirements. Thus, this particular category of environmental standards has the potential to affect trade between countries.

Product design standards frequently extend to specifying the packaging norms for manufactured products.

4.1.2 Setting Environmental Standards

In the past, environmental standards were regarded as Government notifications, wherein the Government and its advisors would take stock of conducted baseline research on the status of the environment, new technology, available information on health impacts of pollutants, etc. and issue certain decrees mandating environmental compliance. Ensuring environmental compliance has had mixed success across the world – countries with weak regulatory control capacities typically experience low levels of environmental compliance.

Presently, however, there is a changing trend in the process of setting environmental standards. Increasingly, environmental standards are prescribed by Government authorities following consultations with the relevant stakeholders such as sector leaders in the industry, technology providers, etc. Such consultations give rise to what are known as negotiated standards, whereby the Government and the stakeholders participate in a series of discussions leading to the creation of a “road map” envisioning incremental advances towards higher standards of environmental quality. The time lines for such road maps may extend for 5 to 10 (and perhaps more) years. Thus, negotiated standards present the ways and means to envision environmental goals well into the future. Additionally, since all concerned parties mutually agree the negotiated standards, it becomes easier to ensure compliance with the standards.

4.1.3 Associated or Allied Regulations

Generally, environmental standards do not exist alone; rather, there are a number of allied regulations to be complied with as well. Allied regulations which are applicable to MSMEs in the dairy sector include the Factories Act, licensing regulations, applicable taxes, dairy standards (food safety and quality), employee insurance, manpower regulations, industrial regulations (industrial control authority), and regulations pertaining to the prohibition of commercial adulteration.

Such allied regulations generally exist so as to protect the workers in the unit and/or the environmental resources being used during the manufacturing processes or the consumer of the product. However, in many cases, MSMEs are not aware of the existence of these regulations, their intended purpose or how to comply with them.

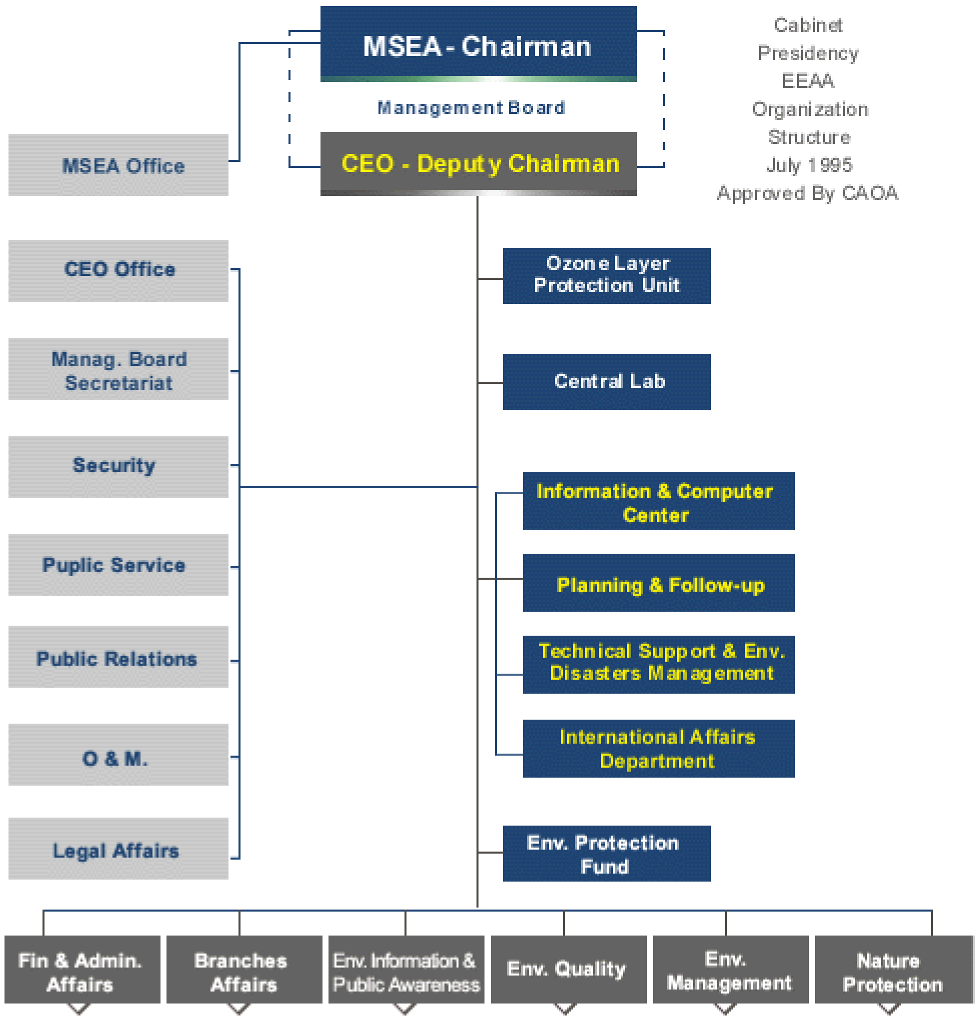
4.1.4 Institutional Framework

In order to be effective as a tool for environmental pollution control, standards must be in line with the implementation capabilities of each country. Implementation capabilities require the establishment of an adequate institutional framework generally consisting of an overseeing body (such as an advisory board), an executive body, enforcement units, research and development functions, testing units, training units, etc.

In Egypt, environmental regulations fall under the mandate of the Ministry of State for Environmental Affairs (MSEA). At the central level, the Egyptian Environmental Affairs Agency (EEAA) represents the executive body of the Ministry. The EEAA is the highest authority in Egypt responsible for promoting and protecting the environment, and coordinating adequate responses to these issues. The EEAA is also responsible for establishing environmental standards for the country.

Figure 4.2 provides an organization chart depicting the overall institutional set-up for the environmental regulatory framework in Egypt at the National level.

Figure 4.2: Organization Chart Depicting the Institutional Set-up for Environmental Regulatory Framework in Egypt at the National Level[50]



At the Governorate level, the Environmental Management Units (EMUs) are the entities responsible for environmental management activities. The EMUs have the responsibility to follow-up the implementation of law 4/1994 and other environmental laws. The EMUs work in association with the Regional Branch Offices under the guidance of EEAA.

4.2 Waste Treatment Practices for Dairy Sector Operations

It follows, that with environmental standards in place, there is a necessity to take corrective actions with the wastes generated. These corrective actions are taken by treating the wastes through the use of end-of-pipe (EOP) technologies. Thus, EOP measures involve treatment of the pollutants prior to their disposal to soil, water and/or air.

The following are the waste treatment practices available for adoption by dairy sector operations:

50 Organization Chart: Ministry of State for Environmental Affairs, Egyptian Environmental Affairs Agency. Available at: www.eeaa.gov.eg/English/main/orgchart.asp.

For Wastewater

The wastewater from dairy sector operations requires primary treatment, generally followed by secondary treatment (i.e. "biological treatment").

Primary treatment of the wastewater consists of: a grease skimming tank, this is required due to the presence of large amounts of oil and grease in dairy wastewater; and an equalization tank because of the intermittent nature of dairy wastewater. In some cases, after having undergone primary treatment dairy wastewater may be discharged to a municipal sewerage system, if the capacity exists, with the approval of the relevant authority.[51] In such cases, the presence of a primary clarifier[52] would not be required.

In cases where the capacity does not exist for discharge to a sewer system then secondary treatment becomes a necessity. Secondary treatment may include the use of one of the following – an activated sludge process, a sequencing batch reactor (SBR), an upflow anaerobic sludge blanket (UASB) reactor, a trickling filter (TF), an aerated lagoon, or a rotating biological contactor (RBC).

Treated water from the secondary treatment stage is allowed to flow into an aeration tank followed by a secondary clarifier. After this stage, the clearer liquid (effluent) is drawn off to a holding tank from where it may be finally discharged to a receiving water body, or taken for land application/irrigation purposes, depending on the environmental regulations being followed at that location. It should be noted that there are no regulations for land application of dairy effluent in Egypt.

The grease skimming from the grease tank may be disposed of by burning or land burial. The organic solids/sludge separated out during primary and secondary treatment are stabilized in a sludge digestion tank, and then pumped to sludge drying beds for sun drying. Depending on the prevailing environmental regulations, the dried stabilized sludge may be used as manure, used to fill up low-lying areas or may be disposed of by incineration (i.e. burning). Figure 4.3 shows a schematic for the treatment of wastewater from dairy processing operations.

In the case of MSME units, the wastewater containing whey and washwater is directly discharged to the sewer, often without any treatment.

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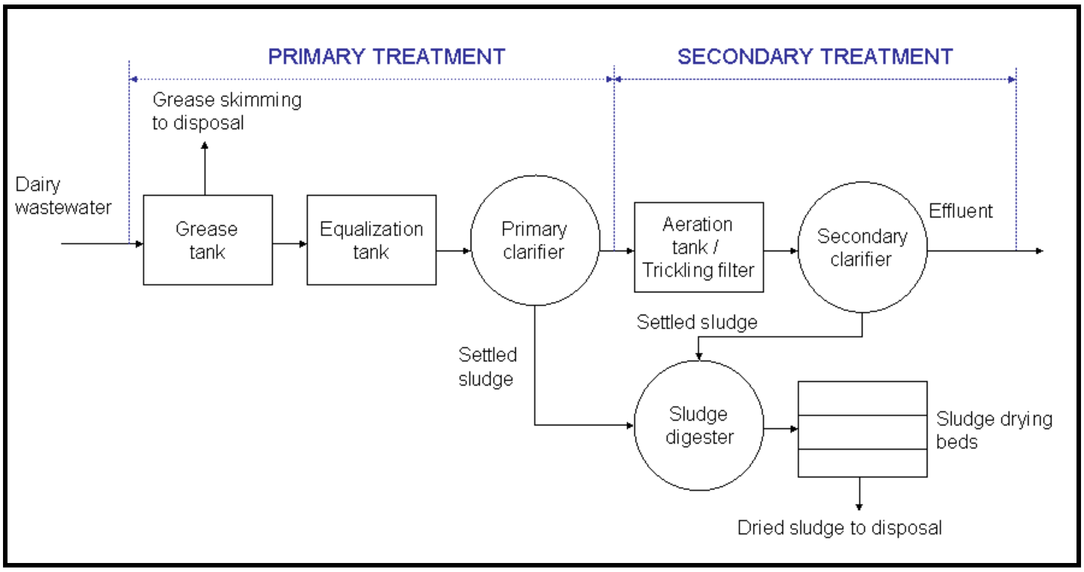
51 This means that the dairy wastewater which has undergone primary treatment may be treated along with the municipal sewerage without further (secondary) treatment.

52 A clarifier is a settling tank in which the suspended matter would settle down to the bottom of the tank, while the clearer liquid would proceed to the next stage of the treatment process.

Figure 4.3: Schematic Diagram for the Treatment of Wastewater



It should be noted that since the process operations in the dairy sector are seasonal the characteristics - quality as well as quantity - of wastewater will vary from season to season. This can influence the choice of the secondary treatment process to be used for wastewater treatment. For example, the sudden change in the quantity and characteristics of wastewater tends to produce adverse effects on the working of the activated sludge process, thus increasing the likelihood of an inferior effluent at the end of the treatment process.

Therefore, the choice of the wastewater treatment process as well as the design parameters[53] would tend to differ on a case-by-case basis. The maintenance and operation of the wastewater treatment plant also requires experienced inputs from an environmental engineer. Such inputs are not readily available to MSMEs. Last but not least is the requirement for electricity/power for running effluent treatment systems; rural areas are not always as well-equipped as their urban counterparts in this respect and the lack of uninterrupted power supply can serve as a major impediment in this regard.

Another strategy, which has been reported as quite successful in the control of water pollution due to industrial operations in geographical clusters, is the concept of "Common Treatment Facilities (CTFs)" or "Common Effluent Treatment Plants (CETPs)". This approach was conceived as a collective means of achieving EOP treatment of combined industrial wastewaters by full-time, professionally trained specialists, at lower unit costs than could be achieved by individual industries. The approach also facilitates discharge monitoring and enforcement by environmental regulatory authorities. Applied to MSMEs in particular –because of the fact that MSMEs also concentrate in geographical clusters, and because the lack of finances and treatment plant operator skills are very much an issue for MSMEs - the concept of CETPs can play a very useful role, since it can deal with most of the perceived gaps at the implementation level. A CETP equipped with a combined resource recovery unit[54] and sludge treatment plant could provide an ideal solution to many of the environmental pollution problems posed by MSMEs. However, while the concept of CETP appears to be a promising solution, there are also some concerns with operational and

53 Such as hydraulic retention time, aeration period, sludge age, etc. Explanation for design parameters will not be provided here, as it is out of the scope of this manual.
54 Resource recovery units are equipped to recover that part of the waste which would normally be discarded, and make it available for reuse as a resource, e.g. recovery of chromium by a resource recovery unit attached to a CETP serving a cluster of leather tanning units.

institutional aspects[55], which require to be dealt with before CETPs can emerge as a solution in wastewater pollution control.

For Atmospheric Emissions

The treatment of emissions to the air from dairy sector operations requires the use of mechanical devices for the control of particulate and gaseous pollutants emitted from boilers. This requires the use of cyclone collectors or wet scrubbers. The operation and maintenance of such equipment involves some skill on the part of the unit where the device is installed.

The treated emissions are then let out through a chimney of a certain prescribed minimum height (see Annex 4.1 for more details).

4.3 Response of MSMEs to the Environmental and Allied Regulatory Framework

In general, the MSMEs in the dairy sector are not as well-equipped as they should be in terms of complying with the environmental regulatory framework. While they may be aware as to the existence of some of the regulations associated with their line of work, there is nevertheless a lack of the following:

- Understanding as to the intended purpose of the regulation,
- Understanding as to how to comply with the regulation,
- Financing mechanisms (including capital and operating costs) for the MSME to avail of in order to equip itself with waste treatment equipment, and
- Skilled operators to run and maintain the waste treatment equipment.

Let us take the example of a wastewater typically generated as the result of MSME scale cheese making unit operations, the major pollution concern resulting from MSME scale dairy processing operations. Depending on the size of operations, almost 8 - 18 cu. m. per day of whey is produced from the manufacture of cheese. This wastewater consists of cheese whey alone or a mixture of whey and washwater. The BOD of whey falls within the range of 40,000 to 50,000 mg/l. After getting diluted by washwater, the resultant wastewater corresponds to about 4,000 - 5,000 mg/l of BOD, which is still significantly higher than the standard permitted for sewer discharge (i.e. 600 mg/l, if the resulting effluent is to be discharged to a sewer system (see Annex 4.1)).

Treatment of whey is expensive in terms of capital as well as operating costs. Furthermore, any such treatment action requires skilled operation. In addition to processing high putrescibility, whey also presents added problems with pH control in biological treatment processes. A SBR type of treatment unit for wastewater quantity of $10m^3$ per day and an operating efficiency of 70% would require an estimated minimum investment of LE 250,000. The cost of an evaporator for $10m^3$ per day of whey would be even more costly at about LE 500,000.

In terms of allied regulations, the situation is not much different. We have already noted the difficulties that MSMEs in the dairy sector face when it comes to complying with quality and hygiene considerations particularly in the case of pasteurization namely:

- Financial constraints,

55 It is not within the scope of this report to expand on these features here.

- Lack of understanding in terms of addition benefits that pasteurization can provide to the MSME unit,
- Difficulties in accessing the appropriate technology at the right scale,
- Lack of skills in operating such equipment,
- Unacceptably high acidity levels in raw milk in the summer particularly and also due to the unhygienic milking practices followed, thus making the raw milk unfit for pasteurization,
- Perceived reduction in the taste quality of product (especially for Roumy cheese) expected due to the effect of pasteurization on natural micro flora associated with raw milk.

Clearly then, while the environmental and allied regulatory framework of Egypt exists, there are still a number of gaps within it, particularly from the perspective of MSMEs. It is important to address these gaps effectively so that the implementation of environmental and allied standards by the MSMEs is possible.

4.4 The Status of Environmental Standards and Strategies for Filling in the Gaps

Currently, environmental standards in Egypt comprise of:

- Occupational health and safety standards,
- Concentration-based disposal standards, and
- Ambient standards.

The National Standards apply to all Governorates. They may be tightened only in the case of designated natural reserves within some Governorates.

In Egypt environmental standards are uniform across all industrial sectors and do not vary as per the age and size of the industry, hence the disposal standards do not distinguish between the polluter's scale of operation. The same yardstick is applied to the large-scale enterprise as well as the micro-scale enterprise. Experience has shown that such applying a uniform standard across a wide range of industry scales is difficult. While a large-scale unit may be adequately equipped in terms of finance, machinery and human expertise to address all the requirements set down by the standards, the MSME unit is likely to lack one or all of these hence making standard compliance difficult.

The disposal standards in Egypt tend to be sector independent; i.e. the same laws apply to an industry engaged in leather tanning operations and an industry engaged in dairy processing. In contrast though, the nature or characteristics of wastes generated across diverse sectors is rather different, and attempting to employ the same disposal standard to wastes generated from different sectors is difficult, if not impossible.

In Egypt, Environmental Impact Assessments (EIAs) are a prerequisite for new industries, while existing industries hold approvals for discharge permits towards meeting the standards. In the context of the dairy industry, plants with a capacity of less than 1 tonne per day of product generation fall under the “white” EIA category (i.e. Form A), whereas plants exceeding this capacity fall under the “grey” category (i.e. Form B) (see Annex 4.2 for Forms A and B). EIA permits enquiry into the project design and investment aspects and is meant to ensure a reasonable level of certainty in compliance with the environmental standards.

However, while EIA has proved to be good proactive instrument for environmental management for medium to large-scale industries, the situation differs substantially in the case of small and micro-scale industries.

Besides the ability of the industry to meet environmental standards, there is also the vital question of the enforcement capability of the Governing authorities. As stated in an earlier part of this section, countries with weak regulatory control capacities typically experience low levels of environmental compliance. At the present time this is the case in Egypt, where human and technical resources for environmental compliance are still being developed. Whilst it is to be expected that in the medium term enforcement of standards and regulations will occur, the present situation is such that small and large scale processing industry are not regulated as they should be. The requirement of human resources and the costs of monitoring for compliance will increase with time.

While Egypt does not currently endorse negotiated standards, the increasing preference for such standards world wide is indicative of their ability to perform from the perspectives of both the regulator and the polluter.

As such in looking at means to improve environmental compliance by industry, Egypt should consider widening the cooperation between line ministries, financial institutions, credit organization, research and technical institutions and industry.

Further, in attempting to meet the specifications laid down by the standards, the manufacturing units have to bear some costs. The extent of these costs will be case-specific and would depend on the type of industry, its location, its scale of operations, types of products the unit produces, manufacturing processes, age of the equipment the unit employs (i.e. old / new), maintenance of the equipment, etc. By and large, such costs tend to be high and hence, MSMEs generally find it very difficult, to comply with the required environmental standards and regulations. As environmental regulations are tightened, costs of compliance also increase.

In order to fill in these gaps, it would be worthwhile to think of long-term strategies as opposed to ad hoc short-term solutions. Instead of enforcing treatment or EOP solutions alone, it would be more prudent to test and develop several innovative approaches towards formulating a practical long-term strategy.

Expanding on the example referred to above, the "pollutants" in the whey are nothing but by-products such as proteins, fat and lactose. Therefore, it is worth considering whey as a misplaced resource rather than a waste, and exploring opportunities to recover economically attractive products from it. (See Section 6.0 for further details.)

While some level of waste treatment is unavoidable, it would be prudent to explore, initiate and implement pollution prevention (as opposed to pollution control) options in day-to-day MSME scale dairy sector operations. Such options include:

- Segregation of wastes,
- Recovery and reuse of by-products,
- Recycling,
- Good housekeeping, etc.,

Such options can be explored through the concept of Cleaner Production.

Chapter 5

5.0 The Concept of Cleaner Production

5.0 THE CONCEPT OF CLEANER PRODUCTION

5.1.1 The Definition of Cleaner Production

The United Nations Environment Programme (UNEP) defines Cleaner Production as[56]:

"The continuous application of an integrated preventive environmental strategy applied to processes, products and services to increase overall efficiency, and reduce risks to humans and the environment. Cleaner Production can be applied to the processes used in any industry, to products themselves and to various services provided in society."

Box 5.1 gives the operational definition of Cleaner Production.

Box 5.1: The Operational Definition of Cleaner Production

The operational definition of Cleaner Production is as follows:

- For **production processes,** Cleaner Production results from one or a combination of: conserving raw materials and energy, substituting toxic hazardous materials with more benign materials, and reducing the quantity and/or toxicity of all emissions and wastes before they leave the production process.
- For **products,** Cleaner Production focuses on reducing environmental impacts along the entire life cycle of the product (from raw material extraction to its ultimate disposal) through appropriate design.
- For **services**, Cleaner Production incorporates environmental concerns into the design and delivery aspects

Thus Cleaner Production:

- is a continuous application, not a one-time activity.
- addresses life cycle impacts, health and safety concerns and emphasizes risk reduction.
- is an holistic environmental management strategy.
- does not deny growth but insists that it be sustainable. It is a 'win-win-win' strategy protecting the environment, the health and safety of consumers and workers while improving efficiency, productivity, profitability, and competitiveness.
- makes sound business sense to industries and service providers as it often results in cost reduction, improved productivity and enhanced competitiveness of wider markets.
- assists regulators in developing proactive strategies for complementing enforcement, or command and control.
- is a forward-looking, anticipatory and preventive philosophy.

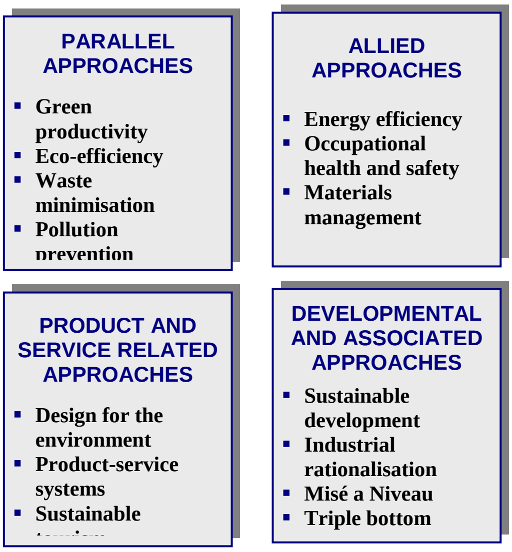
56 Source: *Cleaner Production – Key Elements* by UNEP (Production and Consumption branch). Available at: www.uneptie.org/pc/cp/understanding_cp/home.htm.

5.2 Synergies between Cleaner Production and Other Similar Sounding Approaches

At the time UNEP embarked on the overarching concept of Cleaner Production in 1990, a number of quite similar concepts existed and many others subsequently emerged. It is important therefore to clarify what Cleaner Production is in relation to some of these approaches.

Approaches similar to Cleaner Production may be grouped into four parts: parallel approaches, allied approaches, product and service related approaches, service-related approaches and developmental and associated approaches. Figure 5.1 provides an illustration of these approaches.

Figure 5.1: Cleaner Production and Similar Sounding Approaches

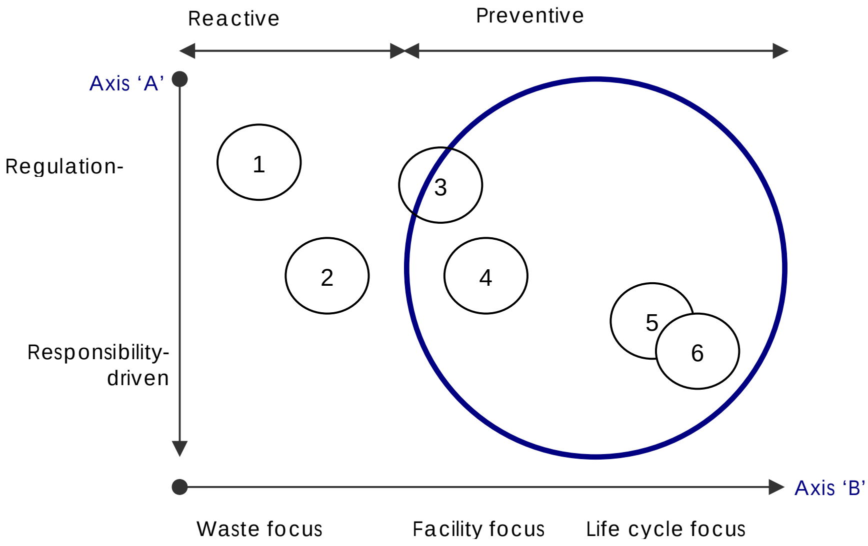


Detailed definitions of the approaches are provided in Annex 5.1**.**

Figure 5.2 illustrates the position of Cleaner Production with respect to some of these concepts on the basis of whether the concept/approach is:

- Reactive or preventive
- Regulation-driven or responsibility driven
- Focused on wastes alone/focused on the facility or unit/focused on the entire life cycle of the product in question

Figure 5.2: Cleaner Production and its Relationship with Other Concepts[57]



1. **EOP technology**
2. **Waste minimization**
4. **Recycle, reuse and recover**
5. **Pollution prevention**

If the blue circle represents the concept of Cleaner Production, then, certain approaches may be classified as either reactive (i.e. EOP waste treatment technology (referred to in Section 5.0), and recycle, reuse and recover) or preventive (i.e. pollution prevention, Cleaner Production, design for the environment and eco-efficiency) in nature. Unlike the reactive approaches, preventive approaches incorporate upstream and downstream considerations into their modes of operation.

Thus, the focus of Cleaner Production is both specific (as it can incorporate the concerns of the facility/unit) as well as far-sighted (since it takes into account the life cycle perspective).

5.3 Reasons for an Enterprise to Adopt Cleaner Production

From Figure 5.2, it can be seen that Cleaner Production incorporates compliance-related, responsibility-driven, facility-focused and life cycle oriented concerns. Hence Cleaner Production is the concept of choice for an enterprise to address not just its environmental, but also its social and economic issues.

57 Modified from: Berkel R. Van and J. V. D. Meer (1997), *Training Course for Future Trainers on Environmentally Sound Technology Transfer*. IVAM Environmental Research, University of Amsterdam.

From the perspective of enterprises in the dairy sector, the large scale units tend to concentrate on the urban market, possess financial-come-technical capacities and trained personnel, and have an ability to absorb and quickly respond to changes resulting from market demands and Government regulations. Many large scale enterprises in the dairy sector are already moving ahead in the direction of conserving resources such as water and energy in their day-to-day operations.[58]

In almost direct contrast however MSMEs are ill-equipped in terms of finances, technology, trained personnel etc., and are unable to respond to government directives on environmental, hygiene and quality issues. Furthermore the concept of Cleaner Production is often viewed with suspicion.

However, the MSMEs in the dairy sector require the concept of Cleaner Production as it will help them achieve the "triple bottom line" of improvements in environmental, health and safety and economic issues.

- **Responding to environmental regulations:** Conventional approaches to industrial pollution management tend to focus on EOP treatment of wastes alone, in an effort to be in compliance with the relevant environmental regulations. While the use of EOP technologies cannot be done away with completely, it cannot be depended upon solely for environmental management purposes either, as:
  - Costs of EOP technology tend to be fairly prohibitive for MSMEs;
  - Skills required for EOP technology operation and maintenance do not exist at the MSME scale;
  - The area required for EOP technology (i.e. the footprint of the EOP treatment plant) tends to be quite large and out of reach as far as MSMEs are concerned.
- **Responding to hygiene and quality regulations:** Hygiene-related issues occupy a very important position. Unhygienic practices across the dairy cycle have the potential to cause adverse effects on:[59]
  - Product quality (e.g. excessively salty cheese products)
  - Consumer health (e.g. through the consumption of dairy products made with raw milk preserved with formalin and/or through the consumption of excessively salty cheese products)
  - The overall economics of the system (e.g. loss of income to the farmer/milk supplier due to the supply of spoilt raw milk to the MSME, losses to the cheese manufacturing unit, etc.)
  - Exports of the dairy products to other countries (e.g. lost export orders to current client countries, inability to realize the potential for new export client countries, etc.).

Additionally, pressures such as fierce market competition from local and foreign large scale modern dairy units, rising cost of raw materials, the push towards modernisation and expansion, etc. require that the MSMEs approach the management of their enterprises in an anticipatory or proactive manner. Only then will they earn benefits such as improved

58 *Self Monitoring Manual: Dairy Industry* by Ministry of State for Environmental Affairs [Egyptian Environmental Affairs Agency (EEAA) and Egyptian Pollution Abatement Project (EPAP)], 2003.
59 The examples given against each aspect in the text that follows have been explained in further detail in Section 2.0 of this report.

environmental performance, increased conversion efficiencies, additional income from by-products (previously deemed as wastes), enhanced productivity and cost-effectiveness.

Cleaner Production presents the MSMEs in the dairy sector in Egypt an appropriate strategy to address the environmental, economic and social issues unique to their sector and scale of operation.

5.4 Overview of Barriers to Cleaner Production

While Cleaner Production is a highly promising strategy for MSMEs to adopt, it is fairly difficult to make the first step. A number of barriers are faced by MSMEs while trying to implement the concept of Cleaner Production:

- Lack of awareness and information not only with respect to the concept of Cleaner Production, but also with respect to associated aspects such as environmental regulations, health regulations, regulations concerning the work environment, etc.
- Difficulties in accessing appropriate technology (i.e. with reference to the correct scale and usage),
- Difficulties in accessing external finance to acquire the appropriate technology (since many MSMEs often find it difficult if not impossible to bear the costs of technology upgrading and/or modernisation on their own),
- Lack of appropriate training for use of such technology,
- Difficulties in envisioning the changes which need to be brought about at the upstream (e.g. hygienic practices during the production of raw milk to be used in making cheese) and downstream ends (e.g. ensuring the acceptability of a new product in terms of taste, i.e. market assessment in case of facility modernisation/expansion) of the production line,
- Presence of economic subsidies for business resource inputs such as subsidies on the price of energy/fuel/water,
- Lack of supporting enabling policies by the Government towards the implementation of Cleaner Production.

Most of the challenges enumerated above are easier for large scale modern dairy units in the sector to face, given their technological and investment capabilities.

5.5 Ways and Means to Implement Cleaner Production

Cleaner Production Opportunity Assessment or CPOA identifies options available for implentation of Cleaner Production. The options fall under one of the following categories:

- ***Housekeeping:*** Improvements to work practices and methods, proper maintenance of equipment etc., fall within this category. Efficient housekeeping can provide significant benefits in terms of saving resources. These options tend to be low cost and provide low-to-moderate benefits.[60]

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60 Interested readers may like to refer to *Good Housekeeping Guide for Small and Medium-sized Enterprises* (available at: www.getf.org/file/ toolmanager/O16F15343.pdf). A complete Table of Contents for this document is provided in Annex 5.2 of this report.

A simple example of good housekeeping in a cheese processing unit is the installation of drip pans or trays to collect milk/whey spills. Such an easily practiced option will help ease the BOD load on the environment and help the enterprise use the resource productively (in the case of milk) in another operation, or dispose of it within the legal environmental discharge limits (in the case of salty whey).

- ***Management and personnel practices:*** This option includes employee/staff training, enhancement of operator skills, and effective supervision on the shop floor. Depending on the number of staff to be trained, this option may involve low-medium costs and provides moderate-to-high benefits.

  A simple example of instilling good management/personnel practices in a cheese processing unit would be training provided to staff for the installation of drip pans or trays to collect milk/whey spills, and the processing/disposal of the collected material thereafter in other operations.

- ***Onsite recycling and reuse:*** This Cleaner Production option involves the return of a waste material either to the originating process or to another process as a substitute for an input material.

  An example of this option in a medium scale mechanized dairy unit[61] *involved the reuse of the by-product whey permeate from the ultrafiltration of white cheese manufacturing. Originally, this whey was disposed off directly to the sewer. The unit now reuses part of this whey in the cheese packaging stage, instead of fresh water. This has resulted in a decrease in the amount of fresh water used for the packaging process, as well as a drop in the organic load generated from the cheese manufacturing operation.*[62]

- ***Recovery of useful by-products and resources:*** This Cleaner Production option entails the recovery of wastes as by-products/resources, which may have useful applications within the industry itself or outside it. This type of option essentially leads to the reuse/recycle, and thus minimization, of waste as well as to cost savings.

  An interesting example of this option for MSME dairy units would be the manufacture of ricotta cheese from whey.[63] *Whey generally tends to be discarded along with washwater. This causes immense environmental impacts (due to the high BOD content of whey) and also results in a loss of what can be reworked as a useful resource - the pollutants in the whey are nothing but potential by-products such as proteins, fat and lactose. It is therefore worth considering whey as a misplaced resource rather than waste. Indeed, the manufacture of ricotta cheese from whey will also enable the generation of a revenue stream for the MSME implementing this particular option.*

- ***Process optimization:*** This option involves rationalization of the process sequence, combining or modifying process operations to save on resources and time, and thus improve the overall efficiency of the process.

  A simple example for an MSME dairy is the increase in cheese yield during curd whey separation through the use of cheese cutter knives. Whey expulsion is an essential part of cheese making, the objective being to reduce the moisture content of the curd from 88% to as low as 40%. Good curd cutting leads to effective whey expulsion, which then permits the resulting equal sized smaller curd to be cooked uniformly throughout the vat. Cheese cutter

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61 Source: *Industrial Pollution Prevention Case Study: Food Sector – Reduction of Milk Losses at Misr Company for Dairy and Food, Mansoura, Egypt*. SEAM Project Food processing Sector, Egypt – Cleaner Production Opportunities, July 1999.

62 A complete copy of this case study is provided in Annex 5.3 of this report. Information about the implementation of this Cleaner Production option is provided under the sub-heading *Whey Re-use in White Cheese Manufacturing*.

63 Annex 5.4 provides a detailed process description and flow diagram for the manufacture of *ricotta* cheese from whey.

knives are used to cut the fresh curd, so as to more effectively separate the cheese and whey. While this particular process optimization may seem minor in nature, it can play a very important role in the day-to-day process of the MSME implementing it; it has been estimated that cheese losses of up to 10% of the total daily cheese production can result from the absence of such simple yet cost-effective equipment.[64]

- ***Raw material substitution:*** Primary and/or auxiliary raw materials can be substituted if better options exist in terms of costs, process efficiency, and reduced health and safety related hazards. Such an approach may be necessary if the materials already in use are difficult to source or become expensive, or come under the purview of new environmental or health and safety regulations. In all cases of material substitution, it is crucial to test the suitability of the new material in terms of environmental and economic benefits, optimum concentration, product quality, productivity, and improved working conditions.
- ***New technology:*** Adopting and transferring new technologies can often reduce resource consumption, minimize wastes, as well as increase the throughput or the productivity. These options are often capital intensive, but can lead to high benefits. Modifications in equipment design can be another option, which tends to be slightly less or equally capital intensive as the option for new technology, but can lead to potentially high benefits.

    An example of new technology for an MSME cheese-making unit could be the introduction of modern ultrafiltration technology. During the past 30 years, the dairy industry has been quite successful in adapting this technology to treat what used to be previously regarded as waste whey. Researchers have explored using membrane filtration for fluid milk, and subsequently, using this milk to manufacture dairy foods including cheeses, yogurt and ice cream mixes. Such processes are able to improve the quality of existing dairy foods, speed the development of new products, and enhance process efficiency and profitability. Overall, the technology is very attractive to dairy processors because it does not require a phase change to remove water, nor does it consume a lot of energy, as compared to condensers and evaporators.

- ***New product design:*** In the context of the dairy sector, the term "new product design" would essentially involve the utilization of by-products previously regarded as wastes and their transformation into useful products. In order to accomplish this, (often) considerable research, laboratory and pilot-scale testing would be required so as to ensure that the new product would meet expectations of taste, texture, ease of operations, pricing, market demand, etc. before it is introduced to the market.

    An example of new product design for an MSME cheese-making unit could be the introduction of a cheese made from whey (also known as 'whey cheese'). This whey cheese would be classified as a new product. All cheese-making units have to deal with the problem of whey discharge from cheese-processing operations. Whey discharge tends to be highly damaging to the environment and its treatment-come-disposal costs are often prohibitive for MSMEs. Some countries around the world (e.g. Northern Ireland, Norway, etc.), further process the by-product whey as a cheese called 'whey cheese'. In doing so, they realize the triple benefits of reusing an otherwise discarded resource, savings on the cost of whey treatment and disposal, and additional income generation.[65]

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64 Source: *Improved Cheese Recovery in Curd-Whey Separation: Mahrous for Dairy Products, Dakahleya, Egypt*. A complete copy of this case study is provided in Annex 5.3 of this report.

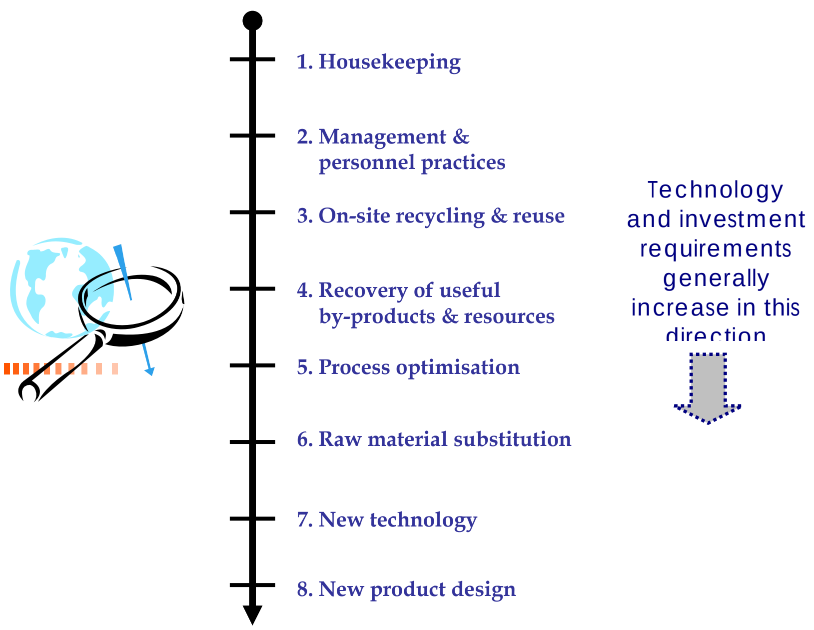
65 The process description for the production of whey cheese has been provided in Annex 5.4 of this report.

5.5.1 A Strategic Approach in Implementing Cleaner Production Options

There are some important points to be kept in mind while identifying, experimenting with and instituting Cleaner Production options. They are as follows:

- In general, it is better to not generate a waste in the first place, rather than generate it and later recycle or recover/reuse it. Therefore, one should only consider the latter type of options once all the others that could prevent waste generation have been examined. Therefore, the hierarchy of options available from the view points of technology and investment requirements may be recognized and practiced, as shown in Figure 5.3.
- In reality, for many of the options a team will identify results as a combination of the above categories so as to produce cost-effective and sustainable results. For instance, any option of new technology should be preceded and followed by improvements in management and training. In addition, the option of new technology often also requires substitution of raw materials.
- It is important to bear in mind that some of the chosen options may require major changes in the processes or equipment or product. Often, these will dramatically reduce waste generation or increase productivity, but they also often imply considerable investments.
- In the case of product re-design as a Cleaner Production option, one should remember that it is a major business strategy. It is likely to involve feasibility studies and market surveys, especially if the supply-chain around the product is already established and is complex.

Figure 5.3: Hierarchy of Cleaner Production Options from the View-point of Technology and Investment Requirements



- It is equally important to bear in mind that certain chosen options will require thorough laboratory/bench scale/pilot studies to ensure that the product quality does not degrade as a result of their application, and that it is acceptable to the market.

- Where avenues exist, the investigation of Cleaner Production options should always be tied in with the entire dairy cycle. This exercise will therefore necessitate an interaction amongst all the players within the cycle; including the small-scale dairy holder (milk suppliers/farmers), milk collectors, cold storage units, equipment suppliers, MSME dairy product marketers, etc. This will allow inter-sectoral linkages to be fully comprehended and taken into consideration for maximum effect..

5.6 A Programmatic Approach to Introducing and Sustaining Cleaner Production in MSMEs

The programmatic approach encourages and enables the formulation of a broad overall outlook that addresses the environmental, social as well as economic concerns in a comprehensive and sustained manner. Without this approach, standalone projects and/or programmes, however well-intentioned, cannot be sustained.

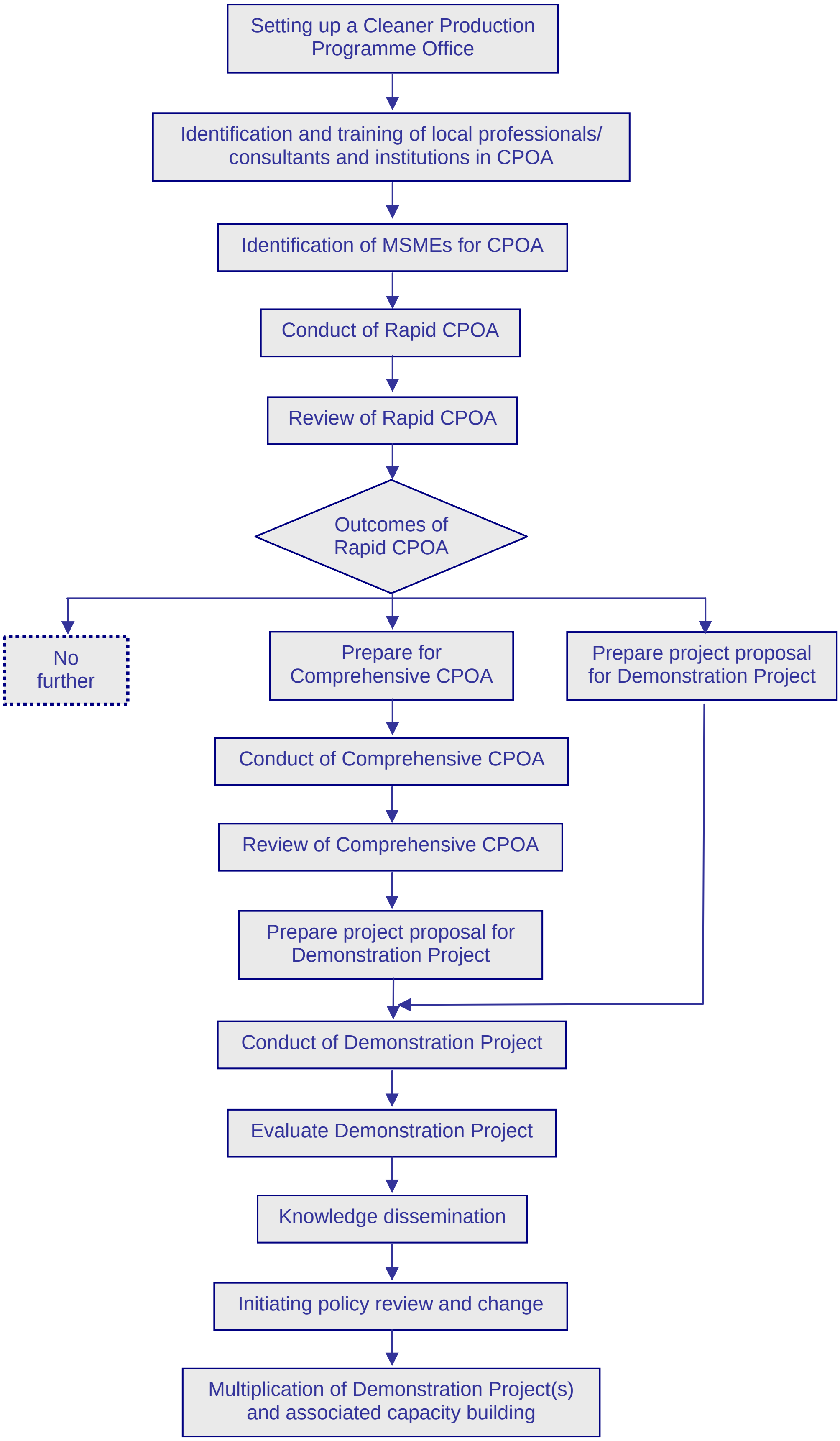
Through a programmatic, cross-sectoral approach, four vital things can be accomplished:

1. Building the capacity (i.e. awareness followed by in-depth understanding) of local professionals for Cleaner Production in the sector,
2. Identifying promising Cleaner Production options to be implemented at MSME units and their subsequent conversion into Demonstration Projects,
3. Initiating appropriate policy change and review, obtaining support of the Line Ministry, and enabling financing mechanisms so as to ensure the sustenance of Cleaner Production in the sector, and
4. Dissemination of the knowledge and experiences earned from the Demonstration Projects so as to achieve a multiplier effect through geographical clusters of MSMEs[66].

The various steps involved in the programmatic approach are explained in Figure 5.4.

66 Figure 2.3a of Section 2.0 shows that MSMEs in the dairy sector tend to operate in geographical clusters.

Figure 5.4: Steps Involved in the Programmatic Approach to Cleaner Production



Reference should be made to "A Guide to Undertake Cleaner Production Opportunity Assessment for MSMEs" and "A Guide to Promote Cleaner Production in MSMEs in Egypt" for further details .[67] All the necessary steps have been thoroughly covered in these manuals, some important points are recapped below.

5.6.1 Building the Capacity of Local Professionals for Cleaner Production in the Sector

Once the Programme Office has been set up, the identification and training of local professionals in CPOA should be undertaken. Building their capacity includes initial awareness followed by development of in depth understanding. The local professionals should have had previous exposure to the sector(s) chosen for Cleaner Production interventions and ideally some working knowledge of the Cleaner Production concept. International consultants should also provide inputs as and when required, e.g. for the provision of overall methodologies to be followed, training of national consultants, review of outputs and advice, training on the preparation and implementation of new Demonstration Projects, etc. International consultants would be required mainly to enhance and build the capacity of national consultants, who in turn will be responsible for taking forward all the Cleaner Production activities. The national consultants would thus be responsible for conducting Cleaner Production activities at the national and regional levels, and would be involved in the development and training of local professionals/trainers through hands-on training. Thus, a simple but crucial framework for training and capacity-building activities must exist for any Cleaner Production Programme to be a success.

5.6.2 Identifying Cleaner Production Options through "CPOA"

Cleaner Production options are identified through the use of a management tool called the Cleaner Production Opportunity Assessment (CPOA). It consists of a systematic and objective review of the manufacturing processes, products and services. It is designed to identify opportunities for increasing productivity, profitability and sustainability of the enterprise, while reducing its environmental impacts and associated risks.

The Rapid CPOA is a quick appraisal of environmental and productivity related opportunities. It is based predominantly on observations made during a walkthrough of the site and discussions with the owner. The Rapid CPOA is generally conducted with the assistance of Cleaner Production consultants with cooperation of the MSMEs. Based on the findings of the Rapid CPOA, decisions are taken in terms of the nature of assistance possible. These decisions could be of either of the following forms:

- No further investigation is warranted; i.e. all investigations stop at this point. This conclusion is reached if the Rapid CPOA shows that there are no opportunities related to Cleaner Production or the owner is not interested or is not supportive of the Demonstration Projects.
- Opportunities for demonstrating Cleaner Production exist. Some of these options may be readily implemented if a suitable proposal is prepared based on the results of the Rapid CPOA.
- Opportunities for demonstrating Cleaner Production exist, however their implementation will require more detailed assessment in the form of a Comprehensive CPOA.

67 Available at www.seamegypt.org. A complete Table of Contents for this document is provided in Annex 5.5 of this report.

If a detailed assessment is required for identifying the Demonstration Project, a comprehensive CPOA will have to be conducted. This assessment is accompanied by cost-benefit analyses and an implementation plan. It is generally conducted with the assistance of Cleaner Production practitioners or consultants with cooperation of the MSME.

A strategy of deploying a number of Rapid CPOAs helps in scoping Comprehensive CPOAs to implement "quality" Demonstration Projects. Implementation of Demonstration Projects through a two step sequence of Rapid and Comprehensive CPOAs is therefore a cost-effective strategy. Both Rapid and Comprehensive CPOA provide hands-on training to the Cleaner Production practitioner, and are therefore useful in building local capacities, especially to achieve a multiplier effect.

A CPOA should be conducted at least once a year to ensure long-term positive benefits are accrued from the technique.

5.6.3 Earmarking Demonstration Projects

Review of a Comprehensive CPOA report should lead to the identification of Demonstration Projects, to finance and implement these it is necessary to prepare project proposal(s). Such proposals are submitted for approval to the office/agency funding the programme for financial/technical assistance.

The proposal should address the need, implementation methodology, cost-benefit analysis, financing mechanisms required, responsibilities etc. of the project.

The Demonstration Project is then evaluated based on certain criteria. The evaluation helps to understand whether the Demonstration Project has been successful in achieving its aims and objectives, and whether it is appropriate for replication. Evaluation also assists in identification of policy-related triggers that may be useful to resolve some of the barriers. Dissemination of a Demonstration Project is the next crucial step as it enables maximum replication of Cleaner Production options at other MSMEs.

5.6.4 Initiating Policy Review and Change

Policy change may be a necessary precursor in creating an enabling environment for inducing the replication of Demonstration Projects. This step addresses policy makers, financial institutions, regulators as well as business/trade associations.

5.6.5 Replicating Demonstration Projects and Enabling Capacity Building

Multiplication of successful Demonstration Projects may necessitate additional inputs from various sources, which may be missing and identified only once a Demonstration Project is targeted or underway. Such sources may include guidance to the new enterprises participating in the replication stage in the form of training workers, preparation of bankable financial proposals where Cleaner Production options involve implementation costs, training of new CPOA professionals, involvement of the private sector and academic institutions. For instance, academic and research organizations have a role to play in the promotion of Cleaner Production, they support research necessary to bring about some of the Cleaner Production innovations and in many cases they also provide a sound infrastructure for the monitoring and analysis activities required in CPOAs. It is important to note that today's students in such institutions will be employed by the industry of tomorrow. Thus, an early exposure to

Cleaner Production concepts can go a long way in mainstreaming Cleaner Production in the sector.

Chapter 6

6.0 Cleaner Production Opportunities

6.0 CLEANER PRODUCTION OPPORTUNITIES

6.1 Introduction

The small-scale dairy sector in many developing countries shares a number of likenesses in terms of perceived threats and opportunities (e.g. lack of awareness concerning health and hygiene issues in the milk production stage, lack of access to suitably scaled technology for dairy processing activities, absence of market information for selling dairy products, etc.). In order to alleviate these threats and recognize the opportunities, various organizations from around the world have undertaken initiatives in the form of short-term projects or longer-term programmes and plans in an effort to obviate these threats, while capitalizing on the opportunities. While some of these initiatives have not specifically been titled as Cleaner Production opportunities, they reflect the term in spirit since they address one or more of the issues faced by MSMEs within the dairy sector – i.e. environmental, social and economic impacts.

For certain stages however, there have been no reported Cleaner Production interventions. Nevertheless, in such cases, information has been provided as to the possible tools or technologies that may be accessed in a bid to address the issues arising at that particular stage in the dairy cycle.

6.2 Cleaner Production Opportunities at the Milk Production Stage

As explained in Section 2 milk production is seasonal as a result of fodder constraints. Intervention by Government is seen as directed primarily at the large scale dairy unit and has produced no benefits at the MSME level.

The lack of support services – veterinary services, awareness and training in the general care of livestock and hygienic milking practices, and their uninterrupted availability for the farmers - has also affected milk production negatively at the traditional small-scale dairy farms.

Although Egyptian standards mandate certain quality and safety criteria for food and dairy products milk testing for quality is largely unheard of for small-scale milk production. Bacteriological tests are also largely unheard of.

The price for raw milk is fixed regardless of its compositional quality. Thus, at the present time, the small-scale farmers in Egypt do not have any incentive in ensuring the production of hygienic raw milk of a good quality. Such a state of affairs adversely affects the consumer, who would be exposed to unhygienic and hence unsafe milk and dairy products.

6.2.1 Cleaner Production Interventions at the Milk Production Stage

Adequate support services; e.g. quality feed inputs, veterinary health and their uninterrupted availability for the farmers and/or suppliers who produce the raw milk are one of the major and logical prerequisites for the successful development and operation of a sustainable MSME scale dairy sector.

Box 6.1: Highlights - Developing Milk Production from Local Resources Project, Vietnam[68]

Background and objectives

Slated to run from June 1996 – December 1997 with a budget of US$221,000, this project focused on goat milk production, collection, processing and marketing of cheese involving small-scale farmers. It was set up in collaboration with the Goat and Rabbit Research Centre, Son Tay, Hatay Province in Viet Nam. The main beneficiaries of the project were small-scale women farmers who not only carried out much of the work at farm level, but who were and continue to be the processors and marketers of their high quality cheese.

Use of local feed resources

A major activity of the project was to promote the use of tree and shrub foliage as the staple diet of goats in confinement. The Jackfruit tree is found in the home gardens of farm families throughout Viet Nam. Planted originally for the consumption and sale of the fruit, it was demonstrated that the leaves provided excellent feed for goats. This led to an alternative use for the tree in areas remote from markets or in situations where the sale price of the fruit did not compensate for the labour of transporting it to the market. The multipurpose tree *Trichanthera gigantea*, introduced from the coffee-growing mountain regions of Colombia in South America, and the shrub *Flemengia macrophylla*, introduced from the Philippines, both adapted well to the infertile acid soils that characterize the hilly and mountain areas of North and Central Viet Nam. Farmers were pleased with the productivity and ease of management of these trees and their good acceptability by goats in confinement.

With the supply of year round quality feed inputs, the farmer will experience a boost in raw milk production, which should leave him less vulnerable to the vagaries of the seasonal availability of feed. Box 6.1 provides highlights of one such project instituted for small-scale farmers by the Food and Agriculture Organization (FAO) in Viet Nam (complete details of the project are provided in Annex 6.1 of this report).

Through the support of veterinary health services, the farmer will be able to maintain a healthy livestock, which in turn should aid in the availability of safe, hygienic processed dairy products.

The vast majority of small scale farmers tend to milk animals by hand, thus adding to the possibility of unhygienic milk collection. Box 6.2 provides highlights of a training programme undertaken for rural farmers in South Africa for the hygienic collection of milk.

Box 6.2: Highlights of Training Programme Undertaken for Rural Farmers in South Africa for the Production of Hygienic Milk[69]

In the mountainous highlands of South Africa, rural farmers are shareholders in a dairy factory that manufactures fresh milk, yoghurt, *Gouda* and Cheddar cheeses. The products are sold to about 600,000 locals living in and around the nearby town. The milk is supplied by the 40 shareholders to the factory, all living within a 70 km radius from the factory.

Training was provided for the farmers (including women), collection centre personnel and processing factory personnel. A training manual and training material was composed consisting of the following modules:

68 Adapted from: *FAO Dairy Projects and Other Activities*. Available at: www.fao.org.

69 *A Case Study of the Production of Milk by Rural Farmers in the Highlands of South Africa* by N.A. Prinsloo and J.J. Keller, in *Report on the FAO E-mail Conference on Small-scale Milk Collection and Processing in Developing Countries (29 May to 28 July 2000)*, pp.64-65. Available at: www.fao.org.

- Personal hygiene
- Micro-organisms
- Micro-organisms: importance
- Micro-organisms: destruction
- Micro-organisms: control
- Cleaning and disinfection
- General cleaning

The farmers were given awareness and training on various aspects such as:

- The importance of cleanliness in and around the livestock milking area,
- The steps to be taken after milking the animals; i.e. washing the udder with boiled water only and then drying it with a paper towel.
- The requirement for testing livestock for mastitis70, the method for the test (the mastitis strip cup for each quarter), and other precautionary activities intended to avoid mastitis in livestock.

As a result of the training, bacterial counts of the raw milked decreased by nearly 70% and the keeping time increased from 3 to 7 days.

The presence of such support services can help achieve Cleaner Production as they will not only meet the growing demand for quality milk by consumers, but will also ensure that the products made using the raw milk meet all the required hygiene, quality and environmental standards.[71]

If the farmer is paid for raw milk produced by him based on the weight and certain other characteristics of the milk, which are enumerated in Box 6.3 the quality and level of hygiene of the milk improves. The farmer understands why hygiene and quality are important because these are directly linked to his income.

Box 6.3: Quality Criteria for Raw Milk

Quality criteria for raw milk include physiochemical and bacteriological aspects.

Physiochemical quality criteria

These criteria generally relate to fat content and protein content, the basic rate of which per kilo of milk varies from one country to another. The basic rate is set for a certain fat and protein content. Each additional degree of fat and protein matter (which could be in the form of percentage or gram/liter) results in a premium being paid above the basic rate and a reduction below this rate.

Bacteriological quality criteria

These criteria relate to testing for bacteriological quality of the milk. It is recommended that tests be generally carried out for specific bacteria such as coliforms, staphylococcus, listeria and butyric spores.

70 Mastitis is defined as inflammation of the udder caused by specific disease producing microorganisms. For a number of years mastitis has been the biggest disease problem in dairy herds. The infection is usually spread from infected to non-infected animals during the milking process. It is a disease of considerable economic importance. An infected animal provides milk of an unacceptable quality, which can cause economic losses to the farmer, cause environmental problems with the disposal of infected raw milk, and also affect the safety of the dairy products made from it. When left untreated, mastitis can ultimately lead to the death of the animal.

71 Recommended reading for hygienic milk handling and processing (provided in Annex 6.2):

- *Clean Milk Production and Support Services* by Dr. O. P. Sinha, Consultant, Dairy Farmers's Organization, Gujarat (India), in *Report on the FAO E-mail Conference on Small-scale Milk Collection and Processing in Developing Countries (29 May to 28 July 2000)*, pp.50-52. Available at: www.fao.org.
- *Hygienic Milk Handling and Processing – Milk Processing Guide Series (Volume 1)* by Food and Agriculture Organization. Available at: www.fao.org.

In most developing countries, at MSME scale production, the tests carried out for the physiochemical and bacteriological quality of milk are density (to determine possible dilution with water) and acidity (to determine suitability for processing). At other times though, the payment systems are devised on the basis of fat content and weight of the collected milk.[72] These tests are generally carried out at a milk collection centre - if and where one exists - where the raw milk collected by the farmer or supplier is tested for its quality. Further details for milk collection centres, milk collection and transportation are providedbelow.

Equipment for Raw Milk Quality Checks and Devising a Milk Payment System[73]

As mentioned earlier, not all stages of the dairy cycle have reported Cleaner Production interventions. However, one type of technology that may be accessed in a bid to address the issues arising at this particular stage (and hence work towards Cleaner Production) in the dairy cycle is given below.

Box 6.4 and Figure 6.1 present details of an Electronic Milk Collection System comprising of milk weighing component (so as to pay the farmer as per the weight of the milk supplied by him) and an electronic milk tester component (so as to pay the farmer as per the fat content of the milk supplied by him). Such electronic milk collection station accessories are very popular particularly in India. Rajasthan Electronics and Instrumentation Ltd. (REIL) of India, in collaboration with M/s.A/SN Foss Electric of Denmark started the commercial production of electronic milk testers in 1981 and sold about 26,000 units to dairy cooperatives all over India.[74]

Box 6.4: Details of a Typical Automatic (Electronic) Milk Collection System

The Personal Computer-based Automatic Milk Collection Station is a specially designed integrated system, which is a combination of several units, viz; Electronic Milk Tester, Milk Weighing System, Personal Computer with a Card Reader / writer and 80-column printer. It is integrated with software support for milk collection and accounts management. It operates on AC-mains as well as on battery, with a built-in battery charger and an automatic switch-over to the battery in case of power failure.

The system is suitable for instant weighing of the milk, measurement of fat content and calculating the amount payable to the member based on fat and weight. The card serves the purpose of member (i.e. farmer/milk supplier) identification and acts as an electronic pass book for the member wherein his/her milk transaction data is stored. The system can also be used later for maintaining the complete records of the milk collection centre together with details of all transactions of the village co-operative society. The sequence of operation requires insertion of the card, pouring of milk in a weighing container, collection of milk sample at the time of pouring, measuring of fat content, calculation of payment and printing of payment slip.

Typical technical specifications are:

Weight measurement: 0 -100 kg

Fat measurement: 0 -13%

Measuring capacity: 120-150 operations / hour

Power supply: AC, 220-240V, 50Hz

72 Recommended reading for milk testing and quality control (provided in Annex 6.3): *Milk Testing and Quality Control – Milk Processing Guide Series (Volume 2)* by Food and Agriculture Organization. Available at: www.fao.org.

73 Recommended reading for devising a milk payment system (provided in Annex 6.4): *The System of Milk Payment in Nepal – Experiences from NDDB* in *Report on the FAO E-mail Conference on Small-scale Milk Collection and Processing in Developing Countries (29 May to 28 July 2000)*, pp.66 - 67. Available at: www.fao.org.

74 *IT at Milk Collection Centres in Co-operative Dairies: The National Dairy Development Board Experience* by Rupak Chakravarty. Available at: www.worldbank.org/wbi/documents/sn37160/Chapter04.pdf.

Figure 6.1: Illustration of an Automatic (Electronic) Milk Collection System[75]

Experiences with Automatic Milk Collection Systems[76]

While manual weighing and fat-testing for milk is also a possibility, previous experiences in India prove that the benefits of installing an electronic system far outweigh the costs involved. For instance,

- Before automation, the farmer was paid only every 10 days. Therefore, even though at times he or she delivered milk each day the farmer was not sure of the reliability of the manual calculations of quality and quantity by the staff at the milking centre.
- Milk for testing was stored in plastic bottles and tested only after the milk collection process was over. This led to unhygienic conditions and fear of contamination at the milking centre.
- The conventional Gerber method for testing the fat content of milk is a cumbersome multi-step method. It has various disadvantages including handling of corrosive chemicals, chances of human error, and use of different types of glassware. All these processes add to the cost and the time taken to test the milk.
- The conventional Gerber method takes 2 to 3 hours to ascertain the fat content of milk. This in turn leads to a delay in the payment to the farmer as the payment is made strictly on the quality of milk. In comparison, it takes about 20 seconds to weigh the milk, test its quality, record the results of the test and pay the farmer with the electronic system.

Furthermore, the importance of speed of operations was also felt in the normal day-to-day workings at the collection centres in India; 600-odd milk collection centres receive milk from about 60,000 farmers daily. On an average, if the saving in time per farmer were 10 minutes every day, it would amount to a huge saving to the tune of 10,000 hours per day! The deployment of this technology is considered instrumental to realize such savings.

75 *IT at Milk Collection Centres in Co-operative Dairies: The National Dairy Development Board Experience* by Rupak Chakravarty. Available at: www.worldbank.org/wbi/documents/sn37160/Chapter04.pdf.
76 *IT at Milk Collection Centres in Co-operative Dairies: The National Dairy Development Board Experience* by Rupak Chakravarty. Available at: www.worldbank.org/wbi/documents/sn37160/Chapter04.pdf.

Strategic entrepreneurship gave a considerable impetus to this system. They offered it to the rural farmer societies free of cost until they were convinced of the utility and satisfied with the performance of the system. In the initial stages the cooperative dairy unions also provided loan facilities to the village societies for the purchase of the system. However, the uphill task of developing the market was left to a few private enterprises. In spite of its usefulness on the whole, it has been predicted that only if a large number of private sector enterprises are involved can the application of this technology be adopted all over India.

The price for the entire system (comprising of the personal computer, weighing machine, milk quality tester, an 80 column dot-matrix printer, and an uninterrupted power supply) in the early 1990s was about US$ 2,250. Prices have been declining ever since and the latest available quote (as of December 2000)[77] offers the system at about US$ 500.

In terms of technological support, intensive training was provided to the personnel who were to operate the systems. Service engineers on motorcycles provided quick maintenance whenever required. Virus-proofing of the systems was also taken care of and back-up procedures for data were defined.

These systems have become so popular that village (rural) societies have been reported buying the systems with their own funds.[78]

6.2.2 Enabling Elements Towards Cleaner Production at the Milk Production Stage

Equipment for Raw Milk Quality[79]

In general, milk testing is not common in most traditional plants. A few MSME plants have started complying with the pasteurization decree issued by the Government of Egypt in the year 2001. Such plants typically tend to look towards "modernisation" of their processing lines and equipment, and include rapid testing systems for raw quality milk checks. Rapid raw milk testing systems are reportedly being imported from Turkey with average cost of LE 8,800. The system performs routine milk tests including parameters such as fat content, protein, lactose and total solids. The more modern (i.e. large scale) dairy plants have reportedly had "very good experiences" with automated systems like Milkscan.

Thus, the following may be viewed as potential enabling elements towards practicing Cleaner Production in Egypt at the milk production stage:

- Awareness and training sessions towards
  - The use of hygienic milking practices,
  - Government standards on milk quality,
  - The importance, establishment and maintenance of a milk payment system, etc.
- Research towards
  - The continued and uninterrupted supply of support services such as quality feed inputs
  - The establishment of a milk payment system, etc.

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77 *Empowering Dairy Farmers Through a Dairy Information and Services Kiosk* by Subhash Bhatnagar. Available at: www1.worldbank.org/publicsector/egov/diskcs.htm.
78 *IT at Milk Collection Centres in Co-operative Dairies: The National Dairy Development Board Experience* by Rupak Chakravarty. Available at: www.worldbank.org/wbi/documents/sn37160/Chapter04.pdf.
79 LE figure provided for the year 2003.

- Enabling financial mechanisms from financial institutions and/or the private sector towards
  - The supply of support services such as veterinary aid,
  - The supply and maintenance of rapid (automated time-saving) equipment for raw milk quality checks
- Knowledge dissemination through demonstration projects clearly illustrating the benefits of undertaking these Cleaner Production opportunities to similarly placed dairy holders, farmers and MSMEs in other Egyptian Governorates.

6.3 Milk Collection and Transportation Stage

Current issues in the milk collection and transportation stage are linked to milk spoilage and the measures adopted to deal with this. Disposal of spoilt milk leads to discharge of highly polluting wastes to drains. Where milk is not rejected MSMEs tend to use high levels of salt to compensate for the high bacterial activity of the milk. This leads to production of salty cheese and salty whey – which in turn reduce income and increase waste disposal costs.

Chain of ownership issues linked to milk quality are also a factor and these can affect the farmer, third party milk collectors and transporters and the MSME units with costs associated with the spoilt milk being variously carried by the different parties involved.

6.3.1 Cleaner Production Interventions

Infrastructure for Milk Collection and Transportation

The system of milk collection centres spread over a radius of 20 to 50 km around the MSME unit/cluster is recognized as the best method of collecting milk produced in dispersed or remote areas. This is a recommended strategy wherever:

- Milk is difficult to sell directly in the place it is produced and
- Where there is an assurance of a regular outlet as an encouragement to the small-scale farmers to produce higher and better quantity and quality of milk.

A possible strategy to improve hygiene across the entire milk collection and transportation system (i.e. starting from the small scale farmer/milk producer and ending at the MSME unit where the milk is taken for further processing), would be to envision a project which can provide the farmer with ideally-designed, easy to clean stainless steel cans for the purpose of milking. This will involve financing of the milk collection cans and the organization of awareness-come-training sessions for the farmers on hygienic milking procedures (refer to Box 6.2) using the cans.

Stainless steel is recommended over plastic and aluminum cans since it is easier to clean and lasts longer. (There have been reports of 5-20 litre recycled cooking oil containers being used by small scale farmers for milk collection purposes, these do not have large enough mouths to ensure thorough cleaning once the milk has been emptied, and they do not have good grips for carrying when full, which is very inconvenient when the farmer may have to travel several kilometers on foot or bicycle to sell the collected milk.)

A collection center with a cold storage (holding) tank (see also the following sub-section on milk preservation) would need to be established.[80] The collection centre would need to be located at a central spot and have a cooling system to suppress harmful bacteriological activity.

Farmers and milk suppliers would bring raw milk in stainless steel cans to the collection center. The milk would be stored in the holding tank, and then transported to the MSME by a delivery tank mounted on a truck. In order to transfer the milk from the collection centre holding tank onto the truck, it would be necessary to provide the collection center with the requisite pumping facilities. The collection center would also need to be provided with an efficient cleaning and sterilization system consisting of hot water tank, hoses and nozzles. Additionally, it would be prudent to provide milking can washing facilities at the collection centre. The provision of water with appropriate cleaning aids and guidance can make a significant contribution towards ensuring hygienic milk collection. Experience has shown that is quite impractical to expect small holders to clean a milking can effectively, which may have been emptied an hour or more earlier at their home.[81]

When implemented, this Cleaner Production opportunity would potentially involve multiple benefits as follows:

- Reduction or elimination the spoilage of raw milk, thus leading to economic benefits to the MSME, farmers and milk suppliers,
- Reduction in the consumption of salt, due to increased confidence in the quality of raw milk,
- Production of cheese with a lower salt content to address a higher-end market (i.e. realize a better payment for the end product), thus increasing economic returns to the MSME, as well as providing a health benefit to the consumer,
- Reduction in salt content of the whey thereby increasing whey utilization potential, and
- Reduction of salt discharge to the environment, as well as a reduction in the overall BOD concentration in the wastewater due to reduction of raw milk spoilage.

The project can thus realize clear environmental, social (health) as well as economic benefits across various stakeholders such as the farmers and milk suppliers, MSMEs and consumers. A preliminary estimate of the involved cost and payback period of this particular Cleaner Production opportunity for a typical Egyptian MSME cheese processing unit[82] is LE 250,000 and 20 months respectively (LE estimate calculated for the year 2002).

Hygienic milk collection and transportation has implications for the milk processing stage; this particular strategy presents positive consequences not just for the farmers and milk suppliers, but also for the MSME units in their processing operations and the consumer demonstrating how a Cleaner Production opportunity may benefit more than one stakeholder.

80 Recommended reading for how to start a milk collection centre (provided in Annex 6.5): *Milk Collection* in *Milk Collection, Processing and Marketing*. Available at: www.fao.org.

81 *Annex 5: Introductory Paper, Discussion Papers, Poster Papers and Comments Received on Topic 1* in *Report on the FAO E-mail Conference on Small-scale Milk Collection and Processing in Developing Countries (29 May to 28 July 2000)*, pp. 77. Available at: www.fao.org.

82 For an MSME unit processing 6.5 tonnes per day of raw milk into 0.65 tonnes per day of hard cheese (*Ras*) in the winter season, 30 kg per day of whey cream as a by-product from the hard cheese whey, and 0.5 tonnes per day of soft white cheese (*Domiaty*) in the summer season.

6.3.2 Enabling Elements at the Milk Collection and Transportation Stage

Milk Collection Centres from the Perspective of Egyptian MSMEs

Milk collection centers were established by *Misr* Dairy & Food Company however, as a result of privatization policy, the production capacity for the company has now decreased markedly and the milk collection centers are no longer in operation. The private sector has established a few milk collection centers in the Delta area, they collect and deliver the milk (after refrigeration) primarily to milk retailers selling raw liquid milk in large cities of Egypt; and only a small quantity of the collected milk goes towards the purposes of cheese making.

The following may be viewed as the potential enabling elements towards practicing Cleaner Production at the milk collection and transportation stage:

- Awareness and training sessions towards
  - The use of milking cans and their maintenance from the point of view of hygiene,
  - The importance of establishing milk collection centres, etc.
- Enabling financial mechanisms from financial institutions and/or the private sector towards the establishment of milk collection centres and associated equipment (i.e. milking cans, nozzles and pipes for cleaning purposes, holding tank, pumping facilities, etc.)
- Knowledge dissemination through demonstration projects illustrating the benefits of undertaking Cleaner Production opportunities to similarly placed dairy farmers and MSMEs.

6.4 Milk Preservation Stage

As explained earlier the preservation of raw milk presents a challenge at the MSME scale given:

- The unhygienic practices during milk collection and transport
- High ambient temperatures

It is estimated that in the winter months, 5-10% of the collected raw milk is spoilt. This rises to 30% during the summer season. Thus, economic losses and environmental damage caused are high. It has been estimated that annual losses of about LE 90,000 to the MSME unit can be attributed to this factor alone, not including the losses caused to the environment (LE estimate calculated for the year 2002).

In some instances, preservatives such as hydrogen peroxide are added to the raw milk in order to suppress the bacterial activity. Formalin has been used as a preservative for raw milk, this material poses a significant health risk to the consumer as it is a carcinogen. [83]

Spoilt raw milk is discharged directly to the sewer/drain. Since the spoilt milk has extremely high levels of BOD, COD and suspended solids, it creates a significant source of pollution. [84]

83 *Egypt Dairy Directive Project*. Available at: www.acdivoca.org/acdivoca/Acdiweb2.nsf/whatwedo/egyptdairy.
84 Terminology such as BOD, COD, etc. is explained in detail in Section 4.0 of this report.

6.4.1 Cleaner Production Interventions

Clearly, some Cleaner Production intervention is necessary in order to overcome the problems in the milk preservation stage of the MSME dairy cycle. Such an intervention should target a reduction and ideally, elimination in the spoilage of raw milk. Such Cleaner Production interventions may take one or all of the following forms depending on the presence or lack of infrastructure for raw milk preservation (i.e. a reliable electrical supply for a cooling system and the cooling system itself). Conventional ice-bank or direct expansion milk cooling units are expensive, costing as much as US$10,000 for a 1,000 litre capacity tank with supporting equipment. The systems are expensive to run, especially when fairly small quantities of milk are collected during the low season. They require a purpose-built building, a reliable three-phase electricity supply, comparatively sophisticated maintenance, and good access roads for heavy milk collection trucks. As a result, they can be difficult to operate efficiently where milk is produced in remote rural areas.

- **In cases where infrastructure for raw milk preservation is entirely absent:**[85]
  The lactoperoxidase system (LP-s) of milk preservation has been advocated as a useful mechanism for the preservation of raw milk collected in cases where no adequate infrastructure (i.e. cooling systems) is present.

The LP-s has been recognized by the FAO since the 1980s as a safe, cheap and flexible method of milk preservation from the farm to the dairy. Developed in Sweden and extensively field-tested, this technology is deemed safe and inexpensive. Box 6.5 provides some highlights of the LP system.

Box 6.5: The Lactoperoxidase System of Milk Preservation

Up to 20% of milk in developing countries is estimated to be lost due to souring (spoilage). In 1991, the *Codex Alimentarius* Commission[86] approved a guideline on the use of the LP-s system of milk preservation. This practical code takes into account the wide variation of the milk collection systems, milk transport and processing all over the world.

LP-s is an enzyme that is naturally present in milk. One of its unique biological functions is an antibacterial effect in the presence of hydrogen peroxide and thiocyanate. Both of these substances are naturally present in milk in varying concentrations. The method of activating LP-s in milk to add about 10 ppm (**p**arts **p**er **m**illion) of thiocyanate (preferably in powder form) to the raw milk to increase the overall level to 15 ppm (5 ppm being naturally present). The solution is thoroughly mixed for 30 seconds and then an equimolar amount (8.5 ppm) of hydrogen peroxide is added (generally in the form of a granulated sodium carbonate peroxyhydrate). The activation of the LP-s has a bacteriostatic effect on the raw milk and effectively extends the shelf-life of the raw milk under tropical conditions for 7-8 hrs. This means that the milk may be transported from the collection point to a processing centre (such as an MSME), with a considerable (if not total) elimination of milk spoilage. The inhibitory effect of the treatment is dependent on the temperature of the stored milk and has been found to act for the following periods of time in laboratory and field experiments carried out in different countries with *raw milk of an initial good hygienic standard:*

Temperature (^{o}C)	Time (h)
30	7-8
25	11-12

85 Adapted from: *FAO Dairy Projects and Other Activities*. Available at: www.fao.org.
86 The *Codex Alimentarius* Commission was created in 1963 by FAO and WHO to develop food standards, guidelines and related texts such as codes of practice under the Joint FAO/WHO Food Standards Programme. The main purposes of this Programme are protecting health of the consumers and ensuring fair trade practices in the food trade, and promoting coordination of all food standards work undertaken by international governmental and non-governmental organizations.

20	16-17
15	24-26

As of July 2000, FAO was promoting the system through the Global LP-s Programme under which a series of national demonstrations of the use and regulation of the system were to be held.

Use of the LP-s does not exclude the necessity of pasteurization of the milk before human consumption. Neither does it exclude the normal precautions and handling routines applied to ensure a high hygienic standard of the milk.

Box 6.6 provides some highlights of the national demonstration of the LP-s of milk preservation in selected South-Eastern Asian countries.

Box 6.6: Highlights - National Demonstration on the LP-s of Milk Preservation in Selected South-Eastern Asian Countries

Background and objectives

Slated to run from December 2001 - November 2002, this programme was a regional technical cooperation programme with 6 participating countries - Bangladesh, Bhutan, Indonesia, Pakistan, the Philippines and Viet Nam. The project conducted national demonstrations on the application of the LP-s of milk preservation at collection centres, thus aiming to raise regional awareness about this safe, cheap and effective alternative milk preservation method.

Outcomes

The adoption of this system coupled with tailored training on hygienic milk handling led to:

- Improved hygienic quality of milk and dairy products
- Expansion in milk collection routes
- Increase in farmers' incomes

Some guidelines for the use of this method are presented in Box 6.7.

Box 6.7: Some Guidelines for the Use of the LP-s system of Milk Preservation[87]

This system is described by *Codex Alimentarius* as intended for utilization in the following situations:

- The method should *not* be used by the individual farmers but at a suitable collection point/centre.
- These centres must be equipped with proper facilities for cleaning and sanitising the vessels used to hold and transport milk.
- They should be given appropriate training including training in general milk hygiene, to enable them to fulfill this in a correct way.
- The dairy processing the milk collected by use of the LP-s system should be responsible for ensuring that the method is used as intended. This dairy should set up appropriate control methods to monitor usage of the method, raw milk quality and quality of the milk prior to processing.
- The inhibitory effect of the treatment is dependent on the temperature of the stored milk and has been found to act for the following periods of time in laboratory and field experiments carried out in

87 Recommended reading for the use of the LP-s in milk preservation (Table of Contents provided in Annex 6.6): *Manual on the use of the LP-System in Milk Handling and Preservation by the Food and Agricultural Organization of the United Nations.* Available at: www.fao.org.

different countries with *raw milk of an initial good hygienic standard:*

Temperature (^{o}C)	Time (h)
30	7-8
25	11-12
20	16-17
15	24-26

There have been some experiments made with LP-s as a preservation system in Egypt. The results of these experiments indicated that the preservation of non LP-s treated pasteurized and LP-s treated pasteurized cow and goat milk were 0 and 17, and 0 and 20 days respectively.[88]

To allow the use of the LP-s system as a means of preservation for milk, the Egyptian legislation would require modification.

- **In cases where adequate infrastructure for raw milk preservation is possible:** Cooling of raw milk by immersing the milk cans into an ice bath is a good method of cooling milk at small-scale milk collection centres. However, many small-scale collection centres may not have ice because they do not have access to reliable electricity. To take into account these problems, an ice-making system could be developed for remote small-scale milk collection centres. The most important requirements for such a system would be a low capital cost and short payback period (i.e. the amount of income generated must be able to pay for the system in a reasonably short time period). Further, to meet this requirement for the rural off-grid application, the system should not require electricity or fuel supply, and should be very durable and low in maintenance needs. Box 6.8 and Figures 6.2 and 6.3 provide details of one such low-cost, low technology cooling system suited especially for MSME-scale dairy unit operations.

Box 6.8: Details of a Low-cost Low Technology Cooling System

ISAAC™ Solar Icemaker

One class of refrigeration systems, which are particularly good candidates for remote off-grid ice-making, are the intermittent absorption refrigeration (IAR) systems. IAR systems have a vessel of absorbent and refrigerant that is heated causing liquid refrigerant to be collected in a second vessel. As the vessel cools, the refrigerant is reabsorbed and a refrigeration effect is produced at the second vessel. These systems are composed generally of steel vessels, piping and valves. Since such components are low cost and very durable, part of the requirements of an appropriate system are satisfied. In addition, IAR systems can be powered by solar energy. Thus IAR systems have great potential for rural off-grid icemaker market.

The ISAAC™ Solar Icemaker developed by Energy Concepts Company of Annapolis (Maryland, USA) meets the features of IAR. It has been reported that this system meets the requirements of low cost and sufficiently high productivity to be cost effective. The solar collector is 12.1 sq. m. and it produces about 50 kg of ice per sunny day. With minimal low cost maintenance, this unit can reportedly function for at least 20 years.

88 *Annex 5: Introductory Paper, Discussion Papers, Poster Papers and Comments Received on Topic 1* in *Report on the FAO E-mail Conference on Small-scale Milk Collection and Processing in Developing Countries (29 May to 28 July 2000)*, pp. 83. Available at: www.fao.org.

As an estimate of the income generated by 50 kg of ice per day, if we consider that 1 kg of ice is able to cool nearly 2 litres of milk to 3°C. If the additional income of selling to a more lucrative market is 10 cents per litre of milk, then the annual additional income is $3,000 (based on operating 300 days per year). This amount of money should recover the cost of an ISAAC™ in a reasonably short period. The unit costs US$4,000 to US$5,000 per unit.[89]

Figure 6.2: ISAAC™ Solar Icemaker[90]

Figure 6.3: Blocks of Ice Made using the ISAAC™ Solar Icemaker[91]

6.4.2 Enabling Elements at the Milk Preservation Stage

Low-cost, Low Technology Cooling Systems

Despite the evident usefulness of such systems, there have been no reported cases of their use in Egypt. The general practice followed for cooling milk in Egypt is the insertion of ice slabs in the milk containers, which are then placed in milk tanks. The preservation of raw milk is generally not an issue in the winter season (the raw milk reportedly reaches its processing destination either early in the mornings or late at nights within 3 hours, at an average temperature of 20°C), there is considerable spoilage during the summer season. The acidity of the raw milk markedly increases to unacceptable levels for drinking purposes, or even for the purposes of yoghurt and Roumy cheese production. Such milk is commonly channelled into producing highly salted Domiaty cheese, or in some cases, may be rejected.

89 See footnote 99.
90 From: www.members.aol.com/SolarIceCo.
91 From: www.members.aol.com/SolarIceCo.

Thus, the following may be viewed as the potential enabling elements towards practicing Cleaner Production in Egypt at the milk preservation stage:

- Awareness and training sessions towards
  - The importance and methodology of application of safe, cheap and effective milk preservation practices like LP-s, when the quantity of milk to be collected is comparatively small, and where the supporting infrastructure for milk preservation is very difficult to establish, or
  - The use and upkeep of low-cost and low-technology cooling channels for milk preservation where the quantity of milk to be collected is comparatively large, and where it is possible to establish the supporting infrastructure for such channels
- Policy changes enabling the use of the LP-s in milk preservation
- Enabling financial mechanisms from financial institutions and/or the private sector towards the supply of low-cost and low-technology cooling channels for milk preservation
- Knowledge dissemination through demonstration projects clearly illustrating the benefits of undertaking these Cleaner Production opportunities to similarly placed dairy holders, farmers and MSMEs.

6.5 Dairy Processing Stage

MSME-scale processors often find difficulties in getting the "right kind of equipment" for the business. In Egypt[92], micro-enterprises are classified as those operating with between 1 to 4 workers, small enterprises as those operating with between 5 to 14 workers and medium enterprises as those operating with between 15 to 49 workers.[93] Such definitions gain significance since what may be small-scale in one country could be medium-scale in another, depending on the level of development. Besides this has a big influence on the choice of technology that may be available.

Raw milk and products manufactured at the MSME scale are sometimes labelled as being unhygienic. Such products may be rejected by the public and hence result in an economic loss for the MSME unit. Most MSME scale producers are unable to pasteurize the raw milk they sell and use in their products notwithstanding a Government directive on compulsory pasteurization. It has been reported that MSMEs are having problems in responding to this directive due to:

- Financial constraints,
- Lack of understanding in terms of additional benefits that pasteurization can provide to the MSME unit,
- Difficulties in accessing the appropriate technology at the right scale,
- Lack of skills in operating such equipment,

92 *Ministry of Foreign Trade – Small and Medium Enterprises (SMEs), Egypt*. Available at: www.sme.gov.eg/sme_statistical_information.htm.

93 On the basis of the definition provided by FAO, small-scale processing units are those units handling more that 500 litres per day but less than 5,000 litres per day. Very small scale or micro-dairies are those handling less than 500 litres per day. At the very bottom line, are the "household level technologies" which are important for household food security (which is the case in Egypt as well).

- Unacceptably high acidity levels in raw milk in the summer particularly and also due to the unhygienic milking practices followed, thus making the raw milk unfit for pasteurization,
- Perceived reduction in sensory quality (especially for Roumy cheese) expected due to the effect of pasteurization on natural micro flora associated with raw milk.

MSME-scale products have to compete with the large-scale manufacturers or multi-national giants. While a substantial export market exists for MSME cheese products, limitations concerning hygiene, packaging and overall product quality require to be addressed before the market share can grow and benefit the local MSME-scale producers.

Box 6.9: Problems Reported with respect to Cheese Exports to Saudi Arabia

The following problems are usually encountered in this connection:

1. Metallic cheese packs are found to be frequently defective due to corrosion.
2. The quality of cheeses generally violates Saudi standards as follows –
   - Harmful microbes are detected in the cheeses.
   - The source of whey is not recorded in the product identity card.
   - Rust of white cheese metallic containers is frequently recorded.
   - Excessively salty flavour and low fat content do not conform to Saudi tastes.

MSME-scale dairy processors in Egypt are generally neither aware of the importance of training, nor do they have access to such facilities. Fellowships and external training generally go to Government organizations. MSME-scale processors are able to receive training only through donor-assisted projects, if at all they operate in the areas designated for donor assistance. Many entrepreneurs start MSME-scale processing through learning by seeing, without formal skills, thus turning the enterprise into a risky business.

Large amounts of salt are used by MSMEs during the cheese making operations. This leads to salty product which often commands a lower price than less salty cheeses, health implications for consumers, poor reuse potential of salty whey and implications for waste treatment.

Thus, the problems with the MSMEs in the dairy sector in Egypt at the dairy processing stage of the dairy cycle may be broadly classified as:

- ❑ Lack of suitably scaled technology,
- ❑ Lack of hygienic practices,
- ❑ Lack of awareness and training (on issues concerning technology as well as hygiene),
- ❑ Difficulties in dealing with the salty whey by-product produced as a result of cheese-making operations,
- ❑ Difficulties in envisaging alternate mechanisms (i.e. Cleaner Production opportunities) for the use of acidic and sweet whey, so as to tap their economic-come-productivity potential.

6.5.1 Cleaner Production Interventions

Cleaner Production Opportunities Concerning Technology Requirements

The MSME processor may grow or modernize in order to adapt his business to a larger and more readily available technology or technologies suited specifically to the scale of the MSME operations are sought out or developed.

- **Modernisation of MSME dairy units:** One strategy that may be adopted to address the issues arising at this particular stage (and hence work towards Cleaner Production) in the dairy cycle is given in Box 6.10.[94]

Box 6.10: Cleaner Production Strategy of Modernising Existing Dairy Processing Operations by Switching to Modern Techniques such as Ultrafiltration (UF)

Technologies such as UF are not new to Egypt as these are currently used by large scale dairy factories. The problem however, is that the MSME scale dairy units lack the needed strategic approach, business acumen and an ability to take technology related decisions. The investments in the UF technology are significant and guidance on how to transform long-followed traditional operations to a modern UF facility is simply not available. Consequently, it is highly likely that investment and technology related decisions on suitable UF equipment to be procured, and market decisions such as the product profile will be poorly taken.

Since there is hardly any data available on the costs and benefits of such a modernisation, the benefits of possible increase in the production, product profile, product quality together with the benefit of reduced environmental impact need thorough quantification in the perspective of MSME units.

The purpose of such a Cleaner Production initiative therefore is to develop a strategic approach towards modernisation of MSME scale units so as to integrate business, technology and environmental considerations. Working with a MSME at a pilot-scale will provide real-life data, and valuable insights to do’s and don’ts along with the quantification of benefits and costs. When consolidated, the project will provide a guidance and implementation process that could be followed by similar units. This information will be useful for other dairy factories, regulators and policy makers, and technology providers as well as investors and/or financing institutions.

The nature of activities to be undertaken such a Cleaner Production initiative will be as follows:

- Monitoring and assessment of the baseline situation at the MSME following the traditional techniques of dairy processing*:* Aspects to be looked at here will include market position, market strategy, environmental considerations, human resource inputs/requirements, and capacity constraints concerning infrastructure.
- Preparing a modernisation plan for the MSME based on pasteurization and UF (e.g. scenario studies for different tonnages of products, probable priority products, type of UF equipment to be procured, ease of availability of spare parts and service, etc.)
- Conducting a rigorous cost-benefit analyses so as to enable the evaluation of options
- Implementing the modernisation plan at the MSME (e.g. obtaining quotes from vendors, finalizing a supplier, drawing up of the contract, preparing the site for new equipment, obtaining required permits, etc.)

94 Recommended reading for research into new consumer dairy products (provided in Annex 6.7): New Consumer Dairy Products from Membrane Technology by Dr. J. W. Siebert and Mr. A. Lalor, Department of Agricultural Economics, Texas A & M University, Texas, U.S.A. Available at: http://agecon.tamu.edu/iama/2000Congress

- Monitoring and assessment of the post-project implementation situation at the MSME
- Preparing documentation and facilitating information dissemination

- **Seeking technologies specifically suited to the MSME scale:** One example of such a technology is complete in-pouch fill, seal, pasteurize and milk cooling system called the MILKPRO unit, developed by the Food and Agriculture Organization (FAO) (refer to Box 6.11 and Figure 6.5). The initial investment of US$10,000 can be paid back within 12 months at a daily throughput of 750 litres. The immediate aims are to increase producer returns by up to 50% and to make increased volumes of attractively packaged, safe pasteurized milk available to consumers at competitive prices. The main advantages of the system are:
  - Ability to handle very small quantities of milk (as little as 50 litres a day) efficiently and safely
  - Low energy and water consumption
  - Reduced waste water generation

Box 6.11: Details about the MILKPRO Unit[95]

FAO has field tested a low-cost, innovative milk pasteurizing unit in Kenya. Built in South Africa, the unit, called the MILKPRO, first fills raw milk into pre-formed polyethylene pouches. The pouches are immediately sealed, treated at 65^{o}C for 30 minutes in a batch pasteuriszer, and cooled to 50^{o}C in a chiller. The heating process is automatically controlled. The unit can handle up to 100 litres of milk an hour and costs just under US$10,000. At a daily throughput of 750 litres the payback period can be as little as 12 months. The unit is operated by plugging into a standard single phase electrical power point, or by using a small diesel or petrol engine. It is especially designed for easy cleaning and maintenance and suitable for installation in existing basic buildings. Because the milk is pasteurized in the pouch, post-pasteurization contamination - the main cause of spoilage - is virtually eliminated. A refrigerated shelf-life of up to 15 days is possible - a good sales plus in today's highly competitive marketplace. The food grade polyethylene pouches can usually be manufactured in-country and printed with eye-catching designs. Though the MILKPRO system was developed only recently, more than 60 units are now in use across 11 countries in Africa, both with small farmer groups and with individual farmers. One unit is in operation in Europe (in Romania) and great interest has also been shown in the USA where MILKPROs are expected to be in operation later this year.

The FAO is also in the process of developing a "directory of small scale milk and milk products processing equipment".[96]

95A more detailed description of the MILKPRO unit may be found on the FAO web-site at: www.fao.org/ag/aga/agap/lps/dairy/MPR/Milkpro/milkpro.htm. The same is also provided in Annex 6.8 of this report.
96 Available at: www.fao.org.

Figure 6.4: An Illustration of the MILKPRO Unit[97]

Cleaner Production Opportunities Concerning Awareness and Training Requirements at the Dairy Processing Stage

With any technology, whether adapted, new or modern, another important aspect is training the people to utilize it. Box 6.12 provides an account of one such training programme being undertaken by FAO for the small scale dairy sector.[98]

Box 6.12: Training Programme for the Small-scale Dairy Sector, Thailand[99]

Slated to run between September 2002 and August 2004, the objective of this programme is to develop the organisation of short-term, tailor made training courses for persons and organisations involved in whole chain of small-scale dairy sector to improve efficiency, quality and safety. A specially tailored small-scale milk collection and in-pouch pasteurizing and packaging system will be field tested at the Sankampaeng Women's Village Co-operative model dairy enterprise and validated to comply with the Food and Drugs Administration food standards and regulations.

Additionally, in order to build local human capacity to expand project activities, a dairy demonstration and training unit will be established at the Chiang Mai Dairy Training Centre. Trainers will be trained who will form the core dairy training team at the centre. Mobile milk quality control and training system will be established to deliver training at field level.

Through these project activities, it is expected that the rural smallholder milk production system will expand and small-scale milk processors can improve the quality of their products. Since the programme is ongoing, the final outcomes will be visible on completion of the project.

97 *Low Cost Milk Packaging-Pasteurising-Chilling System.* Available at: www.fao.org.
98 More examples of technology-come-hygiene allied training projects are available at the MSME scale. However, it is not the intention of this report to provide an exhaustive list and details of each training initiative here.
99 *FAO Dairy Projects and Other Activities.* Available at: www.fao.org.

Cleaner Production Opportunities in Dealing with the Salty Whey By-Product Produced as a Result Of Cheese-Making Operations

As mentioned earlier, some generation of salty whey is inevitable, as the recipe for certain cheeses (i.e. hard cheese in particular) calls for the use of salt. The pressing of the salted cheese curd will expel salty whey. This type of whey has limited potential in reuse and recovery options and should therefore be minimized to as far an extent as possible. Box 6.13 provides an example of salt minimization in whey.

Box 6.13: Practicing Cleaner Production through Salt Minimisation in Whey[100]

An American Dairy manufacturing a wide variety of cheese at its plant wanted a better method of disposal for the salt whey generated as a by-product of its cheese manufacturing operations. Since this particular whey was salty, it could not be reused as a food grade additive.

Previously, the dairy employed land spreading of salt whey since the practice was allowed by the state it was operating within. However, the practice of land spreading was unattractive to them because "it increased the level of chlorides in the soil and posed a slight risk of crop damage if applied incorrectly". Additionally, it presented a "logistical burden" to the dairy.

Consequently, the dairy decided to recover salt from the salty whey by means of an evaporator[101] and reusing this recovered salt in the cheese production process. A stainless steel process pipeline from the salting tanks to the evaporator was installed. The evaporation-recovery process separated the pumpable salt whey from water and hence significantly reduced the total net amount of salt whey. The remaining salt whey was reused in the cheese production process, while the recovered water was used for cleaning and other purposes that did not require potable water.

Initially, there was concern that the use of the recovered salt would have an adverse effect on the flavour and shelf life of the cheese. After implementing the Cleaner Production opportunity, the dairy found that the recovered salt whey actually enhanced the flavour of the cheese and had no adverse effects on its chemical composition or shelf life.

Given below are some details concerning cost-benefit analysis and payback periods.

Original process (before initiating Cleaner Production)

Feedstock: Salt (0.45 tonnes/day at US $48/0.45 tonnes)

Waste: Approximately 900 litres/day of salt whey waste

Disposal method: Land spreading

After initiating Cleaner Production[102]

Feedstock: Recovered salt whey (0.18 to 0.23 tonnes/day) and fresh salt (0.23 to 0.27 tonnes/day)

Waste: Approximately 0.18 tonnes/day of salt whey containing up to 45 kg of salt

Capital cost: US $2,000 for the purchase and installation of the additional stainless steel pipeline

Operating/maintenance cost: This cost was approximately US $70/tonne of salt recovered.

Payback period: 2 months (calculated based on capital costs of US $2,000 and salt purchasing savings of US $12,500 annually)

100 Wisconsin Department of Natural Resources: *Pollution Prevention Case Study: Salt Whey Recovery/Re-use by Evaporation*. Available at: www.dnr.state.wi.us/org/caer/cea/publications/casestudy/casestudies/sw167.htm.

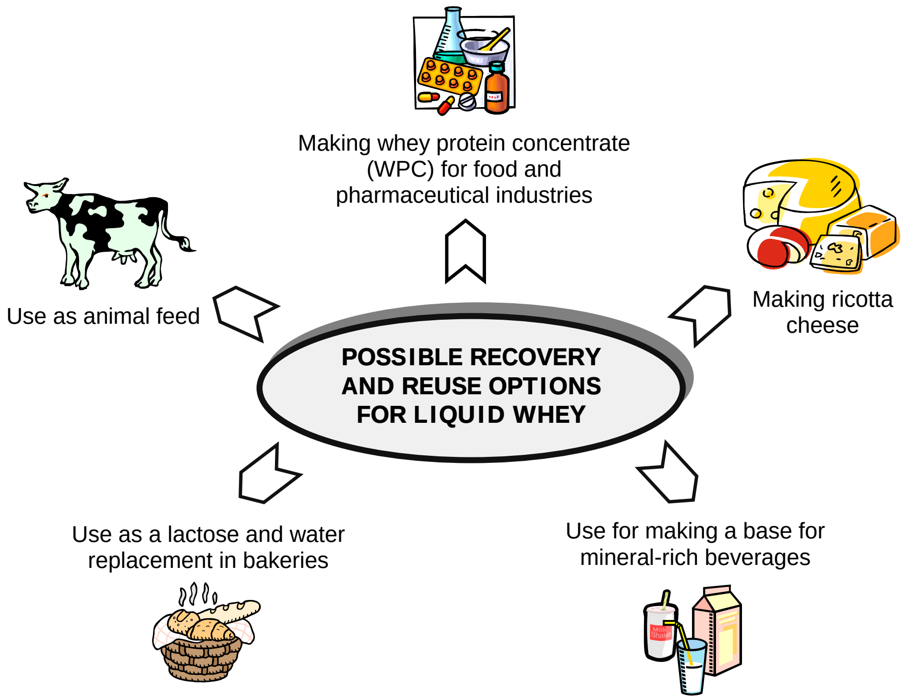
101 The recovery process was developed by modifying an evaporator that was previously used for recovering edible whey.

102 Not all the salty whey can be recovered at the time this Cleaner Production opportunity was being experimented with. The United States Department of Agriculture (USDA) did not allow dairies to reuse salty whey which has come in contact with wooden containers due to sanitation concerns. The dairy hoped to eventually recover all the salty whey by replacing the wooden containers with plastic containers. The remainder of the salty whey (i.e. the portion not included in evaporation-recovery) had to be disposed of through land spreading.

Cleaner Production Opportunities Concerning Realization of Economic and Productivity Potential of Sweet and/or Acidic Whey at the Dairy Processing Stage

Cleaner Production opportunities may be applied to sweet and acidic whey as a means to realize an additional economic-come-productivity potential from what used to be considered a waste, and therefore make larger profits (see Figure 6.5**).**

Figure 6.5: Cleaner Production Opportunities for the Recovery and Reuse of Economically Attractive By-Products from Sweet and / or Acidic Whey[103]



6.5.2 Enabling Elements at the Dairy Processing Stage

Thus, the following may be viewed as the potential enabling elements towards practicing Cleaner Production at the dairy processing stage:

- Research and strategic technological and economic advice towards
  - The seamless provision of new modernized technology;
  - The design, process optimization and maintenance of technology scaled to MSME units.
- Awareness and training sessions towards
  - The importance of hygiene in day-to-day dairy processing operations;
  - The need, use and maintenance of any newly installed technology (e.g. pasteurization, UF systems, etc.);

103 Sources:
- *Do It With Dairy: Formulations and Applications*. Available at: www.doitwithdairy.com/ apps/appmain.htm.
- *Winning Whey*. Available at: www.preparedfoods.com/archives/1998/9807/9807wheys.htm.
- *Cleaner Production Assessment in Dairy Processing* by United Nations Environment Programme and Danish Environment Protection Agency, 2000. Available at: www.unep.org/library.

- Government standards concerning the quality of finished dairy products and the liabilities associated with non-compliance;
- Government standards and consequences concerning the discharge of environmental pollutants (especially, but not limited to, salty whey - to the environment), the environmental and health impacts of pollutants and the liabilities associated with non-compliance;
- Alternate mechanisms for the use of acidic and sweet whey, as a means of earning additional returns and decreasing environmental liabilities.

- Policy reforms enabling
  - The adoption of new technology by allowing subsidies on equipment to be used for MSME-scale upgrading
  - The protection of consumer health and ensuring that the dairy products meet criteria for exports through regulations governing limits on salt usage in all dairy products;
  - The use of novel and appropriate waste utilization techniques (e.g. reuse of whey generated as a by-product of cheese processing operations for baked goods manufactured in bakeries).
- Enabling financial mechanisms from financial institutions and/or the private sector towards investment in new/modern technology.
- Knowledge dissemination through demonstration projects clearly illustrating the benefits of undertaking these Cleaner Production opportunities to similarly placed MSMEs in other Egyptian Governorates.

6.6 Cleaner Production Opportunities at the Dairy Distribution and Marketing Stage

Dairy products may be sold at large supermarkets, through small groceries or specialised laban shops. At least 80% of dairy products made at the MSME scale are sold through laban shops. However, the retail distribution of dairy products is fragmented and there is a marked absence of a common entity among the dairy producing, collection, processing and distribution-come-marketing parties. As of 1997, there were two state owned co-operative groups, each consisting of approximately 500 outlets. Both groups previously had to source products from other parastatal organisations but are now autonomous commercial entities.

As a result, it is difficult (if not impossible) for MSME scale dairy farmers and/or units to: get the best possible price for their milk; make strategic decisions about new product lines; gather news about market assessments vis-à-vis pricing of products in the markets; the supply and demand situation, etc.

The goal of the Egyptian Exporters Association (EEA) is to develop Egyptian non-traditional exports and increase Egyptian exporters' competitive advantage, helping them reach and compete in targeted markets with sophisticated and enhanced products or services matching international market demands. EEA offers a comprehensive service package from information, market research, technology transfer, export promotion, to market entry.

Agriculture-Led Export Businesses (ALEB) was established and funded by USAID to support Egypt's private sector. ALEB provides assistance in collecting and utilizing market information, integrating new food processing technologies, improving adherence to international food quality and safety standards, enhancing marketing and business skills, strengthening associations; and forming strategic alliances.

Their activities primarily address export activities; they do not extend throughout the entire dairy cycle and do not orient themselves particularly towards MSMEs.

6.6.1 Cleaner Production Interventions at the Dairy Distribution and Marketing Stage

There is an urgent need for strategic guidance to aid the MSME dairy processor towards Cleaner Production by:

- Assessing technology-related decisions,
- Conducting risk evaluations (e.g. calculation of pay back times),
- Carrying out research and development,
- Initiating and sustaining training and dissemination activities,
- Establishing enabling mechanisms such as financial assistance through donor-assisted credit lines, Government policy directives, etc.

The prospect of being able to ensure higher returns for one's products has a direct impact on the likelihood of exploring Cleaner Production opportunities and implementing Cleaner Production options.

If a processor has to take a major decision concerning expensive equipment procurement for his cheese processing unit as a result of a recommended Cleaner Production option, it is likely that his decision will be influenced by the payback period and price he may obtain for his product. If the sale price of new products and payback times for new technology are not attractive, the processor may feel unable to recoup his investment on the Cleaner Production option in an acceptably short period, he may decide not to undertake that Cleaner Production option.

Box 6.14 provides the example of the Kenya Dairy Board, which was restructured into a "modern, cost-efficient, self-reliant body that works to promote the dairy industry and which is accountable to the entire dairy industry".[104] This example shows the value of a central body in obtaining the best for member organizations.

Box 6.14: Restructuring the Kenya Dairy Board[105]

Slated to run from November 2001 - August 2003, this project was aimed at restructuring the Kenya Dairy Board (KDB). The Kenyan dairy sector is responsible for almost one-third of national agricultural Gross Domestic Product. Uniquely for Africa, some 600,000 smallholders produce about 60% of the country's marketed milk, with women being directly involved in milking, household processing and marketing. Approximately 80% of this milk is sold raw in the unregulated informal market, leading to public concerns about hygiene and safety. Due to persistent mismanagement, the KDB was facing financial problems and marketing less than 20 million litres of milk annually, down from upwards of 250 million litres in its heyday. In 1992, the processing and sale of milk was liberalized and there were over 40 small and medium-sized companies and co-operatives processing some 150 million litres of milk annually. Many smallholder milk

104 *FAO Dairy Projects and Other Activities*. Available at: www.fao.org.
105 See footnote 121

producers supplied/supply milk to these new processors.

As part of the measures aimed at expanding the dairy industry to respond to these developments, and the increasing demand for milk and dairy products, the Ministry of Agriculture and Rural Development sought to reform KDB. The objective of the project was thus to prepare and initiate the implementation of a programme to restructure and commercialize KDB into a modern, cost-efficient, self-reliant body that works to promote the dairy industry and which is accountable to the entire dairy industry.

The outcomes of this project include the following:

- A remodelled organizational and staffing structure to reflect KDB's updated purpose and independent functions related to delivery of services and information
- A set of clear and easily understood standards for the dairy industry
- 19 workshops, training courses and field days held for up to 500 key stakeholders representing KDB (board members and staff), milk producers, processors, market intermediaries, other dairy institutions and Government agencies to sensitize them to the process of changing KDB
- Development and initiation of media campaigns to raising consumer awareness about the new dairy industry structure and standards, milk hygiene, safety and nutritional benefits

6.6.2 Enabling Elements at the Dairy Distribution and Marketing Stage

Dairy Institutions

At the present time, there is no dairy institution specific for MSMEs in Egypt. The following are the institutions involved in dairy research in Egypt:

- Dairy Science and Technology Departments, Faculties of Agriculture
- Food Hygiene Departments, Faculties of Veterinary Medicines
- Agricultural Research Center
- National Research Center

One of the biggest barriers here is the weakness of communication between such institutions and the MSMEs in the dairy sector.

Thus, the following may be viewed as the potential enabling elements towards practicing Cleaner Production in Egypt at the dairy distribution and marketing stage:

- The establishment of a national, modern, cost-efficient, self-reliant body which works to promote the dairy sector specifically at the MSME scale
- Capacity building of and communication-upgrade between the present institutions involved in dairy research in Egypt.
- Awareness and training sessions towards
    - The importance of hygiene in day-to-day dairy processing operations
    - The need, use and maintenance of any newly installed technology (e.g. pasteurisation, UF systems, etc.)
    - Government standards concerning the quality of finished dairy products and the liabilities associated with non-compliance
    - Government standards and consequences concerning the discharge of environmental pollutants (especially, but not limited to, salty whey - to

the environment), the environmental and health impacts of pollutants and the liabilities associated with non-compliance

- Alternate mechanisms for the use of acidic and sweet whey, as a means of earning additional returns and decreasing environmental liabilities

Recommendations for overcoming existing barriers to these opportunities, realizing the potential enabling elements towards practicing Cleaner Production and sustaining Cleaner Production activities at the various stages of the dairy cycle are provided in the next Section of this report.

Chapter 7

7

7.0 Sustaining Cleaner Production

7.0 SUSTAINING CLEANER PRODUCTION

7.1 Mainstreaming Cleaner Production

Mainstreaming Cleaner Production amongst the MSMEs in Egypt should be achieved by the following milestones:

Milestone 1: Raising awareness

Milestone 2: Conducting training

Milestone 3: Conducting Cleaner Production Opportunity Assessments

Milestone 4: Conducting Demonstration Projects

Milestone 5: Disseminating information on successful Demonstration Projects

Milestone 6: Initiating policy review and change

Milestone 7: Multiplication of successful Demonstration Projects

The milestones will help ensure sustainability and represent the steps developed by a programmatic approach to the issues – as advocated in Section 5.

The following recommendations are made in view of the unique problems faced by MSMEs in the dairy sector in Egypt.

- ❑ Adopt a focused programmatic Cleaner Production approach towards addressing the various issues through the MSME dairy cycle in Egypt.
- ❑ Identify MSME clusters for the dairy sector and implement all interventions on a cluster basis for maximum impact/multiplier effects.
- ❑ Where existing, supplement dairy associations at the MSME scale with awareness-raising and training programmes on Cleaner Production. Where such associations do not exist, foster awareness and need for the formation of such associations. Such entities must cover as many stages as possible in the MSME dairy cycle; namely, dairy production, collection, transportation, preservation, processing and distribution-come-marketing.
- ❑ Enable financial assistance towards the multiplication of promising/successful Demonstration Projects. Experience with Cleaner Production programmes reveals that a 20% reduction in waste and emissions is achievable with no investment. A further 10-20% reduction is possible with minor investments with a pay-back period of less than six months. Even though these Cleaner Production investments are highly profitable few enterprises that have participated in Cleaner Production programmes have been able to implement them. This is mainly due to lack of effective and applicable financing mechanisms. Unfortunately, MSMEs do not enjoy a good credit rating, which affects their borrowing capacity to a great extent. One technique to overcome such a problem is the establishment of revolving funds (see Box 7.1).

Box 7.1: Financing Cleaner Production Through Revolving Funds

The Nordic Environment Finance Corporation (NEFCO) – Revolving Facility for Cleaner Production Investments:

As a means towards improving the situation concerning lack of finance for Cleaner Production implementation, in 1997, the Nordic Environment Finance Corporation (NEFCO) set up a Revolving (Fund) Facility for financing of priority Cleaner Production investments targeted at a specific region in its area of operation, i.e. North-western Russia and the Baltic Countries.[106] NEFCO offered financing of up to 90% of the investment (the range of loans was US $50,000 - $200,000 required for high priority Cleaner Production projects. They offered firms fixed low interest rates with maturity dates based on the expected time for returns on the investments to materialize. This payback time frame could be extended to 20% longer that the ROI period, up to a maximum of 3 years. The assets of the borrowers were used as collateral. The efforts are aimed at funding model projects, which could demonstrate the win-win-win potential of Cleaner Production to domestic financiers and other enterprises.

National Cleaner Production Centres or NCPCs play a vital role in the identification, preparation, supervision and monitoring of projects (each of these aspects are included in loan applications). They also assist firms in developing environmental management systems such as ISO 14001. They act as intermediaries between industrial enterprises and NEFCO. NEFCO is typically invited by the Centres to present seminars on the revolving loan facility for Cleaner Production investments.

As of January 2002, 39 projects have been approved for financing under the program 10 of which are currently active, 16 loans have been disbursed and the repayment phase has begun for the first projects. Approximately 10 new project applications are received annually. The fund has grown from a size of €2 million to €6.7 million.[107]

Recommendations that NEFCO (2001) is currently employing based on their experience with the Revolving Loan Facility include:[108]

Delivery of specific training and project preparation on financial benefits of Cleaner Production projects at the enterprise level

Advisory services/consultancies are necessary to assist the enterprises in preparing project proposals and loan applications

Training and advising is also needed for financiers in order to secure solid baselines, supervise project implementation and monitor project results

- Enable technical assistance towards the multiplication of successful Demonstration Projects. This may be accomplished through organizations such as National Cleaner Production Centres (NCPCs) and Cleaner Production Centres (CPCs). NCPCs are CPCs established under the aegis of the NCPC Programme backed by the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Programme (UNEP). Generally speaking, CPCs include Pollution Prevention (P2) Centres, Cleaner Production Laboratories, Technical Assistance Centres for P2, Centres of Investment Projects and Environmental Certification, Centres for P2, Clean Technology Offices, etc. Where such organizations do not exist, the gap may be filled in with the establishment of institutions such as Cleaner Production Clinics. Technical assistance may be in the form of:

106 For more information, refer to *Revolving Facility for Cleaner Production Investments* at www.nefco.org/cleanerprod.htm.
107 *Draft Technical Report on Cleaner Production Implementation in SMEs*. Available at: www.iadb.org/mif/v2/files/appendix.pdf.
108 See footnote 124.

- Cleaner Production counselling or consultation services to MSMEs through consultant resources provided at the associations of MSMEs.
- Capture and documentation of specific information and technical needs of MSMEs on the interface of Cleaner Production.

Further, as seen in Box 7.1, NCPCs, CPCs, and Cleaner Production Clinics can play a vital role in the identification, preparation, supervision and monitoring of projects (each of these aspects are included in loan applications). They may assist firms in developing environmental management systems such as ISO 14001. They can act as intermediaries between industrial enterprises and the facilitator of the revolving fund.

- Address the shortage of Cleaner Production professionals in the dairy sector. This may be brought about through the use of NCPCs, CPCs and Cleaner Production Clinics. In this context, the NCPCs, CPCs, and Cleaner Production Clinics can:
  - Increase the interest and opportunity for consultants and institutions to provide Cleaner Production-related services.
  - Build and upgrade skill levels amongst consultants on Cleaner Production.
- Meet the requirement of Cleaner Production in education through the introduction of Cleaner Production in the curriculum at technical colleges and universities. Such courses may be full-time or part-time in nature and must be provided in the local language for reasons of wider acceptance and dissemination. The students from these institutions will be employed by the industry of tomorrow. Thus, an early exposure to Cleaner Production concepts can go a long way in mainstreaming Cleaner Production in the sector.
- Review the pasteurization directive keeping in mind the difficulties that MSMEs are facing in this context. Besides encouraging compliance with the Government decreed pasteurization requirements, the promotion of UF technology specifically tied in with the pasteurization requirement is likely to provide a production—come-economic boost to the more financially sustainable medium-scale dairy units. Promotion of ultrafiltration technology could be best achieved as a package, which should ideally incorporate all the ingredients crucial to shifting towards the technology; i.e. technical and financial assistance, market research, new product research, relaxations on import duties for UF machinery and equipment, etc.
- Improve hygiene in the milk production and collection system through relevant Cleaner Production initiatives, especially for MSMEs unable to shift towards UF technology. It would also be worthwhile to explore MSME-scale technology options for pasteurization requirements (see also Boxes 6.2 and 6.11). In this regard, concerted efforts towards research in indigenously developed MSME-scale technology would be extremely useful, since importing new technologies and maintaining them may be expensive and difficult, and hence out of reach for many MSMEs.
- Build capacity of research institutions in the country towards the R & D needs of the dairy sector, specifically at the MSME scale. Research activities may focus scientific as well as socio-economic features; i.e.
  - Locally developed technologies,
  - Quality feed inputs to dairy animals,
  - Salt minimization in whey,

- Reuse of whey in other applications such as bakeries, the pharmaceutical industry, etc.
- Affordable mobile testing kits,
- Research into new dairy products and avenues concerning market demand, access and so on for such products.

- Promote the formation of co-operative dairy structures in the various Governorates in which the MSMEs operate. It is generally accepted that an integrated approach along co-operative lines helps to enhance production, procurement, processing and marketing of milk. Such co-operatives can go a long way towards providing a regularized and standardized link between rural milk supply centres and urban demand centres.[109] Box 7.2 provides some highlights on a farmer-owned co-operative in India.

Box 7.2: Highlights on *Amul* Co-operative, a Farmer-owned Dairy Co-operative in India

The farmer-owned *Amul* Co-operative in Anand, Gujarat, has become a model for all dairy development projects in India. The core of the project is the village milk cooperative. According to the Anand Pattern, a village cooperative society of primary producers is formed under the guidance of a supervisor or milk supply officer of the Co-operative Dairy Union (district level cooperative owning the processing plant). A milk producer becomes a member by paying a nominal entrance fee. He must then agree to sell milk only to the society. The members elect a managing committee headed by a chairman. This committee is responsible for the recruitment of staff is in charge of the day-to-day operations of the society. Each society has a milk collection center to which the farmers take their milk in the morning and evening.

Starting with 18 milk sheds or collection centers in the first phase, Operation Flood now organizes marketing of milk from 179 milk sheds in over 500 towns. These milk sheds form the catchment area from where milk is brought into the cities. In addition to organizing milk collection and marketing, the cooperative also standardizes methods of procurement, processing and quality control of milk, assuring the producer and farmers of fairness in these procedures. The number of farmers organized into village milk producers' cooperative societies is now 1,000,000 and the daily procurement of milk by the cooperatives is 13,000,000 litres per day.

Milk is procured from the farmers at the village cooperative societies and is then sent to the district cooperative dairy union by trucks in cans or by tankers from the bulk coolers located at the villages. It is weighed and tested for fat at the dairy docks and then the milk is pasteurized. The dairy then converts the milk into liquid milk for sale and various milk products as per the product mix provided by the state-level Dairy Federation that markets the products of all the dairies in the state. Surplus milk from the dairies, after meeting the local liquid milk requirement and converting into various products, is then sent to the Mother Dairies situated in metro cities by road milk tankers or rail milk tankers (40,000 litre capacity). Liquid milk is generally sold in urban centers in plastic pouches, which is packed at the district dairies. In metros, milk is also sold through bulk vending booths, where consumers can obtain a measured quantity of milk by inserting a coin in an automatic machine.

A National Milk Grid has been formed by linking deficit areas with the surplus areas thus assuring proper marketing of the milk and hence an assured return to the rural producers. For example, milk is sent across a distance of 2,200 km (3,498 miles) from Anand in Gujarat to Calcutta in West Bengal by rail tankers.

109 *IT at Milk Collection Centres in Co-operative Dairies: The National Dairy Development Board Experience* by Rupak Chakravarty, National Dairy Development Board, Anand – 388 001, India. Available at: www.worldbank.org/wbi/documents/sn37160/Chapter04.pdf.

- Enable increased environmental compliance amongst MSMEs by exploring the introduction of environmental standards specific not only to the dairy sector, but also to the MSME scale.
- Develop guidelines concerning land disposal of whey. In cases where land disposal may not be a suitable option, either due to unavailability or associated risks, it would be practical to explore collective mechanisms for waste treatment and disposal, namely CETPs (see Section 4.4).

A simultaneous undertaking of the recommendations provided above is likely to go a long way towards sustaining Cleaner Production amongst the MSMEs in the dairy sector in Egypt.

ANNEXES

ANNEX 2.1 LIST OF GOVERNORATES IN EGYPT

Alexandria	ALX
Assiut	ASI
Aswan	ASW
Beheira	BEH
Beni Suef	BEN
Cairo	CAI
Dakahleya	DAQ
Damietta	DAM
Fayoum	FAY
Gharbiya	GHA
Giza	GIZ
Ismailia	ISM
Kafr El-Sheikh	KAF
Kalyobiya	QAL
Qena	QEN
Luxor City	LUX
Matrouh	MAT
Minia	MIN
Monofiya	MON
New Valley	NEW
North Sinai	NSI
Port Said	POR
Red Sea	RED
Sharkiya	SHA
Sohag	SOH
South Sinai	SSI
Suez	SUZ

ANNEX 2.2 TABLES ON MILK PRODUCTION IN EGYPT

Table A: National Livestock Herd (2002)

Animal	Stock	
	Head	%
Cattle	3,810,000	24.39
Buffaloes	3,550,000	22.73
Sheep	4,671,500	29.90
Goats	3,470,000	22.21
Camels	120,000	0.77
Total	**15,621,500**	**100**

Source: Agricultural Production (Live Animals) FAOSTAT Agricultural Database, FAO 2003.

Table B: Geographical Distribution of Milk Production (Governorates: 2001)

No.	Governorate	Milk	
		Metric Tonnes	%
1	Behera	4,59,121	11.99
2	Mania	3,26,774	8.53
3	Sharkia	2,89,404	7.55
4	Gharbia	288,562	7.53
5	Kafr-El Sheikh	274,302	7.16
6	Menoufia	256,526	6.70
7	Sohag	251,552	6.57
8	Beni Suef	214,966	5.61
9	Assiut	207,748	5.42
10	Qena	175,582	4.58
11	Dakahleya	175,177	4.57
12	Kalyubia	155,971	4.07
13	Fayoum	154,960	4.05
14	Giza	126,549	3.30
15	Nobaria	120,598	3.15
16	Damietta	90,027	2.35
17	Alexandria	58,463	1.53
18	Aswan	38,078	0.99
19	Ismailia	37,919	0.99
20	New Valley	37,764	0.99
21	Suez	34,709	0.91
22	Matrouh	2,849	0.07
23	Port Said	24,709	0.65

24	Luxor	18,967	0.50
25	Cairo	7,037	0.18
26	North Sinai	1,629	0.04
27	Red Sea	705	0.02
28	South Sinai	18	0.00

Source: Statistics of Livestock and Poultry Resources, No. 7, 2002. Central Management of Agricultural Economic, Ministry Of Agriculture and Land Reclamation, Egypt.

Table C: Population Estimates (1,000), 1997 - 2001

Population	**1997**	**1998**	**1999**	**2000**	**2001**
Rural	36,728	37,470	38,202	38,914	39,601
Urban	27,605	28,051	28,505	28,970	29,452
Agricultural Population	24,961	24,938	24,912	24,871	24,805
Non-Agricultural Population	39,372	40,567	41,782	43,014	44,275
Total	**64,333**	**65,505**	**66,693**	**67,884**	**69,080**

Table D: Milk and Milk Products as a Food Supply, 1997 - 2001

Animal Products	**1997**	**1998**	**1999**	**2000**	**2001**
Cal/Cap/Day (Number)	231	242.2	252.8	282.7	273.4
Prot/Cap/Day (Gr)	15.9	17	18	20.3	19.7
Fat/Cap/Day (Gr)	17.2	17.8	18.5	20.6	19.9
Milk - Excluding Butter					
Food (Mt)	2,870,883	3,056,862	3,332,774	3,387,845	3,525,502
Supply/Cap/Yr (Kg)	44.6	46.7	50	49.9	51
Cal/Cap/Day (Number)	63.6	66.6	70.3	71	74
Prot/Cap/Day (Gr)	3.8	4	4.3	4.3	4.4
Fat/Cap/Day (Gr)	4.2	4.4	4.6	4.7	4.9
Milk / Animal Products %					
Cal/Cap/Day	27.53%	27.50%	27.81%	25.11%	27.07%
Prot/Cap/Day	23.90%	23.53%	23.89%	21.18%	22.34%
Fat/Cap/Day	24.42%	24.72%	24.86%	22.82%	24.62%

Table E: Total Stocks of Milk Animals (Heads), 1997 - 2002

Stocks	1997	1998	1999	2000	2001	2002
Buffaloes	3,095,921	3,149,429	3,329,700	3,379,410	3,532,244	3,550,000
Cattle	3,117,495	3,216,698	3,417,580	3,529,720	3,801,071	3,810,000
Goats	3,187,214	3,260,990	3,308,150	3,424,756	3,466,771	3,470,000
Sheep	4,260,138	4,351,834	4,390,727	4,469,131	4,671,243	4,671,500
Camels	128,000	113,000	116,000	120,000	120,000	120,000
Total	**13,788,768**	**14,091,951**	**14,562,157**	**14,923,017**	**15,591,329**	**15,621,500**

Table F: Total Milk Production, 1997 - 2002

Production (Mt)	1997	1998	1999	2000	2001	2002
Buffalo Milk	1,889,983	2,022,380	2,018,200	2,030,305	2,050,610	2,050,610
Cow Milk,	1,324,376	1,351,880	1,596,880	1,638,400	1,870,000	1,900,000
Milk, Buffalo and Cow	3,214,359	3,374,260	3,615,080	3,668,705	3,920,610	3,950,610
Goat Milk	14,375	14,500	15,000	15,000	15,000	15,000
Sheep Milk	91,000	92,500	93,000	93,000	93,000	93,000
Milk, Total	**3,319,734**	**3,481,260**	**3,723,080**	**3,776,705**	**4,028,610**	**4,058,610**

Table G: Milk Equivalent – Import and Export, 1997 – 2001

Exchange	1997	1998	1999	2000	2001
Imports - Qty (Mt)	526,262	520,811	729,027	616,963	583,455
Imports - Val ($ 1000)	149,608	149,127	194,130	154,858	142,280
Exports - Qty (Mt)	14,150	9,321	40,605	17,741	20,075
Exports - Val ($ 1000)	4,428	3,563	16,187	5,767	5,356

Table H: Total Milk Supply and Usage (Metric tonnes or Mt), 1997 - 2001

Milk - Excluding Butter	1997	1998	1999	2000	2001
Production (Mt)	3,319,734	3,481,260	3,723,080	3,776,705	4,028,610
Imports (Mt)	308,513	340,509	494,030	333,347	304,200
Stock Change (Mt)	4,286		-70,040	70,040	
Exports (Mt)	11,104	8,456	41,764	18,748	22,239
Domestic Supply (Mt)	3,621,429	3,813,313	4,105,306	4,161,345	4,310,571
Feed (Mt)	578,138	577,792	583,465	593,578	597,401
Food (Mt)	2,870,883	3,056,862	3,332,774	3,387,845	3,525,502
Other Uses (Mt)	6,421	4,596	2,912	1,684	1,053
Waste (Mt)	165,987	174,063	186,154	188,835	201,430

Table I: Geographical Distribution of Milk Animals (Head), 2001

	Cows						
Governorate	**Baladi**	**Foreign**	**Crossbreed**	**Total**	**Buffalo**	**Total**	**Total %**
Urban							
Cairo	1,615	1,722	104	3,441	5,428	8,869	0.12%
Alexandria	12,989	183	22,368	35,540	43,173	78,713	1.07%
Port Said	0	0	22,505	22,505	11,633	34,138	0.47%
Suez	3,472	8,014	3,144	14,630	11,787	26,417	0.36%
Lower Egypt							
Behera	286,340	17,173	195,764	499,277	34,1887	841,164	11.47%
Nobaria (Behera)	38,096	48,370	18,497	104,963	40,645	145,608	1.99%
Gharbia	106,291	7,181	80,156	193,628	265,630	459,258	6.26%
Kafr-El Sheikh	193,447	3,859	99,222	296,528	257,588	554,116	7.56%
Dakahleya	75,356	7,573	58,372	141,301	188,844	330,145	4.50%
Damietta	7,126	6,276	57,700	71,102	28,894	99,996	1.36%
Sharkia	162,513	12,289	98,374	273,176	288,387	561,563	7.66%
Ismailia	24,210	5,567	3,052	32,829	26,312	59,141	0.81%
Menoufia	166,508	3,968	8,192	178,668	286,790	465,458	6.35%
Kalyubia	66,869	4,383	5,153	76,405	184,754	261,159	3.56%
Upper Egypt							
Giza	100,993	3,367	9,425	113,785	148,803	262,588	3.58%
Beni Suef	286,623	2,718	70,078	359,419	154,122	513,541	7.00%
Fayoum	144,888	6,034	34,101	185,023	122,996	308,019	4.20%
Menya	324,214	7,041	60,859	392,114	364,742	756,856	10.32%
Assiut	67,839	5,062	139,756	212,657	214,041	426,698	5.82%
Sohag	190,327	4,850	41,421	236,598	262,807	499,405	6.81%
Qena	174,740	5,133	19,494	199,367	224,337	423,704	5.78%
Luxor	17,334	134	1,481	18,949	17,589	36,538	0.50%
Aswan	50,344	12	3,150	53,506	38,493	91,999	1.25%
Frontier							
North Sinai	0	619	2,605	3,224	156	3,380	0.05%
South Sinai	20	0	0	20	22	42	0.00%
Red Sea	817	77	204	1,098	1,789	2,887	0.04%
Matroh	676	0	3,177	3,853	700	4,553	0.06%
New Valley	34,199	3	43,263	77,465	895	78,360	1.07%
Total	**2,537,846**	**161,608**	**1,101,617**	**3,801,071**	**3,533,244**	**7,334,315**	**100.00%**
Total %	**34.60%**	**2.20%**	**15.02%**	**51.83%**	**48.17%**	**100.00%**	

Table I: Geographical Distribution of Milk Animals (Head), 2001

Governorate	Cows				Buffalo	Total	Total %
	Baladi	Foreign	Crossbreed	Total			
Urban							
Cairo	86	2,654	40	2,780	4,257	7,037	0.18%
Alexandria	3,860	466	17,224	21,550	36,913	58,463	1.53%
Port Said	0	0	16,957	16,957	7,752	24,709	0.65%
Suez	958	24,024	2,503	27,485	7,224	34,709	0.91%
Lower Egypt							
Behera	75,484	49,186	121,181	245,851	213,270	459,121	11.99%
Nobaria (Behera)	7,343	92,914	5,630	105,887	14,711	120,598	3.15%
Gharbia	29,208	18,773	58,091	106,072	182,490	288,562	7.53%
Kafr-El Sheikh	43,864	6,201	65,192	115,257	159,045	274,302	7.16%
Dakahleya	14,319	18,600	35,471	68,390	106,787	175,177	4.57%
Damietta	2,593	15,705	50,005	68,303	21,724	90,027	2.35%
Sharkia	35,134	22,593	56,762	114,489	174,915	289,404	7.55%
Ismailia	7,522	11,957	2,574	22,053	15,866	37,919	0.99%
Menoufia	40,144	11,045	5,802	56,991	199,535	256,526	6.70%
Kalyubia	13,859	9,566	2,525	25,950	130,021	155,971	4.07%
Upper Egypt							
Giza	19,298	9,778	5,846	34,922	91627	12,6549	3.30%
Beni Suef	69,313	8,074	46,102	123,489	91477	21,4966	5.61%
Fayoum	39,172	11,875	18,085	69,132	85828	15,4960	4.05%
Menya	68,915	13,143	40,171	122,229	204545	32,6774	8.53%
Assiut	12,714	8,611	75,075	96,400	111348	20,7748	5.42%
Sohag	48,900	7,181	25,493	81,574	169978	25,1552	6.57%
Qena	11,408	6,730	10,702	28,840	146742	17,5582	4.58%
Luxor	5,391	249	616	6,256	12711	1,8967	0.50%
Aswan	13,171	10	2,102	15,283	22795	3,8078	0.99%
Frontier							
North Sinai	0	705	842	1,547	82	1,629	0.04%
South Sinai	4	0	0	4	14	18	0.00%
Red Sea	80	115	75	270	435	705	0.02%
Matroh	143	0	2,438	2,581	268	2,849	0.07%
New Valley	8,211	0	28,925	37,136	628	37,764	0.99%
Total Milk Tonnes	**571,094**	**350,155**	**696,429**	**1617,678**	**2,212,988**	**3,830,666**	**100.00%**
Total Milk %	**14.91%**	**9.14%**	**18.18%**	**42.23%**	**57.77%**	**100.00%**	

ANNEX 2.3 EGYPTIAN STANDARDS FOR MILK AND MILK PRODUCTS

Standard No.	Title of Standard	No. of Pages	Mandatory Decree
0154-01/2001	Milk and Milk Products - P1: Raw Milk	5	179/1996 M
0154-02/1992	Milk and Milk Products – P2: Natural Liquid Cream (2001 Update)	4	179/1996 M
0154-03/1992	Milk and Milk Products – P3: Natural Dried Cream “Cream Powder” (2001 Update)	5	179/1996 M
0154-04/1992	Milk and Milk Products – P4: Natural Whipped Cream(2001 Update)	4	179/1996 M
0154-05/2001	Milk and Milk Products – P5: Natural Cow’s Cream (2001 Update)	6	179/1996 M
0154-06/2001	Milk and Milk Products – P6: Local Natural Buffalo’s Cream (2001 Update)	4	179/1996 M
0154-07/2001	Milk and Milk Products – P7: Milk Fat Products of Cow’s Milk (2001 Update)	6	179/1996 M
0154-08/2001	Milk and Milk Products – P8: Local Natural Buffalo’s Ghee (2001 Update)	4	179/1996 M
0155/1974	Standard Methods For Milk and Milk Products Analysis	26	179/1996 M
0999-01/1988	Processed Cheese P1: Processed Cheese	4	179/1996 M
1007-05/2001	Hard Cheese P5: *Ras* Cheese	5	179/1996 M
1008-01/2000	Soft Cheese P1: General Standards of Soft Cheese	6	179/1996 M
1008-02/2000	Soft Cheese P2: Cream Cheese (Double Cream)	5	179/1996 M
1008-03/2000	Soft Cheese P3: Domiaty Cheese	3	179/1996 M
1008-04/2000	Soft Cheese P4: Karish Cheese	6	179/1996 M
1008-05/2000	Soft Cheese P5: Thallaga Cheese	5	179/1996 M
1132-02/1990	Processed Cheese Containing Vegetable Oils and Fats – P2: Cheese Spread Containing Vegetable Oils and Fats (1994 Partial Update)	4	179/1996 M
1133-01/1990	Processed Cheese Containing Vegetable Oils and Fats - P1: Processed Cheese Containing Vegetable Oils and Fats	4	179/1996 M
1183/1998	Semi Hard Cheese – P1: Semi Hard Cheese (2001 Update)	5	179/1996 M
1183-01/1998	Semi Hard Cheese – P1: Gouda Cheese (2001 Update)	6	179/1996 M
1183-02/1998	Semi Hard Cheese – P2: Blue Cheese Ripened With Mold (2001 Update)	5	179/1996 M
1183-03/1998	Semi Hard Cheese – P3: Edam Cheese (2001 Update)	6	179/1996 M
1185-01/1993	Ice Cream and Sherbets-P1: Ice Cream (2001 Update)	5	179/1996 M
1185-02/1993	Ice Cream and Sherbets-P2: Sherbets (2001 Update)	4	179/1996 M
1185-03/1993	Ice Cream and Sherbets-P3: Ice Cream With Vegetable Fats (2001 Update)	4	179/1996 M

Standard No.	Title of Standard	No. of Pages	Mandatory Decree
1267/1975	Determination and Sampling Methods Of Milk and Milk Products For Analysis	8	179/1996 M
1599/2001	Vegetable Oil Cream Powder Prepared For Whipping	7	179/1996 M
1600/2001	Vegetable Oil Liquid Cream Prepared For Whipping	6	179/1996 M
1616/2001	Pasteurized Milk	4	179/1996 M
1623/2001	UHT Long Life Milk	5	179/1996 M
1633/1987	Flash Sterilized Fermented Milk Beverages (2001 Update)	3	179/1996 M
1641/1993	Flash Sterilized Flavored Sweetened Milk (2001 Update)	4	179/1996 M
1648/2001	Dried Milk	4	179/1996 M
1650/1991	Sweetened Flavored Yoghurt	3	179/1996 M
1768/2001	Vegetable Oil Dried Milk	5	179/1996 M
1830-01/2001	Concentrated Milk –P1:Evaporated Milk And Concentrated Non Sweetened Milk	5	179/1996 M
1867/1990	Vegetable Oil Soft Cheese	3	179/1996 M

ANNEX 4.1 ENVIRONMENTAL REGULATORY FRAMEWORK FOR THE DAIRY SECTOR IN EGYPT[1]

Concerning the workplace

In Egypt, the Ministry of Manpower is responsible for issues pertaining to labour safety and health in workplaces (Law 137/1981). A number of laws exist to ensure that there are no violations to the environment of the workplace. These laws and possible locations where violations to the workplace may occur are listed below:

- Gas emissions from the boiler house are regulated by Article 43 of Law 4/1994, Article 45 of the Executive Regulations and Annex 8. The limits for the relevant pollutants are listed in Table A.
- In locations where any heating activity is conducted, the temperature and humidity are regulated by Article 44 of Law 4/1994, Article 46 of the Executive Regulations and Annex 9.
- In refrigeration rooms, ammonia leaks are regulated by Article 43 of Law 4/1994, Article 45 of the Executive Regulations and Annex 8.
- Near heavy machinery, noise is regulated by Article 42 of Law 4/1994, Article 44 of the Executive Regulations and Table 1, Annex 7.
- Ventilation is regulated by Article 45 of Law 4/1994 and Article 47 of the Executive Regulations.
- Smoking is regulated by Article 46 of Law 4/1994 and Article 48 of the Executive Regulations and Law 52/1981.
- Work and environment conditions are addressed in Law 137/1981 for labour, Ministry of Housing Decree 380/1983, Ministry of Industry Decree 380/1982.

Table A: Maximum Limits of Emissions in the Work Place

	Threshold values			
	Time average		Exposure limits for short periods	
Material	**PPM**	**mg/cu.m.**	**PPM**	**mg/cu.m.**
Ammonia	25	18	35	27
Carbon dioxide	5,000	9,000	15,000	27,000
Carbon monoxide	50	55	400	440
Sulphur dioxide	2	5	5	10

[1] Adapted largely from *Self Monitoring Manual: Dairy Industry*, 2003 by Ministry of State for Environmental Affairs [Egyptian Environmental Affairs Agency (EEAA) and Egyptian Pollution Abatement Project (EPAP)].

Concerning Effluent / Wastewater

Limits for pollutants in wastewater vary depending on the type of receiving water body. The parameters which should be monitored and/or inspected are:

- BOD
- COD
- pH
- Oil and grease
- Temperature
- Total suspended solids (TSS)
- Settlable solids (SS)
- Total dissolved solids (TDS)
- Residual chlorine

Table B represents the permissible limits of discharge to the different types of receiving water bodies (i.e. the sea, the Nile river, canals, agricultural drains and public sewers), according to the different relevant laws.

Table B: Egyptian Environmental Legal Requirements for Discharge of Industrial Wastewater to Various Types of Water Bodies

Parameter (mg/L, unless mentioned otherwise)	Coastal environment[2]	Sewer systems[3]	Underground reservoir and Nile river branches / canals[4]	Nile river (mainstream)	Drains (municipal)	Drains (industrial)
BOD_5 (20°C)	60	< 600	20	30	60	60
COD	100	< 1,100	30	40	80	100
pH	6-9	6 – 9.5	6-9	6-9	6-9	6-9
Oil and grease	15	< 100	5	5	10	10
Temperature (°C)	10°C > average temperature of receiving water body	< 43	35	35	35	35
TSS	60	< 800	30	30	50	50
SS	-	< 10	-	20	-	-
TDS	2,000	-	800	1,200	2,000	2,000
Chlorine	-	< 10	1	1	-	-

[2] As per Law 9/94.
[3] As per Law 93/62 (as Decree 44/2000).
[4] As per Law 48/82 applies to discharge of industrial wastewater to this category of water body as well as to the Nile river (mainstream), and municipal and industrial drains.

Spent lube oil has a negative impact on water and soil, and therefore, its disposal requires monitoring. A record should be kept for this purpose.

Concerning Solid Waste

A number of laws address solid waste management. The following laws apply to scrap and sludge from the wastewater treatment plant (WWTP).

- Law 38/1967 addressing public cleanliness regulates the collection and disposal of solid wastes from houses, public places, commercial and industry establishments.
- Ministry of Housing, Utilities and Urban Communities (MHUUC) Decree no. 134 of 1968, providing guidelines from domestic and industrial sources, including specifications for collection, transportation, composting, incineration and land disposal.
- Law 31/1976 which amended Law 38/1967.
- Law 43/1979, the Law of Local Administration, which states that city councils are responsible for 'physical and social infrastructure', effectively delegating responsibility for infrastructure functions.
- Law 4/1994 regulating incineration of solid waste.

Concerning Hazardous Material and Waste

Law 4/1994 introduced the control of hazardous material and wastes.[5] The dairy industry does not generate any hazardous wastes.

Articles 25, 31 and 32 of the Executive Regulations (Decree no. 338/1995) specify the necessary precautions for handling hazardous materials.

Articles 29 and 33 of the Law make it mandatory for those who produce or handle dangerous materials in gaseous, liquid and / or solid form(s) to take precautions to ensure that no environmental damage shall occur.

Activities concerning the usage and storage of fuel for boiler usage (i.e. hazardous material) are covered by Law 4/1994.

Materials classified as hazardous for the dairy industry include hydrochloric acid and nitric acid. These acids are used in the washing of vats, tanks and vessels used in dairy processing operations.

Note that there are no explicit articles in Law 4/1994 or in Decree 338/1995 (Executive Regulations), regarding holding a register for hazardous materials. However, maintaining a register for hazardous materials is implicit in Article 25 of the Executive Regulations, which addresses the matter of application for a license.

The Environmental Register

Article 22 of Law 4/1994 states that the owner of the establishment shall keep a register showing the impact of the establishment activity on the environment. Article 17 and Annex 3 of the Executive Regulations specify the type of data recorded in the register.

[5] Note that hazardous "material" differs from hazardous "wastes", in that wastes are generated *after* the material has been used in a process.

The emergency response plan and the hazardous materials register are also part of the Environmental Register.

Concerning Emissions

Article 40 of Law 4/1994, Article 42 of the executive regulations and Annex 6 deal with gaseous emissions from combustion of fuel. The statutes relevant to the combustion of fuel are:

- The use of *solar* oil and other heavy oil products, as well as crude oil shall be prohibited in dwelling zones.
- The sulphur percentage in fuel used in urban zones and near dwelling zones shall not exceed 1.5%.
- The design of the burner and fire-house shall allow for complete mixing of fuel with the required amount of air and for uniform temperature distribution, so as to ensure complete combustion and minimize gas emissions caused by incomplete combustion.
- Gases containing sulphur dioxide shall be emitted through chimneys rising sufficiently high, in order that these gases become diluted before reaching the ground surface. Also, fuel using high content of sulphur in power generating stations, industry and other regions lying away from inhabited urban areas, providing that atmospheric factors and adequate distances to prevent these gases from reaching the dwelling and agricultural zones and regions, as well as the water courses shall be observed.
- Chimneys from which a total emission of gaseous wastes reaches 7,000–15,000 kg/hr shall have heights ranging between 18–36 m.
- Chimneys from which a total emission of gaseous wastes reaches more than 15,000 kg/hr, shall have heights exceeding at least two and half times the height of the surrounding buildings, including the building served by the chimney.

The permissible limits of emissions from sources of fuel combustion are given in Table C.

Table C: Maximum limits for emissions from sources of fuel combustion

Pollution:	Maximum limit (mg / cu. m. of exhaust)
Sulphur dioxide	3,400
Carbon monoxide	250
Smoke	50

Note: As per Ministerial Decree no. 495, 2001.

Concerning Allied Standards and Certificates

The Ministry of Industry and the Ministry of Health jointly set standards and issue certificates for dairy producers in compliance with quality and hygienic considerations. Raw milk Standard Number 154/2001 sets limits for compositional, microbiological and contaminant levels. Raw milk must be free from *Salmonella, Listeria* and *Brucella*. *Staphylococcus Aureus* must not exceed 100 cfu/ml. The maximum limit mandated for *Bacillus cererus* is 1 cfu/ml, while the maximum somatic cell count is 750,000/ml. Additionally, raw milk should be free from any additives, preservatives, antibiotics, drugs and disinfectants. The levels of pesticide residuals, mycotoxins and radiation must comply with the international standards (*Codex Alimentarius* Commission Standards). Refer also to Annex 2.3 for a list of *Egyptian Standards for Milk and Milk Products*.

ANNEX 5.1 CLEANER PRODUCTION AND OTHER SIMILAR SOUNDING APPROACHES

Parallel Approaches

Green Productivity: It is a term used by the Asian Productivity Organization (APO) to address the challenge of achieving *sustainable production*. APO started its Green Productivity Programme in 1994. Just like Cleaner Production, green productivity is a strategy for enhancing productivity and environmental performance for overall socio-economic development. The approach of green productivity and Cleaner Production are almost synonymous.

Eco-efficiency: The term was coined by the World Business Council for Sustainable Development (WBCSD) in 1992. *It is defined as the delivery of competitively priced goods and services that satisfy human needs and ensure quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the earth's estimated carrying capacity*. This approach is favoured by many in the industrial sector. The approaches of eco-efficiency and Cleaner Production are almost synonymous.

Waste Minimization: The approach of waste minimization was introduced by the U.S. Environmental Protection Agency (USEPA). *In this approach, waste and pollution reduction occurs on-site, at the source through changes of input raw materials, and / or technology changes, good operating practices and product changes.* Compared to Cleaner Production, waste minimization is in one sense broader, in that it also includes off-site recycling of waste, but in another sense, it is narrower, since it does not cover product (re)design to minimize all life cycle impacts.

Pollution Prevention: The terms Cleaner Production and pollution prevention are often used interchangeably. The distinction between the two tends to be geographic - pollution prevention tends to be used in North America, while Cleaner Production is used in other parts of the world. Both approaches focus on a strategy of continuously reducing pollution and environmental impact through source reduction - i.e. eliminating waste within the process rather than at the end-of-pipe. *However, Cleaner Production includes the aspect of reduction of impacts and risks across the life cycle of a product, and in this sense is a more comprehensive approach*[1].

Source Reduction: Source reduction is a term that is synonymous with Cleaner Production - *reducing generation of wastes or contaminants at the source, and thereby reducing releases that could pose hazards to the environment and public health.*

Toxics Use Reduction: *Toxics use reduction is the elimination or avoidance of toxic substances in products or processes so as to reduce risks to the health of workers, consumers, and the public, and to minimize adverse effects on the environment*. Toxics use reduction is a *special* case of Cleaner Production since it focuses specifically on the aspect of reducing toxicity / hazards.

Allied Approaches

Energy Efficiency: Energy efficiency is essentially a sub-set of Cleaner Production. The approaches of *energy conservation* and *renewable energy* often have strong elements of Cleaner Production.

[1] Note that the acronym "P2" is often used for pollution prevention.

Occupational Health and Safety: It is often the case that *efforts to protect the health and safety of workers will require reducing emissions at the source, by changing raw materials or modifying the process*. To all intents and purposes, this is Cleaner Production. In a more indirect way, efforts to make the working environment safer for workers will result in better productivity.

Materials Management: Since the purpose of materials management is to manage materials more efficiently and reduce losses and waste, it comes very close to Cleaner Production.

Product and Service Related Approaches

Design for the Environment (DFE): DFE is the systematic consideration, during product design, of issues associated with the environment *over the entire life cycle of a product*. This approach attempts to *create financial and environmental savings by redesigning products to reduce environmental impact*. The object is to minimize or eliminate anticipated waste generation and resource consumption in *all the phases of the life cycle; viz. raw material sourcing, production, product distribution, use, and disposal.* DFE is also called eco-design.

Product-Service Systems: This approach focuses on creating a *community-wide system for ensuring the best use and reuse of products*. As with DFE, this approach focuses on the product element of Cleaner Production.

Sustainable Tourism: This term has strong links with Cleaner Production. Sustainable tourism requires tourist services to reduce their use of material and energy intensity and to reduce generation of pollution.

Developmental and Associated Approaches

Sustainable Development: This term is defined as development that meets the needs of present generations without compromising the ability of future generations to meet their own needs. *The strategy of Cleaner Production is driven by the vision of sustainable development*.

Industrial Rationalization: This is a term that deals with large-scale shifts in patterns of industrial production. Since it is often used in circumstances where inefficient industrial sectors are being phased out, it often has a strong, but generally unrecognized, component of Cleaner Production.

Mise à Niveau: A French term that corresponds to *industrial upgrading, this term is used in circumstances where entire industrial sectors are being upgraded and modernized*. Such modernization often contains a generally unrecognized component of Cleaner Production, since modern technologies are often more efficient in their consumption of material inputs.

Triple Bottom Line: A methodology for measuring and reporting on *financial, environmental and social performance*, this tool can have incorporated into it *strong elements of Cleaner Production*. Today, this approach is being experimented with as a way of pushing forward the Cleaner Production agenda.

ANNEX 5.2 TABLE OF CONTENTS FOR THE GOOD HOUSEKEEPING GUIDE FOR SMALL AND MEDIUM-SIZED ENTERPRISES[2]

Page

[2] Manual available at: www.getf.org/file/toolmanager/O16F15343.pdf

ANNEX 5.3 SEAM CASE STUDIES

INDUSTRIAL POLLUTION PREVENTION CASE STUDY: FOOD SECTOR – REDUCTION OF MILK LOSSES AT *MISR* COMPANY FOR DAIRY AND FOOD - MANSOURA, EGYPT

INTRODUCTION

A range of pollution prevention opportunities have been identified and are currently being implemented by Misr Company for Dairy and Food in Mansoura, Egypt. To date, this has involved a total investment of LE113,250 and is resulting in annual savings of LE 309,250.

A summary of how these improvements were identified and the underlying problems solved, follows.

THE FACTORY

This factory is one of nine owned by the public sector company "*Misr* for Dairy and Food" and is one of the largest producers of dairy products in Egypt. The Mansoura factory was built in 1965 and has a workforce of around 420.

The factory annually processes an average of 7,200 tonnes of milk, producing mainly pasteurised milk, white cheese, blue cheese and *mish*. Yoghurt, sour cream, ghee and processed cheese are also produced.

Process Description

Outline of Main Processes

The main process units present in the factory are outlined below:

- ***Milk Receiving, Preparation and Storage -*** Raw milk is delivered from collection centres to the factory's reception area where it is tested and graded. If it is of a suitable quality it is then accepted and refrigerated prior to use.
- ***Milk Pasteurization*** - The received milk is pasteurised by being rapidly heated and cooled. It is then either sent for packaging or for further processing.
- ***White Cheese Manufacturing*** - White cheese is produced from the milk concentrate produced by the ultrafiltration of pasteurised milk, which is then curded, packaged and sold.
- ***Ghee Manufacturing*** - Initially, cream is separated from the raw milk and blended with artificial ghee and salt and then cooked. This mixture is then incubated for a day and then packed. *Morta* is a generated as a by-product of this process (0.05%), which is also packed and sold.
- ***Roquefort Cheese Manufacturing*** - The pasteurised milk is placed in basins, where it is curded, incubated, and refrigerated, followed by punching. It is stored for one month to allow the blue colour to develop and then packed and stored for dispatch. 20% of the milk used in this process is lost as whey.
- ***Processed Cheese Manufacturing*** - Quark and Roquefort cheese are minced and cooked with skimmed milk, whey protein and some additives such as salts and emulsifiers, followed by cooling and packing.
- ***Yoghurt and Sour Cream Manufacturing*** - Milk and fixing agents are mixed to produce yoghurt, which is then automatically packed in small cartons, incubated and refrigerated for dispatch.

- ***Mish (Salty Cheese Mix) Manufacturing*** - This is produced using dairy products rejects. These are mixed, ground and filtered to separate the solids from the whey. Preservatives are added and the product is packaged.

Service Units

Factory service units include tin can manufacturing, refrigeration and storage, a boiler station, a quality control laboratory, a warehouse and maintenance workshops.

Water Consumption

The factory uses about 37,080 cu.m./year of water from the Mansoura City potable water supply:

- Processing - 2,880 cu.m./year.
- Equipment and floor washing - 20,160 cu.m./year.
- Boiler feed and cooling water - 6,840 cu.m./year.
- Domestic use - 7,200 cu.m./year.

Wastewater Characteristics

- Volume: 30,240 cu.m./year of industrial wastewater from different factory streams,
- BOD: 13,160 ppm,
- COD: 18,800 ppm,
- TSS: 10,640 ppm.

There is no industrial wastewater treatment facility and the wastewater is disposed into the city sewerage system.

POLLUTION PREVENTION OPPORTUNITIES

Pollution prevention opportunities were identified by means of an industrial audit. This identified various improvement opportunities; a description of the most important being:

1. Different solid wastes stored haphazardly in open areas and roads, constituting a fire risk and impairing the general appearance of the premises.
2. Considerable amounts of milk were wasted due to overflow during the filling of storage and service tanks.
3. Milk leakages control in the milk packaging and refrigeration units.
4. Oils used in the car and truck maintenance facilities were drained to factory sewers, encouraging drain blockage and consequent development of foul odours.
5. Excessive consumption of mazout in the boiler house, due to poorly tuned boilers. This also resulted in excessive air emissions (mainly smoke and carbon monoxide) being discharged from the boiler stacks.

CLEANER PRODUCTION APPLICATIONS

During the audit stage, particular attention was paid to those improvements which could be carried out at low or no cost to the factory. These were given a high priority as they are easy to implement and often entail significant savings.

The measures which have already been implemented by the factory or are under implementation through the Cleaner Production Demonstration Projects of the SEAM Project are briefly outlined below.

Low Cost “Housekeeping” Improvements

Improve Housekeeping

In-plant housekeeping of factory units and buildings was improved, factory drainage, sewers, and manholes were maintained and upgraded to eliminate blockage and overflow problems. In-plant roadways were paved and signposts added to allow for better traffic flow of factory vehicles. Unattended areas were planted with trees and greened. Overall, the factory has improved its image and cleanliness.

Implementation Cost: LE 10,000

Used Garage Oil: Collection for Resale

Pollution loads from the garage and workshops constitute the highest level of suspended solids (9,148 ppm), and the only source of mineral oil and grease (1,245 ppm) generated in the factory. Oil, grease and lubricants are now collected instead of being disposed to the sewer, with the following benefits:

- Approximately 0.75 tonnes of oil are accumulated monthly and sold at LE275 per tonne.
- Reducing the strength of wastewater,
- Improving the cleanliness of the garage and workshops,
- The prevention of serious blockage of sewers and overflow (as oil and grease tend to solidify milk products if mixed in sewers).

Implementation Cost: LE 500

Annual Savings: LE 2,500

Solid Waste: Collection and Sale

Solid wastes generated by the factory were initially segregated and then either disposed or sold:

- Garbage and packaging wastes are trucked out daily and disposed at the city's general dump area.
- Solid wastes such as scrap iron and metal objects are sold in auctions or to special scrap dealers.

This action has achieved an efficient removal of wastes from the site, and improved the cleanliness of the factory premises. LE120,000 was generated as a "one off" sum from the sale of solid wastes.

Implementation Cost: LE 3,000

Savings: LE 120,000

Water and Energy Conservation

Boiler Tune-Up and Upgrade

The ratio of air to *mazout* was optimised to increase the efficiency of the boilers, hence reducing *mazout* consumption and gas emissions. Benefits of this measure include:

- *Mazout* consumption has been reduced by 60 tonnes/year, saving LE 10,740.
- Solar consumption has been reduced by 12 tonnes/year, saving LE 4,980.
- Electricity consumption has been reduced by 12,775 kWh/year, saving LE 2,500.

Restoration of Softening Unit

The softening unit was restored to prevent the scaling of the boiler by chemical treatment of the feedwater.

As a result of implementing this improvement, tuning and upgrading the boilers, steam generation from 1cu.m. of water has increased from 1 tonne to 1.16 tonnes, corresponding to a 16% increase in boiler efficiency.

Implementation Cost: LE 2,000

Annual Savings: LE 18,750

Reuse and Recycling

Increase Refrigeration Efficiency and Rationalise Packaging

Raw milk storage units and the refrigeration room of the packaged milk products were upgraded to prevent spoilage and loss. This was achieved through investment in a refrigeration system which permitted temperature to be fully controlled. The benefits from this intervention include:

- Increased production capacity.
- Improved process efficiency.
- Improved quality control.
- Reduced reject rates of the final product.

The packaging unit was relocated from a restricted area to be adjacent to the refrigeration facility thus preventing handling losses. This has reduced milk losses by 3.3 tonnes/month, corresponding to monthly savings of LE3,330.

Implementation Cost: LE 26,500

Annual Savings: LE 39,600

Whey Reuse in White Cheese Manufacturing

4.4 cu.m. of permeate with a high lactose concentration (4.5%) is generated as a by-product from ultra-filtration in this process. Originally, this was disposed directly to the sewer. The factory now reuses 50% of this in the cheese packaging stage, in place of fresh water. This has resulted in a 50% drop in the organic load generated from the white cheese unit from 5,800ppm to about 3,000ppm. Almost 2,200 cu. m. of water are saved on an annual basis.

Implementation Cost: none

Annual Savings: LE 2,000

Installation of New Equipment

Total losses from the factory in both raw milk and products was shown to be 0.80 tonnes/day. The receiving and pasteurisation processes were the greatest sources of wastage, with milk losses of up to 0.7 tonnes/day, valued at LE252,000 per year.

The Problem: Raw milk coming into the factory is transferred directly from the delivery vehicles into the storage tanks. As there were no level gauges or controls on the tanks, overfilling and spillage frequently occurred.

The Solution: Installation of Level Controls - milk storage tanks were equipped with level sensors and stopcocks to prevent overflow particularly during the receiving stage. This type of sensor was selected rather than infra-red sensors, as foaming of the milk as it is transferred can result in inaccurate readings and subsequent overflow.

Implementation Cost: LE 10,250

The Problem: Leakages of milk from valves throughout the system were common, resulting in milk loss and an increased organic load of the final effluent.

The Solution: Installation of Control Valves - food quality, stainless steel control valves were installed throughout the factory where required, including the milk receiving, storage and pasteurisation areas. Forty valves were required.

Implementation Cost: LE 64,000

The implementation of the above improvements has resulted in daily savings of 350 kilograms of milk. A total of 126 tonnes of milk are recovered annually resulting in savings of LE126,000 per year. Additional benefits include:

- Reduced pollution loads,
- The elimination of floor spills,
- Improved hygiene and safety.

ECONOMICS

Throughout industry, pollution prevention and environmental protection measures can offer real financial benefits in terms of:

- Reduced raw materials consumption;
- Waste minimisation and
- Reuse or recycling of in-plant materials.

Implementing these measures will also result in reduced environmental pollution and movement towards discharge consent limits.

The total capital and operation costs invested in the cleaner production measures at the Mansoura factory amounts to LE 116,250. This has produced total savings of over LE 308,850, with an average payback period of around 4 months.

Summary of Cost Benefits

Factory Unit	Action	Capital and Operation Costs (LE)	Yearly Savings (LE)	Payback Period (month)
All	Improve Housekeeping and Solid Waste Removal	13,000	120,000 (“one off” sale)	1
Milk Packaging and Storage	Rationalise Milk Packaging and Increase Milk Refrigeration Efficiency	26,500	39,600	8
White Cheese	Reuse Whey	0	2,000	Immediate
Boiler House	Upgrade Boiler and Restore Softening Unit	2,000	18,750	< 1
Garage	Collect Used Oil	500	2,500	< 3
Milk Receiving and Pasteurisation	Milk Tank Level Controls	10,250		
	Food Quality Valves	64,000	126,000	7
Total		**116,250**	**308,850**	< 5

Benefits and Achievements

- **Recovery solutions and better quality control** of milk products and by-products has **recovered** 166 tonnes of milk/year (2.3%), which was previously wasted.
- **Water consumption** has **dropped** by 6%.
- ***Mazout*** **consumption** has **decreased** by 10%.
- **Solar consumption** has **decreased** by 5%.

- **Electricity consumption** has been **reduced** by 9%.

CONTACTS

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  Fax: 20 2 257 7207

A CLEANER PRODUCTION CASE STUDY: IMPROVED CHEESE RECOVERY IN CURD WHEY SEPARATION: *MAHROUS* FOR DAIRY PRODUCTS - DAKAHLEYA, EGYPT

Introduction

A number of cleaner production opportunities were implemented in Mahrous and Sons for Dairy Products (Mahrous) to increase cheese yield, improve quality control and to reduce the pollution load of wastewater discharges. Total cost of implementation was LE 102,261 and resulted in annual savings of LE122,060.

The Factory

Mahrous and Sons for Dairy Products is located in Manzala City, Dakahleya where it has operated a small scale cheese making plant since the 1950's using traditional cheese making techniques. Mahrous receives and processes 10 tons of raw milk each day. In winter, the plant produces 1.11 tons/day of *Roumy* cheese, considered to be the main hard cheese in Egypt. In summer, 1.50 tons/day of *Domiaty* cheese (high salt soft white cheese) is produced from a lower quality summer milk. Daily wastewater discharges are 21-23m^3. Mahrous employs 8 workers.
A brief summary of the process is:

1. Milk receiving – milk is received twice daily and filtered with a cheesecloth to remove debris.
2. Heating and renneting (30 minutes) – heated to 32^{0}C. Annatto and Rennet are added, stirred and the batch is then left for 25 minutes for curd to form.
3. Cutting and stirring (45 minutes) – curd is cut using a long metal knife.
4. Cooking and salting (45 minutes) – curd is cooked using hot water (44^{0}C); salt is added in the last 15 minutes.
5. Whey draining and moulding (15 minutes) – the cooked curd is transferred to a cheesecloth filter; the recovered curd is divided into 12.5 kg cloth lined moulds; butterfat is recovered from the filtered whey.
6. Pressing (3 hours) – mechanically pressed for 3 hours at room temperature
7. Ripening (3 months) – stored on wooded shelves and turned frequently.

Cleaner Production Opportunities

A rapid Cleaner Production Opportunity Assessment undertaken by SEAM identified a number of environment and productivity opportunities as follows:

- Poor separation of curd from whey resulting in lower productivity and high pollution load in wastewater discharges.
- A higher than desired usage of salt in cheese making.
- Poor hygienic conditions.

Cleaner Production Implementation

Mahrous is facing increased competition from larger firms and there is a need to take action to improve efficiency and quality. Cleaner Production interventions to help Mahrous included the following:

Introduction of a mechanical vat to improve cheese processing

A double-walled stainless steel cheese vat, with an overhead cutting and stirring mechanism was installed. The stirring mechanism is driven by two motors for longitudinal and rotational movement and operated by a touch screen control panel. The mechanised process yielded 5.8% more Roumy cheese per ton of milk processed than the old system that relied on manual stirring using wooden paddles.

A 25% reduction in the Total Suspended Solids and an 8.5% BOD decrease in the whey was achieved with the mechanical vat.

Traditional vat

Mechanical vat

Mechanical vat

Installation of a hot water boiler

A solar-fired boiler was installed to provide hot water for indirect heating of the cheese vats. It replaced gas and solar fired burners that had been previously used to heat the vats directly. Consequently, bottled butane was eliminated and solar use reduced by half. The lower heat levels and particulate emissions significantly improved working conditions in the immediate area.

Water boiler

Replacement of wooden draining table with a stainless steel table

The wooden draining table was replaced with a stainless steel table with one whey drainage point. Product hygiene was improved and the amount of uncontrolled spillage to the floor was minimised.

Optimise salt use in cheese making

With little operating or control procedures, excessive salt was used during the cooking and salting stage. Following a series of trials salt usage was reduced by 50%. While small financial savings were achieved the salt content in whey discharge was significantly reduced.

Improved quality control

pH meter, centrifuge, associated glassware and chemicals were provided and staff trained on quality control procedures. Better quality control helped to identify, and reject, poor quality milk at its receipt and also allowed any process-related problems to be identified and corrected as they occurred.
Implementation took 4 months with technical and financial assistance provided by SEAM.

Cleaner Production Pays

The total capital cost of implementation was LE 102,261. This included costs of the mechanical vat (LE 33,000), stainless steel draining tables (LE 5,000), hot water boiler (LE 60,000) and the laboratory equipment (LE 4,261).
Annual savings of LE122,060 were achieved as follows:

- Production of *Roumy* cheese increased 5.8% leading to around LE 110,500 of additional income per year.
- Salt use in processing was reduced by 217 kg/day leading to annual savings of LE 4,250.
- Energy consumption was reduced daily by 80 litres of solar and one cylinder of butane leading to savings of LE7,310 per year.

The investment made was thus paid back in **10 months**.

Other benefits included:

- Although the volume of whey discharged remained the same, its pollution load decreased. Total suspended solids were reduced by 25% and BOD and COD were reduced by 8.5%. In addition, there was a reduction of 217kg/day of salt that was previously discharged to the environment.

- Particulate emissions were considerably reduced through the elimination of the open burners improving thereby the working environment.

It is therefore not surprising that within six months of installation, more than 23 traditional cheese making companies in Egypt have started implementing ideas proven at Mahrous.

More Information

Further information can be obtained from the Egyptian Environmental Affairs Agency. Additional cleaner production information can be downloaded from the SEAM website http://www.seamegypt.org.

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30 Misr Helwan Agriculture Road, Maadi, Cairo
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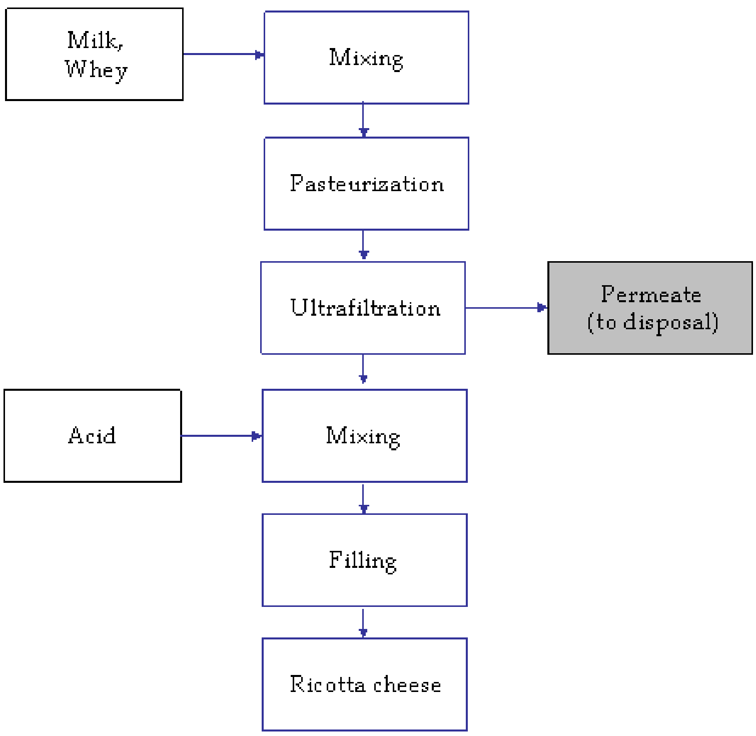
ANNEX 5.4 MANUFACTURE OF *RICOTTA* CHEESE FROM WHEY

Process Description and Flow Diagram

The manufacture of *ricotta* cheese using ultrafiltration (UF) technology *also* involves the input of whey as a raw material, thus transforming a so-called waste into a valuable resource. Figure 1 provides a flowchart of *ricotta* cheese manufacture using ultrafiltered milk and whey.

Milk undergoes UF treatment to a reduction of 15 - 20% of its original volume. The retentate is heated and the pH is adjusted with acid for protein flocculation. UF offers several major contributions to the ricotta manufacturer, including an 80% reduction of required heat, a sweet permeate (versus an acid whey), and a smooth quality final product.

Figure 1: Manufacture of Ricotta Cheese with UF Technology[3]



Manufacture of Whey Cheese[4]

Whey cheese or *Mysost* cheese has its origins in Norway. As the name suggests, it is made from whey. *Mysost* has a dark colour and a sweet taste. The sweet taste is due to the high sugar content of the evaporated whey and the final cheese may contain up to 40% sugar. The texture can range from semi-firm like fudge to the consistency of stiff peanut butter. The brown colour and sweetness result from slowly cooking the milk until its sugars caramelize.

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3 Adapted from *Ultrafiltration: An Accepted Process in the Dairy Industry*. Available at: www.marschall.com/marschall/proceed/pdf/84_05.pdf. .

4 *Traditional Cheese Making Manual* by Charles O'Connor, International Livestock Centre for Africa Addis Ababa, Ethiopia. Available at: www.cgiar.org/ilri/training/span/cheese.pdf

Process description

1. Use equal quantities of fresh milk and whey.
2. Heat the mixture carefully until it simmers without boiling and stir frequently.
3. Continue heating until the mixture thickens.
4. Transfer to a shallow container (3 cm deep) and as it hardens cut it into suitably sized pieces.
5. The cheese may be eaten fresh or stored in an airtight container.

ANNEX 5.5 TABLE OF CONTENTS FOR THE SEAM GUIDANCE MANUAL ON CLEANER PRODUCTION IN MSMEs OF EGYPT[5]

[5] Manual available at: http://www.seamegypt.org

PAGE

ANNEX 6.1 IMPROVING THE WELL-BEING OF POOR FARMERS BY DEVELOPING MILK PRODUCTION FROM LOCAL RESOURCES PROJECT: VIETNAM[1]

Background and Objectives

Slated to run from June 1996–December 1997 with a budget of US$221,000, this project focused on goat milk production, collection, processing and marketing of cheese involving small-scale farmers. It was set up in collaboration with the Goat and Rabbit Research Centre, Son Tay, Hatay Province in Viet Nam.

Project activities also concentrated towards responding rapidly to market demands and opportunities in the form of goat cheese. This approach enabled the provision of a high rate of return to farmers for their milk and has resulted in the successful and sustainable operation of the enterprises started by the project.

The project approach was based on simple low-cost technologies and on training. It is worth noting that the main beneficiaries of the project were small-scale women farmers who not only carried out much of the work at farm level, but who were and continue to be the processors and marketers of their high quality cheese.

The milk is collected daily by a centre financed by the beneficiary community. The centre produces goat cheese which is sold here in Hanoi in several shops and restaurants.

Outputs /outcomes /impacts

Providing improved goats to farmers

There was a major increase in the population of improved goats at all project sites. No major problems were encountered and the recipient farmers rapidly acquired the skills needed to manage and feed the goats on a full or semi-confinement basis. Most families were able to comply with project obligations to hand on to neighbours the equivalent in numbers and weight of the goats received.

Use of local feed resources

A major activity of the project was to promote the use of tree and shrub foliage as the staple diet of goats in confinement. The Jackfruit tree is found in the home gardens of farm families throughout Viet Nam. Planted originally for the consumption and sale of the fruit, it was demonstrated that the leaves provided excellent feed for goats. This led to an alternative use for the tree in areas remote from markets or in situations where the sale price of the fruit did not compensate for the labour of transporting it to the market. The multipurpose tree *Trichanthera gigantea*, introduced from the coffee-growing mountain regions of Colombia in South America, and the shrub *Flemengia macrophylla*, introduced from the Philippines, both adapted well to the infertile acid soils that characterize the hilly and mountain areas of North and Central Viet Nam. Farmers were pleased with the productivity and ease of management of these trees and their good acceptability by goats in confinement.

[1] *FAO Dairy Projects and Other Activities*. Available at: www.fao.org/ag/aga/agap/lps/dairy/FDP/FDP.htm#asiaregion.

Milk production, collection and processing

Simple equipment for pasteurizing milk and processing it into cheese was installed in all five project sites. In Hatay province 15,000 kg of milk were processed into 1,500 kg of cheese during the 16 months following the installation of the first unit in the Goat and Rabbit Research Centre. In the mountain provinces of Tuyen Quang and Thai Nguyen the quantities of cheese were 100 kg and 120 kg in shorter periods of 5 and 8 months, respectively. The technology was simple, employing a proprietary lactobacilli starter and rennet as coagulant, with prior pasteurization of the milk. The cheese produced was sold in Hanoi in restaurants and specialized food shops.

Installation of low-cost plastic bio-digesters

The technology of low-cost plastic bio-digesters was developed originally in Colombia and has reduced the cost of a family size bio-digester to less than US $50. A total of 116 units were installed and these were well received by participants in the project.

Electronic mail linkages

The priority given by the Government to the upgrading of telecommunication networks was a vital component in ensuring the effective use of the computers and modems installed in all five participating centres. In the first year of the project use was made of the e-mail linkages to the Internet established by the regional FAO-supported project (GCP/RAS/143/JPN), which used a UUCP protocol over a standard telephone line from a server in the Oxford Forestry Institute in the United Kingdom. Since January 1998 there has been direct dial-up access to the Internet through service providers in major cities in Viet Nam. The ease and immediacy of communication provided by e-mail helped considerably in the process of coordinating the project activities, especially regarding contacts with the international consultants.

Training and demonstrations

More than 600 farmers and extensionists participated in the training courses held in all five cooperating centres. The National Coordinator, staff of the Goat and Rabbit Research Centre and the international consultants shared in the task of imparting knowledge on:

- Management and feeding of dual-purpose goats; clean milk production
- Collection, pasteurization and processing of milk into cheese
- Planting of multipurpose trees and shrubs and harvesting of the foliage
- Installation and maintenance of low-cost plastic biodigesters
- Use of e-mail

Further, the number of people visiting the project sites increased from 684 (28 delegations) in 1996 to 955 (54 delegations) in the first 8 months of 1998. Other institutions in rural areas began to support the introduction of goats as a means of income generation from locally available inputs. The project technology was introduced into remote villages in Quang Binh province as a component of the activities of an Integrated Feed Security project financed by German Technical Cooperation. An International Fund for Agricultural Development-funded poverty alleviation project in tribal areas of India (Bihar/Madhya Pradesh Tribal Community Development Project) will introduce the technology as a major feature of activities destined to increase income from livestock.

The project also attracted significant attention from other donors and the approach was replicated by the International Fund for Agricultural Development (IFAD) and German Technical Co-operation[2] (GTZ) among others in the region. Other donors (UK, Gruppo di Volontariato Civile[3] or GVC Italian NGO) have funded the replication of this project in a larger area (UK) or in other locations (GVC).

Several national and international institutions (NGOs, Embassies, line Ministries) are visiting the project site to know about this experience. Most of the success is due to the dynamism of the national institution involved (Goat and Rabbit Research Centre), which has been able to optimize the available resources.

This project also received FAO Edouard Saouma Award[4] for the year 2000-2001.

2 *Deutsche Gesellschaft für Technische Zusammenarbeit*

3 Also known as the Civil Volunteer Group

4 The *Edouard Saouma Award* was established in 1993 by the FAO conference, for a national or regional institution which has implemented with particular efficiency a project funded by the Technical Cooperation Programme (TCP). Particular emphasis is given to the nature, the sustainability and the replicability of the achievements and the catalytic effects generated compared to the inputs provided by the TCP.

ANNEX 6.2 RECOMMENDED READING FOR HYGIENIC MILK HANDLING AND PROCESSING

Discussion Paper 1.1: Clean Milk Production and Support Services[5]

Dr OP Sinha, Consultant, Dairy Farmers' Organization, Management and Training A/6 Avkar Apartment, Near IRMA. ANAND 388 001 (India)

1. Clean Milk Production

Agriculture is the base of India's economy. Agriculture forms 31% of the national GDP (see e.g. http://www.nic.in/agricoop/stats.htm) and approximately 75% of India's population live in villages and depend on crop and livestock farming for their livelihood. Livestock production, including dairying, plays a multipurpose role in the agriculture systems of India. Milk is a cheap but high value source of nutrients for the rural population. If milk is not produced hygienically it can affect the health of many people.

Besides being a health hazard, contamination of milk can lead to huge economical losses. Contamination may occur at different levels: at farm level, during collection and storage, and at processing centres. Milk contains many essential nutrients, such as carbohydrates, proteins, lipids, minerals and vitamins and therefore might act as an ideal medium for rapid proliferation of harmful microorganisms. Milk needs to be protected from all possible sources of microbial contamination and various types of disease organisms. When the milk is secreted from the udder, it is almost sterile. The employment of hygienic practices at the time of milking is therefore one of the first and most important steps in clean milk production.

'Clean Milk' is generally defined as "milk drawn from the udder of healthy animals, which is collected in clean dry milking pails and free from extraneous matters like dust, dirt, flies, hay, manure etc. Clean milk has a normal composition, possesses a natural milk flavour with low bacterial count and is safe for human consumption".

Clean milk production results in milk that:

- Is safe for human consumption and free from disease causing microorganisms,
- Has a high keeping quality,
- Has a high commercial value,
- Can be transported over long distances,

[5] *Report on the FAO E-mail Conference on Small-scale Milk Collection and Processing in Developing Countries (29 May to 28 July 2000)*, pp. 50-52. Available at: www.fao.org/ag/aga/agap/lps/dairy/ ECS/Proceedings/proceed.htm. Retrieved from the World Wide Web on June 30, 2003.

- Is a high quality base product for processing, resulting in high quality products.

Contamination and Control Measures at Farm Level

Potential sources of contamination of milk are dung, water, utensils, soil, feed, air, milking equipment, the animal and the milker her/himself. Contamination of milk can occur at the following levels:

- Animal shed and environment
- The Animal
- Milker and milking routine
- Milking equipment
- Storage and transport

Animal shed and environment

The animal shed is one of the main sources of contamination. At the same time however, a good shed protects against micro-organisms as it keeps out other animals, people, wind, rain and excessive heat, all increasing the danger of contamination. Mud, urine, faeces, and feed residues should regularly be removed from the shed. The shed should have proper drainage, sufficient light and ventilation. In very wet areas, sprinkling slaked lime over the surface will help to dry it out quickly.

The milking area of the shed needs special hygienic attention. The floor of the milkshed should be swept with clean water, and disinfected with one-percent bleaching powder solution. Facilities should be provided for a sufficient supply of safe and potable water for drinking, washing udders and flanks of the animals, utensils and milkers' hands etc.

The Animal

The animal itself is one of the most significant sources of contamination, care and management of the animal and its health is therefore the starting point for clean milk production. Milk from diseased animals should be kept separate and disposed of safely. Animals suffering from any contagious disease, including mastitis, should be segregated from the healthy ones.

The skin of the animal provides a large surface for possible contamination. Long hairs on the flanks, hind legs, tail and udder should be clipped at frequent intervals. If washing of animals is not practised regularly as is observed in most cases, at least grooming of the animals should be done to keep the hair and dust away from milk. The udder is the part of the animal nearest to the milk and needs to be washed before each milking, and dried with a clean cloth or towel.

Milker and Milking Routine

In the case of hand milking, the danger of contamination coming from the milker is higher as compared with machine milking. The milker should therefore be free from contagious diseases. Nails should be well trimmed; she/he should wear clean clothes and should wash her/his hands with soap and water before milking, then dry with a clean towel. A good milking routine prevents contamination of the milk. A consistent milking method at regular intervals, fast but gentle and complete milking, and sanitary methods during milking are all important aspects. Feeding roughage at the time of milking should be avoided. If the calves are suckling, the calf should be allowed to suckle at the beginning of the milking. The udders and teats should be washed and massaged for at least 30 seconds and dried prior to milking. Foremilk should be examined and abnormal milk should be discarded. The foremilk should not be allowed to run on the floor as this increases the danger of contamination. The milk should be drawn directly into the pail as fast as possible. The milker should not wipe their hands on the body of the animals or on their own body. After milking, the teats can be dipped or sprayed with a gentle antiseptic solution. The milking area should be thoroughly cleaned after each milking.

Milking Equipment

Dirty milking equipment is one of the main sources of infection of milk. About 15 minutes before milking, milking equipment should be rinsed with a sanitizing solution. In this way, dust and contaminating agents will be removed. Milking equipment should also be thoroughly cleaned after use because any milk residues in the equipment will allow microorganisms to grow rapidly. The utensils and equipment used during milking should be of standard quality. They should be made up of acceptable, non-absorbent, corrosion-resistant material and should be easy to clean. The utensils and equipment should not have any joints or open seams and should be free from dents, rust etc. The milking utensils and equipment should be thoroughly cleaned and sanitised after each milking. An acceptable, non-toxic and non-corrosive cleaning and bactericidal agent should be used for cleaning and sanitation. After cleaning and sanitation, the utensils and equipment should be stored in such a manner and location to prevent contamination from flies, insects dust, dirt, rodents etc. They should preferably be stored in an inverted position off the ground to facilitate drainage of wash water.

Storage and Transport

Before storage, it is best to filter the milk with a clean cloth in order to remove large particles that might have entered the milk. The cloth should be thoroughly cleaned after use and left to dry in the sun. Heat, light and violent movement can all cause breakdown of certain components in the milk. Milk should therefore be cooled as quickly as possible. In case chilling is not feasible, preservatives like lactoperoxidase can be added to prolong the time before the milk gets spoiled (Discussion Paper 1.2 will deal with this issue). Milk should be stored in clean containers with a lid and kept in a cool and shady place where the danger of contamination is minimal. Milk should be transported in clean containers, transport time should be kept to an absolute minimum and violent movement of the milk should be avoided as milk fat can soon turn rancid in the presence of oxygen.

2. Economics of Clean Milk Production

When setting standards for clean milk production, it is important that the standards reflect the local conditions. If milk is boiled before use and consumed within hours of production, high capital investments to improve hygiene may not be an economic necessity. With an increasing time between milking and consumption, hygienic measures should improve. At the same time, with an increasing scale of farming, there is more room for investments in hygienic practises. The cost of clean milk production should not exceed the benefit of the farmers. Milk payments should be an incentive to improve the hygiene, and clean milk production should be financially rewarded.

3. Support Services Related to Clean Milk Production.

Milk Producers' Organizations (MPOs) should provide "Support-Services" to increase clean milk production. An effective and well trained animal health service should be available at any time to look after the health of animals, arrangements should be made for regular vaccination and checking against contagious diseases by the qualified veterinarians. Veterinary first aid should be readily available around the clock at village level.

To avoid spoilage, milk collection centres should be set up at locations where producers can easily access. Milk producers' organizations should have their own arrangements for milk processing, manufacturing of by-products and marketing to maximise returns to the producer.

In many developing countries, knowledge of hygiene is often not sufficient. One of the most important support-services regarding clean milk production is "Extension-Education". The ultimate aim of this service should be to develop the awareness amongst the milk producers towards cleanliness of milk shed, clean milk production and animal health care. These services should be organised at the village level and main thrust should be given to empower the women members.

Bibliography:

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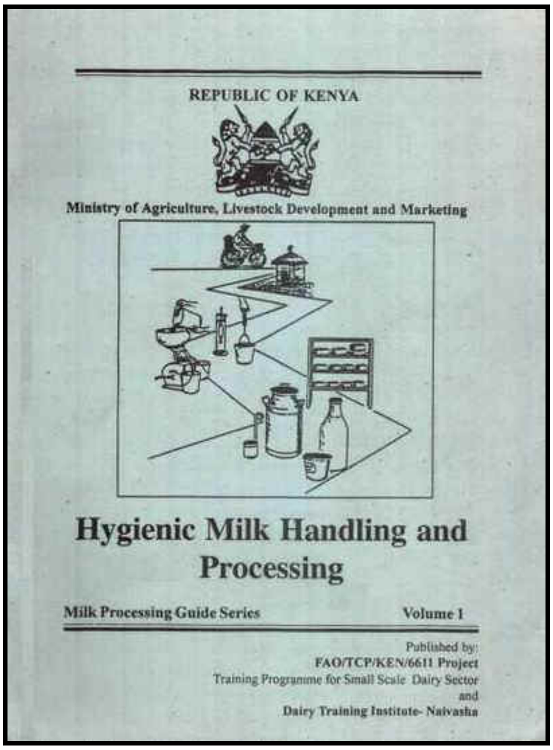
- Dr JB Prajapati, Fundamentals of Dairy Microbiology

- Indian Standard Code: For hygienic conditions for production, processing, transportation and distribution of milk
- NNDB: Milk procurement and Technical Input Manual
- OP Sinha, Guidelines for establishment of milk producers organizations (in Indian context)
- OP Sinha, Technical Report on Impact of Milk Producers organizations on rural development in India

Hygienic Milk Handling and Processing – Milk Processing Guide Series (Volume 1), Training Programme for Small Scale Dairy Sector and Dairy Training Institute – Naivasha[6]

Food and Agriculture Organization (FAO/TCP/KEN/6611 Project)



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[6] Available at: http://www.fao.org/ag/aga/publication/mpguide/mpguide1.htm. Retrieved from the World Wide Web on December 19, 2003.

1. Introduction

Good quality milk is essential for production of good quality dairy products, taste and flavour, free from pathogens and long keeping quality.

GOOD QUALITY DAIRY PRODUCTS CANNOT AND CAN NEVER BE MADE FROM POOR QUALITY RAW MILK.

Good quality raw milk must be:

- Free from debris and sediment.
- Free from off-flavours.
- Low in bacterial numbers.
- Normal composition and acidity.
- Free of antibiotics and chemical residues.

In order for milk to reach the processor and ultimately the consumer still in good condition, a number of things must be observed right from the farm level to the processing factory, and thereafter to the retailers and consumer. This booklet will highlight the essential steps that must be taken at each level in order to preserve nature's best food- MILK.

2. Hygienic Milk Production at the Farm

Whether milking by hand or machine, good hygiene is essential.

This requires that:

- The milker's hands and clothes are clean and he or she is in good health.
- The milking machine and milk storage equipment such as milk churns are kept clean and are in good condition (i.e. without cracks or dents which are difficult to clean and can easily harbour bacteria.

- Immediately after milking, the milk must be cooled preferably to 4° C. This requires mechanical refrigeration or milk cooling tanks. These are expensive and can usually be afforded by large scale commercial farms.

For small scale dairy farmers, setting up a milk cooling centre centrally may be the ideal solution. Where farmers bring their milk to a cooling centre through a co-operative, they should do so as soon as milking is completed. A Milk cooling centre with a capacity of 1000 - 3000 litres will serve up to 300 small holder farmers ensuring that the quality of their milk when produced under hygienic conditions is well preserved and accepted at the processing plant.

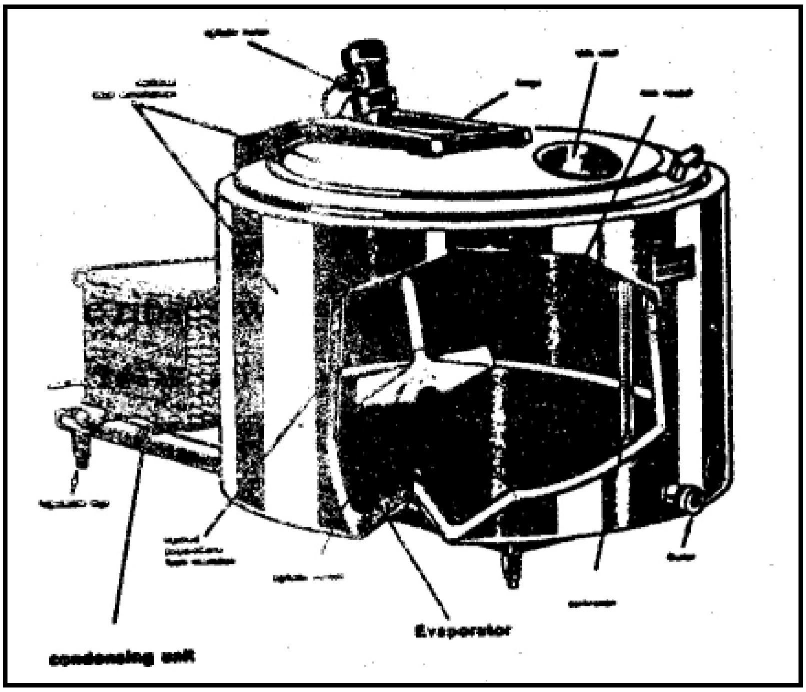


Figure 1: A Bulk (Direct Expansion) Milk Cooling Tank (1000 - 3000 litres)

It is important to remember that under a hot environment milk will spoil within 3-4 hours. So any means of cooling that will lower the temperature of milk from 38° C at milking will help to prevent multiplication of bacteria. There are several options available. In highland areas such as Kinangop, Limuru and Tiniboroa where the water temperature can be as low as 10° C, the milk may be cooled down to 2° C using water temperature by one of the following techniques.

- Immersing milk cans in a water trough connected to a water tap or water spring.
- Using an in-can rotary cooler.

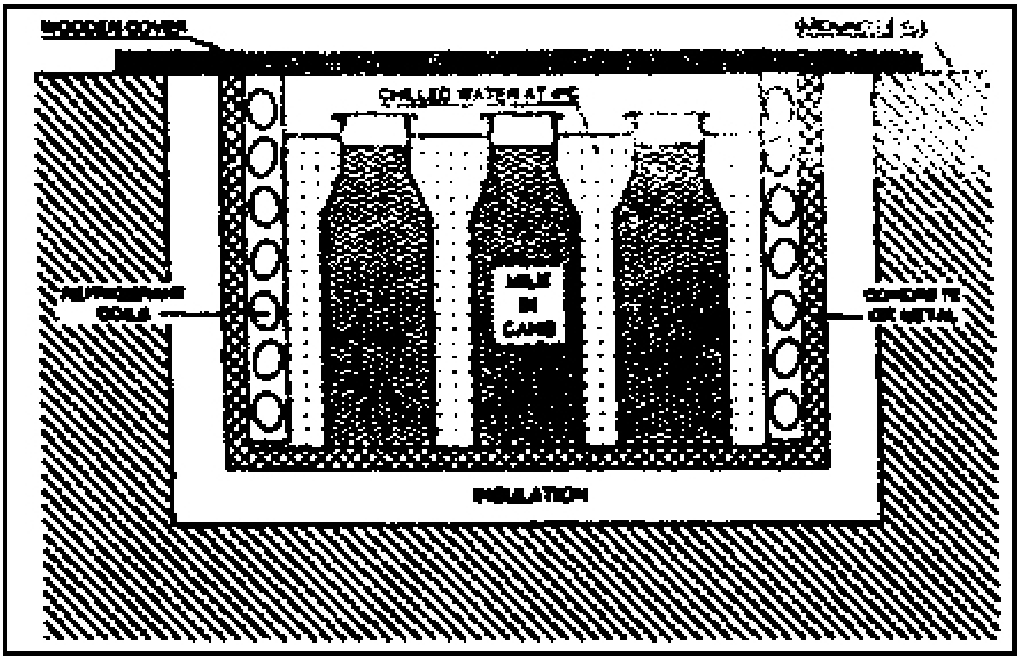


Figure 2: Milk Cooling by Immersion in a Trough with Cool Water

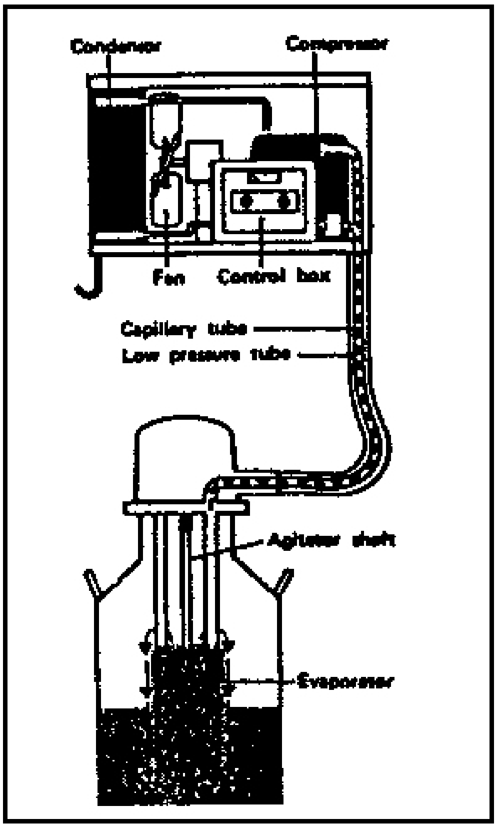


Figure 3: In-can Rotary Milk Cooling

- Using a surface milk cooler

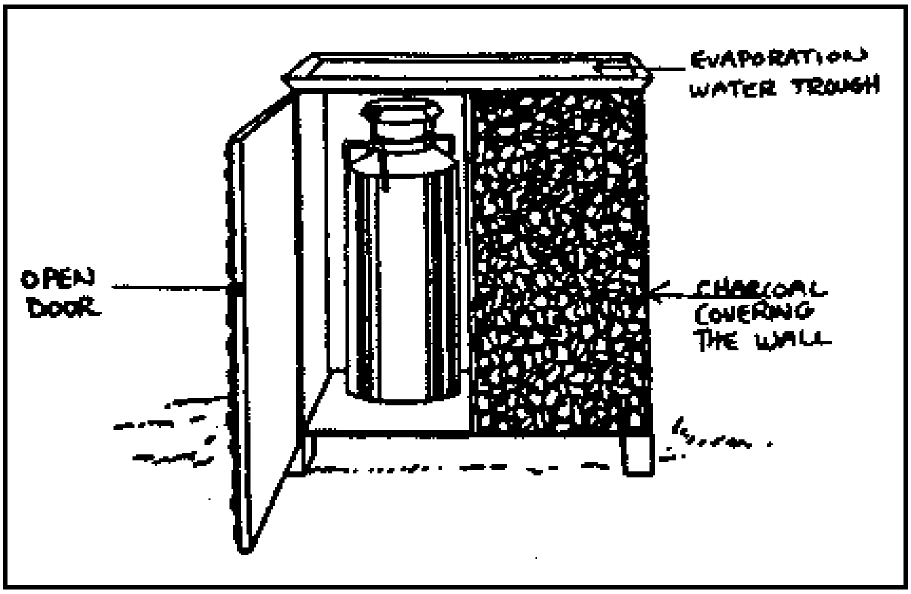


Figure 4: Surface Milk Cooler

In hot areas like in the coast, Western Province, North Eastern, Nyanza, cooling of milk blow 3-5° C below ambient temperature may be achieved through use of charcoal lined evaporative cooling cabinet.

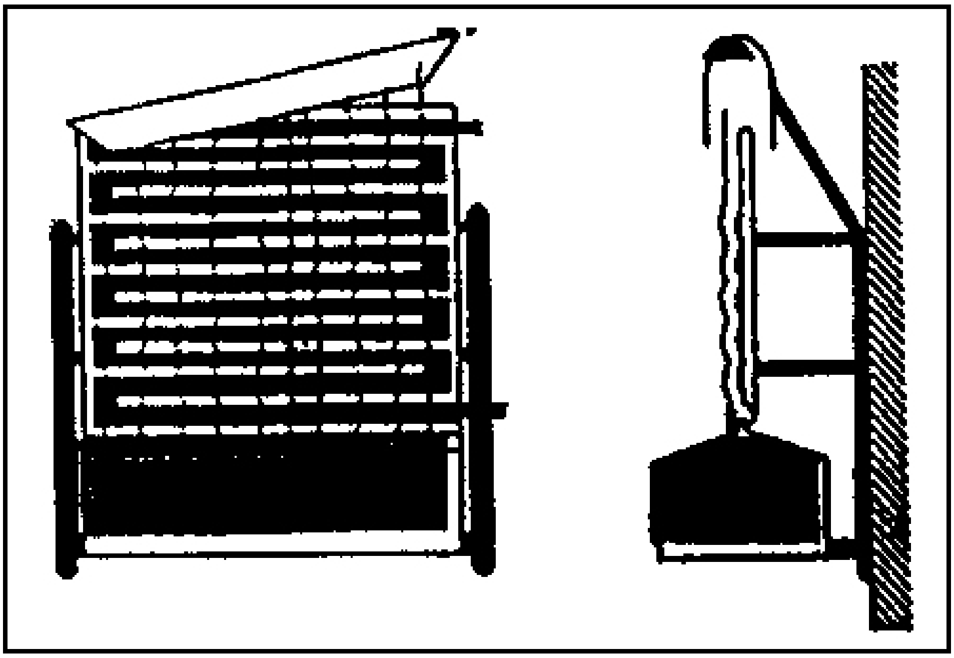


Figure 5: Evaporative Charcoal LinedCooler

3. Milk Transport to Processing Factory

3.1 Bulk milk transport

Milk cooled on the farm or cooling centre may be transported in milk cans or in bulk tankers. Bulk tankers are insulated, so the milk will remain cold until it reaches the plant (provided the transport is fast, i.e. short distance or good roads enabling milk to be delivered before the temperature of milk rises above 10° C).

3.2 In-can milk transportation

Alternatively, such milk may be filled in cans and transported in milk cans. This has, the advantage that a farmer's can of POOR quality milk will not be mixed with other farmers' GOOD quality milk and spoil the lot!

Since the cans are not insulated, the transport to the factory must be efficient enough to enable milk reach the factory in acceptable condition.

In the case of farmers delivering milk via pick-up (collection) points it is advisable that the milk cans are placed in a shaded area while awaiting pick-up by a milk transport vehicle.

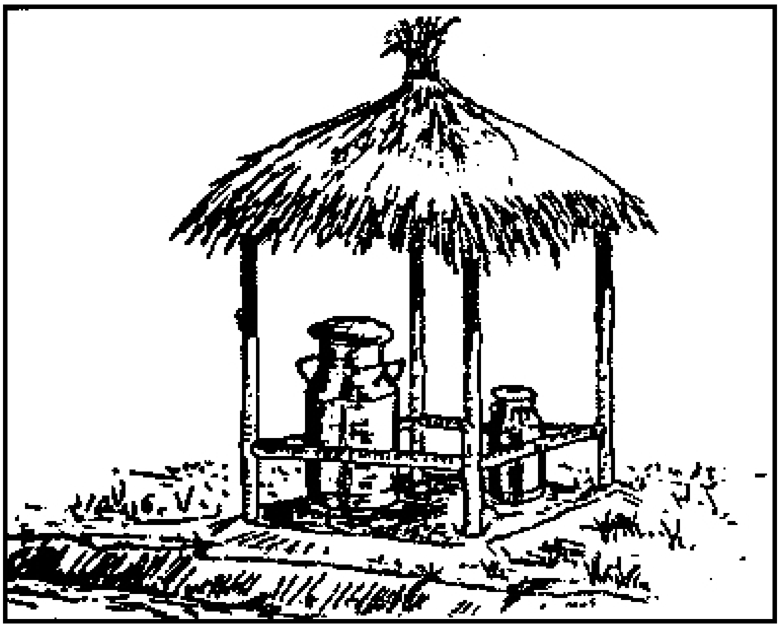


Figure6: Provision of Shade at Pick up-Points is Important

Bad milk will be rejected at the dairy plant. The farmer will lose money, the milk transporter may lose money if the fault is his. The nation will suffer because its people will not have the high quality food. To avoid all these bad things happening, hygienic milk handling is essential at each stage; at the FARM, COOLING CENTRE AND DURING TRANSPORT.

4. Dairy Sanitation at the Farm

It is in the interest of every farmer and milk processor that the following are observed at the dairy farm

4.1 Proper sanitation of milk cans

Immediately cans are emptied of milk they should be cleaned as follows:

- Cold water rinse.
- Scrubbing with brush and warm detergent (any unperfumed liquid soap will do).
- Cold water rinse.
- Sterilization (sanitisation) with boiling water or steam if available or use dairy sanitising solution such hypochlorite or commercial brand preparations in accordance with manufacturer's instructions.
- Dry cans on a drying rack. Exposure to sunlight will enhance killing off bacteria during drip drying of cans.

4.2 Milking machines

Milking machines should be cleaned according to recommended practice:

- Cold water rinse.
- CIP detergent circulation cleaning with dairy detergent in hot water.
- Hot water rinse.

Timely replacement of worn out rubber parts should be undertaken regularly.

4.3 The cows

Follow proper milking hygiene; mastitis cows should be milked last and their milk discarded. Milk from cows treated with antibiotics should not be mixed with milk from healthy cows. Observe the required 4 day withdrawal period. Milk with antibiotics will affect consumers' health as well as spoiling activity of lactic starter cultures used in cheese, yoghurt and Mala manufacture.

4.4 Milk transport vessels (cans and tanks)

All milk transport vessels should be cleaned in the same way as outlined for milk cans above. There should be provision for water at milk cooling centres to enable ALL milk suppliers' vessels or cans to be rinsed with cold water.

5. Hygienic Milk Handling at Dairy Factories

5.1 General guidelines

- Floors of dairy buildings must be made of bard washable surface. Walls should be smooth and washable to about 2 meters from floor level and painted with light colour.
- Doors should be self shutting while windows should be rendered insect proof by mosquito netting to keep flies out.
- Rooms should be kept clean and in good repair.
- All product-contact surfaces should be kept cleaned immediately before use or as often as necessary, by cleaning techniques appropriate to the equipment and process.

- Equipment and utensils should be disinfected immediately. before use, and whenever there has been possibility of accidental contamination.
- Equipment repairs and maintenance should preferably be carried out after processing. Whenever machines have to be fixed during production runs, adequate precautions should be taken to prevent contamination of dairy products.

5.2 Cleaning and disinfections of plant and equipment.

- Equipment used for handling liquid milk products should preferably be cleaned and disinfected after each period of use and at least daily.
- Equipment used in handling fat rich products such as butter and cheese should be cleaned as required, but in any case not less than once a week.
- The basic steps of cleaning plant and equipment are:
    - i. Rinsing with water to remove excess soil Cold or tepid water (40-50° C)may be used, but hot water of up to 85C maybe used for buffer nuking equipment.
    - ii. Washing with a detergent should then follow until the surface of the equipment is clean. This may be used in conjunction with manual scrubbing or ClP cleaning depending on the type of equipment.
    - iii. A final rinse with cold potable water should be done until the surface is five of detergent.
- Disinfection: Disinfection of dairy equipment may be carried out by means of:
    - i. Steam - Steaming should be done for 10- l5 minutes after the condensate has attained 85° C.
    - ii. Hot water - Hot water at8O C(use soft water only to prevent deposition of salts) for at least 20 minutes in circulation cleaning for 15 minutes at 85° C
    - iii. Detergents/disinfectants - used as part of the cleaning process at temperatures between 45-60° C in manual cleaning and for cold milk lines, storage tanks and tankers.

5.3 Packaging

- Packaging materials should be:
    - i. Stored in a dry place away from manufacturing areas;
    - ii. Used in a clean and sanitary manner;
    - iii. Non-toxic.
- Packaging should be carried out in away that:
    - i. Avoids contamination of processed products.

ii. Protects the product against contamination until the product reaches the consumer.

5.4 Hygienic Storage of finished products

Products should be stored in clean conditions at appropriate temperature and humidity to prevent deterioration or permit maturation (e.g. cheese).

5.5 Hygienic Transport

Products should be transported in clean vehicles under appropriate condition and be kept away from other goods.

5.6 Personnel Hygiene and Health

- It is recommended that persons engaged in handling foods should be subjected to health checks in accordance with provisions of the Public Health laws of Kenya.
- Factory premises should be provided with clean running water and good washrooms.
- Workers should wear clean protective clothing and working gear (e.g. gum boots, coats, overalls and caps).

5.7 Laboratory Quality Control

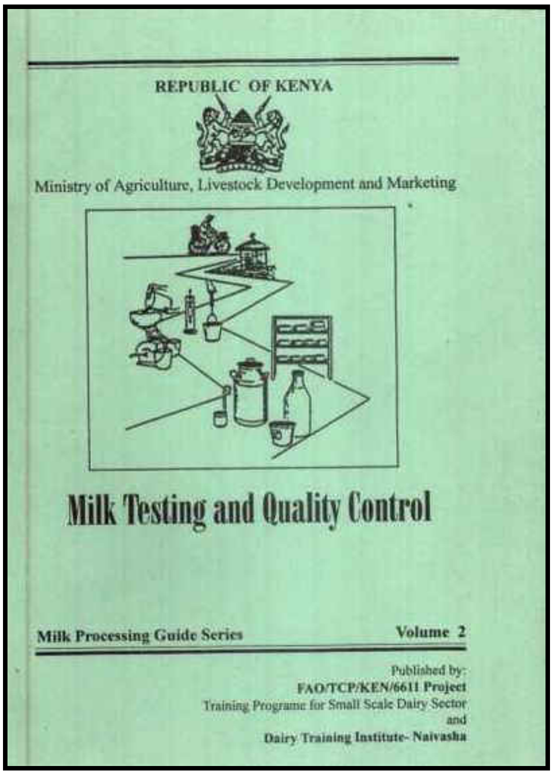
Milk and other raw materials should be subjected as required to regular testing in order to ensure wholesomeness and freedom from pathogens.

Annex 6.3

Recommended Reading for Milk Testing and Quality Control

Milk Testing and Quality Control – Milk Processing Guide Series (Volume 2), Training Programme for Small Scale Dairy Sector and Dairy Training Institute – Naivasha[7]

Food and Agriculture Organization (FAO/TCP/KEN/6611 Project)



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[7] Available at: http://www.fao.org/ag/aga/publication/mpguide/mpguide2.htm. Retrieved from the World Wide Web on December 19, 2003.

1. Introduction

Milk testing and quality control is an essential component of any milk processing industry whether small, medium or large scale. Milk being made up of 87% water is prone to adulteration by unscrupulous middlemen and unfaithful farm workers. Moreover, its high nutritive value makes it an ideal medium for the rapid multiplication of bacteria, particularly under unhygienic production and storage at ambient temperatures. We know that, in order for any processor to make good dairy products, good quality raw materials are essential. A milk processor or handler will only be assured of the quality of raw milk if certain basic quality tests are carried out at various stages of transportation of milk from the producer to the processor and finally to the consumer.

There are a number of standard manuals and text books on milk quality control. However these may not be easily available to the emerging small scale to medium scale processors in Kenya.

For these reasons, the Training Programme for the Small Scale Dairy Sector under project GOK/FAO/TCP/KEN/6611 has assembled this guide on Milk Testing and Quality Control so that it may be used for training and by the private small scale dairy processors. The methods selected are simple and basic and will suffice the requirements of most milk quality control laboratories of small scale processing units. For the larger plants with bigger laboratories more tests are to be found in the bibliography at the end of this booklet.

2. Milk Testing and Quality Control

2.1 What is milk quality control?

Milk quality control is the use of approved tests to ensure the application of approved practices, standards and regulations concerning the milk and milk products. The tests are designed to ensure that milk products meet accepted standards for CHEMICAL COMPOSITION AND PURITY AS WELL AS LEVELS OF DIFFERENT MICRO-ORGANISMS.

2.2 Why have milk quality control?

Testing milk and milk products for quality and monitoring that MILK PRODUCTS, PROCESSORS and MARKETING AGENCIES adhere to accepted codes of practices costs money. There must be good reasons why we have to have a quality control system for the dairy industry in Kenya.

The reasons are:

- To the Milk Producer: The milk producer expects a fair price in accordance with the quality of milk she/he produces.
- To the Milk Processor: The milk processor who pays the producer must assure himself/herself that the milk received for processing is of normal composition and is suitable for processing into various dairy products.
- To the Consumer: The consumer expects to pay a fair price for milk and milk products of acceptable to excellent quality.
- To the Public and Government Agencies: These have to ensure that the health and nutritional status of the people is protected from consumption of contaminated and sub-standard foodstuffs and that prices paid are fair to the milk producers, the milk processor and the final consumer.

All the above-is only possible through institution of a workable quality testing and assurance system conforms to national or internationally acceptable standards.

2.3 Quality control in the milk marketing chain in Kenya

- At the farm: Quality control and assurance must begin at the farm. This is achieved through farmers using approved practices of milk production and handling; and observation of laid down regulations regarding, use of veterinary drugs on lactating animals, regulations against adulterations of milk etc.
- At Milk collection Centres: All milk from different farmers or bulked milk from various collecting centres must be checked for wholesomeness, bacteriological, and chemical quality.
- At the Dairy Factories: Milk from individual farmers or bulked milk from various collecting centres.
- Within the Dairy Factory: Once the dairy factor has accepted the farmer milk it has the responsibility of ensuring that the milk is handled hygienically during processing. It must carry out quality assurance test to ensure that the products produced conform to specified standards as to the adequacy of effect of processes applied and the keeping quality of manufactured products. A good example is the phosphatase test used on pasteurised milk and the acidity development test done on U.H.T milk.
- During marketing of processed products: Public Health authorities are employed by law to check the quality of food stuffs sold for public consumption and may impound

substandard or contaminated foodstuffs including possible prosecution of culprits. This is done in order to protect the interest of the milk consuming public.

2.4 Techniques used in milk testing and quality control

2.4.1 Milk sampling

Accurate sampling is the first pre-requisite for fair and just quality control system. Liquid milk in cans and bulk tanks should be thoroughly mixed to disperse the milk fat before a milk sample is taken for any chemical control tests. Representative samples of packed products must be taken for any investigation on quality. Plungers and dippers may be used in sampling milk from milk cans.

2.4.2 Sampling milk for bacteriological testing

Sampling milk for bacteriological tests require a lot of care. Dippers used must have been sterilised in an autoclave or pressure cooker for at least 15mm at 120° C before hand in order not to contaminate the sample. On the spot sterilisation may be employed using 70% Alcohol swab and flaming or scaling in hot steam or boiling water for 1 minute.

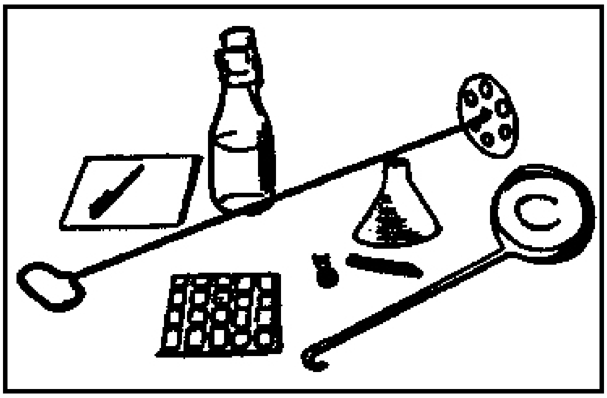

Figure 1: Equipment Used for Taking Milk Samples

2.4.3 Preservation of sample

Milk samples for chemical tests: Milk samples for butterfat testing may be preserved with chemicals like Potassium dichromate(1 Tablet or ½ ml 14% solution in a ¼ litre sample bottle is adequate.) Milk samples that have been kept cooling a refrigerator or ice-box must first be warmed in water bath at 40 ºC, cooled to 20ºC, mixed and a sample then taken for butterfat determination. Other preservative chemicals include Sodium azid at the rate of 0.08% and Bronopol (2-bromo-2-nitro-1,3-propanediol) used at the rate of 0.02%.

If the laboratory cannot start work on a sample immediately after sampling, the sample must be cooled to near freezing point quickly and be kept cool till the work can start. If samples are to be taken in the field e.g. at a milk cooling centre, ice boxes with ice pecks are useful.

2.4.4. Labelling and records keeping

Samples must be clearly labelled with name of farmer or code number and records of dates, and places included in standard data sheets. Good records must be kept neat and in a dry place. It is desirable that milk producers should see their milk being tested, and the records should be made available to them if they so require.

2.4.5 Common testing of milk.

2.4.5.1 Organoleptic tests

The organoleptic test permits rapid segregation of poor quality milk at the milk receiving platform. No equipment is required, but the milk grader must have good sense of sight, smell and taste. The result of the test is obtained instantly, and the cost of the test are low. Milk which cannot be adequately judged organoleptically must be subjected to other more sensitive and objective tests.

Procedure:

- Open a can of milk.
- Immediately smell the milk.
- Observe the appearance of the milk.
- If still unable to make a clear judgement, taste the milk, but do not swallow it. Spit the milk sample into a bucket provided for that purpose or into a drain basin, flush with water.
- Look at the can lid and the milk can to check cleanliness.

Judgement:

Abnormal smell and taste may be caused by:

- Atmospheric taint (e.g. barny/cowy odour).
- Physiological taints (hormonal imbalance, cows in late lactation- spontaneous rancidity).
- Bacterial taints.
- Chemical taints or discolouring.
- Advanced acidification (pH < 6.4).

2.4.5.2 Clot on Boiling (C.O.B) Test

The test is quick and simple. It is one of the old tests for too acid milk(pH<5.8) or abnormal milk (e.g. colostral or mastitis milk). If a milk sample fails in the test, the milk must contain many acid or rennet producing micro-organisms or the milk has an abnormal high percentage of proteins like colostral milk. Such milk cannot stand the heat treatment in milk processing and must therefore be rejected.

Procedure:

Boil a small amount of milk in a spoon, test tube or other suitable container. If there is clotting, coagulation or precipitation, the milk has failed the test. Heavy contamination in freshly drawn milk cannot be detected, when the acidity is below 0.20-0.26% lactic acid.

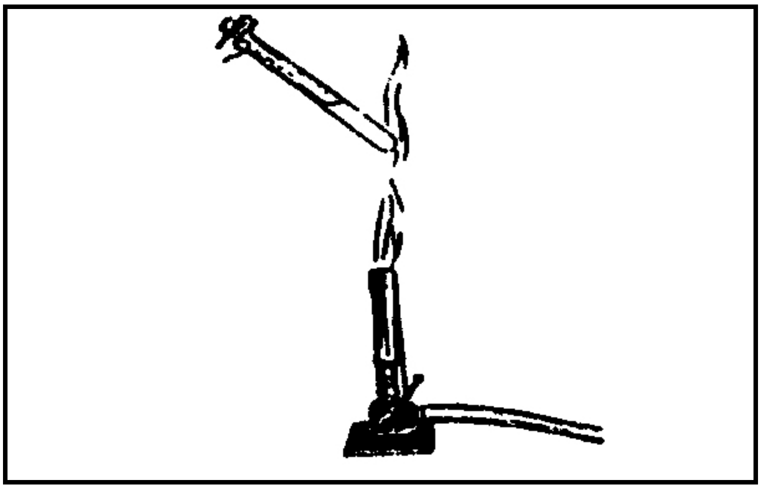

Figure 2: Equipment Used in C.O.B. Test

2.4.5.3. The Alcohol Test

The test is quick and simple. It is based on instability of the proteins when the levels of acid and/or rennet are increased and acted upon by the alcohol. Also increased levels of albumen (colostrum milk) and salt concentrates (mastitis) results in a positive test.

Procedure:

The test is done by mixing equal amounts of milk and 68% of ethanol solution in a small bottle or test tube. (68 % Ethanol solution is prepared from 68 ml 96% (absolute) alcohol and 28 ml distilled water). If the tested milk is of good quality, there will be no coagulation, clotting or precipitation, but it is necessary to look for small lumps. The first clotting due to acid development can first be seen at 0.21-0.23% Lactic acid. For routine testing 2 ml milk is mixed with 2 ml 68% alcohol.

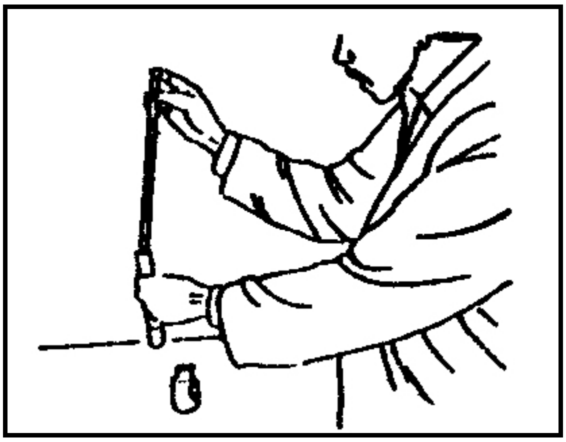

Figure 3: Equipment Used in Alcohol Test

2.4.5.4. The Alcohol-Alizarin test

The procedure for carrying out the test is the same as for alcohol test but this test is more informative. Alizarin is a colour indicator changing colour according to the acidity. The Alcohol Alizarin solution can be bought ready made or be prepared by adding 0.4g alizarin powder to 1 litre of 61% alcohol solution.

Results of the test:

Parameter	Normal milk	Slightly acid Milk	Acid milk	Alkaline Milk
pH	6.6 – 6.7	6.4 – 6.6	6.3 or lower	6.8 or higher
Colour	Red brown	Yellowish-brown	Yellowish	Lilac
Appearance of milk	No coagulation no lumps	No coagulation	Coagulation *	No coagulation **

Note:

* = Sour milk looks yellowish with small lumps or completely coagulated.

** = Alkaline milk looks like lilac and it may be mastitis milk. Clots and flakes too, indicate mastitis milk.

2.4.5.5 Acidity test

Bacteria that normally develop in raw milk produce more or less of lactic acid. In the acidity test the acid is neutralised with 0.1 N Sodium hydroxide and the amount of alkaline is measured. From this, the percentage of lactic acid can be calculated. Fresh milk contains in this test also "natural acidity" which is due to the natural ability to resist pH changes .The natural acidity of milk is 0.16 - 0.18%. Figures higher than these signify developed acidity due to the action of bacteria on milk sugar.

Apparatus:

- A porcelain dish or small conical flask
- 10 ml pipette, graduated
- 1 ml pipette
- A Burette, 0.1 ml graduations
- A glass rod for stirring the milk in the dish
- A Phenolphthalein indicator solution, 0.5%in 50% Alcohol

- 0.1N Sodium hydroxide solution.

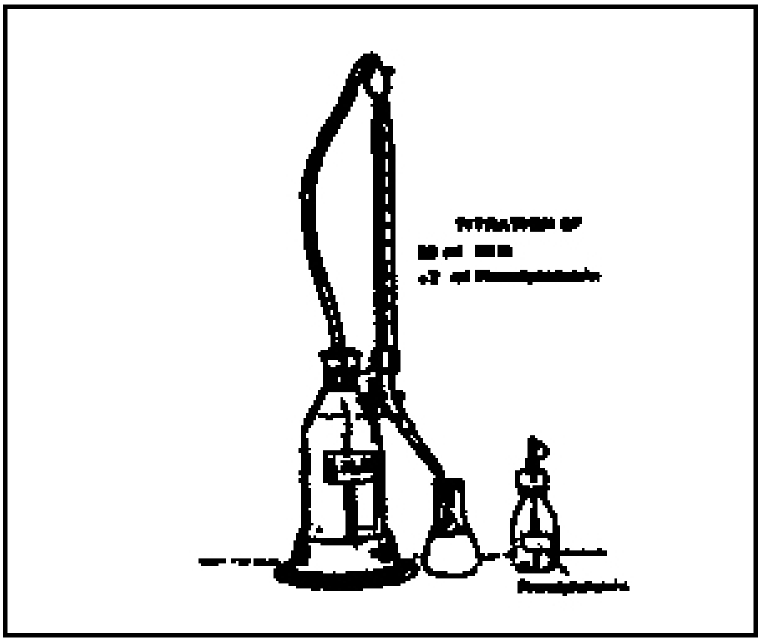

Figure 4: Apparatus Used for the Acidity Test

Procedure:

9 ml of the milk measured into the porcelain dish/conical flask, 1 ml Phenolphthalein is added and then slowly from the burette, 0.1 N Sodium hydroxide under continuous mixing, until a faint pink colour appears. The number of ml of Sodium hydroxide solution divided by 10 expresses the percentage of lactic acid.

2.4.5.6 Resazurin test.

Resazurin test is the most widely used test for hygiene and the potential keeping quality of raw milk. Resazurin is a dye indicator. Under specified conditions Resazurin is dissolved in distilled boiled water. The Resazurin solution can later be used to test the microbial activity in a given milk sample.

Resazurin can be carried out as:

- 10 min test.
- 1 hr test.
- 3 hr test.

The 10 min Resazurin test is useful and rapid, screening test used at the milk platform. The 1 hr test and 3 hr tests provide more accurate information about the milk quality, but after a fairy long time . They are usually carried out in the laboratory.

Apparatus and reagents:

- Resazurin tablets

- Test tubes with 10 ml mark
- 1 ml pipette or dispenser for Resazurin solution.
- Water bath thermostatically controlled
- Lovibond comparator with Resazurin disc 4/9

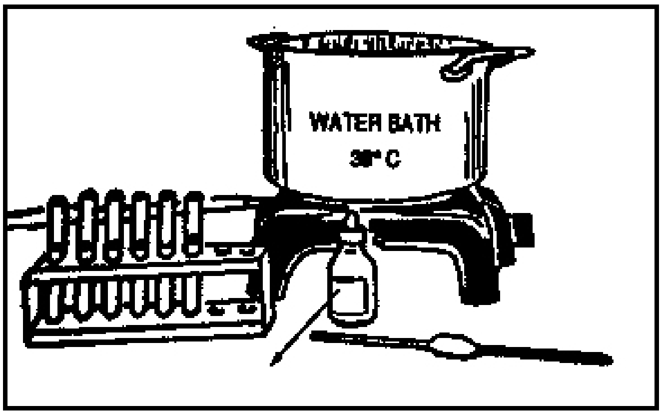

Figure 5: Apparatus Used in the 10 min. Resazurin Test

Procedure:

The solution of Resazurin as prepared by adding one tablet to 50 mIs of distilled sterile water. Rasazurin solution must not be exposed to sunlight, and it should not be used for more than eight hours because it losses strength.

Mix the milk and with a sanitized dipper put 10 ml milk into a sterile test tube.

Add 1 ml of Resazurin solution, stopper with a sterile stopper, mix gently the dye into the milk and mark the tube before the incubation in a water bath, place the test tube in a Lovibond comparator with Resazurin disk and compare it colorimetrically with a test tube containing 10 ml milk of the same sample, but without the dye (i.e. the blank).

Readings and results (10 minute Resazurin test)

Resazurin disc no.	Colour	Grade of milk	Action
6	Blue	Excellent	Accept
5	Light blue	v. good	Accept
4	Purple	Good	Accept
3	Purple pink	Fair	Separate
2	Light pink	Poor	Separate
1	Pink	Bad	Reject
0	white	Very bad	Reject

2.4.5.7 The Gerber Butterfat test

The fat content of milk and cream is the most important single factor in determining the price to be paid for milk supplied by farmers in many countries.

Also, in order to calculate the correct amount of feed ration for high yielding dairy cows, it is important to know the butterfat percentage as well as well as the yield of the milk produced. Further more the butterfat percentage in the milk of individual animals must be known in many breeding programmes.

Butterfat tests are also done on milk and milk products in order to make accurate adjustments of the butterfat percentage in standardised milk and milk products.

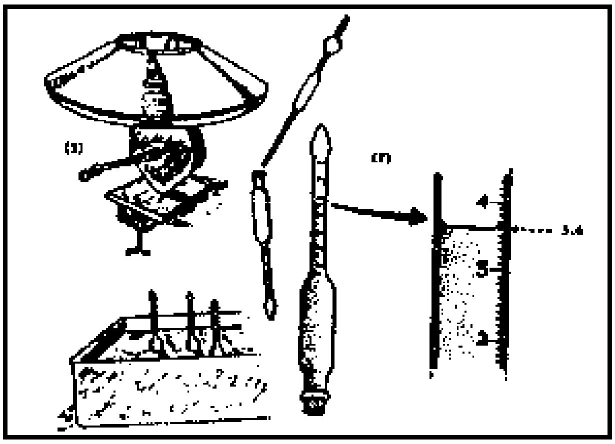

Figure 6: Equipment Used in Gerber Butterfat Test

Apparatus for DF test:

- Gerber butyrometers, 0-6% or 0-8% BF
- Rubber stoppers for butyrometers
- 10.94 or 11 ml pipettes for milk
- 10 ml pipettes or dispensers for Gerber Acid
- 1 ml pipettes or dispensers for Amyl alcohol
- Stands for butyrometers

Gerber water bath Reagents:

- Gerber sulphuric acid,(1.82 g/cc)
- Amyl alcohol

Treatment of samples:

Fresh milk at approximately 20ºC should be mixed well. Samples kept cool for some days should be warmed to 40ºC, mixed gently and cooled to 20ºC before the testing.

Procedure:

Add 10 ml sulphuric acid to the butyrometer followed by 10.94 or 11 ml of well mixed milk. Avoid wetting of the neck of the butyrometer. Next add 1 ml of Amyl alcohol, insert stopper and shake the butyrometer carefully until the curd dissolves and no white particles can be seen. Place the butyrometer in the water bath at 65ºC and keep it there until a set is ready for centrifuging. The butyrometer must be placed in the centrifuge with the stem (scale) pointing towards the centre of the centrifuge. Spin for 5 min. at ll00 rpm. Remove the butyrometers from the centrifuge. Put the butyrometers in a water bath maintained at 65ºC for 3 min. before taking the reading.

Note: When transferring the butyrometers from the centrifuge into the water bath make sure that the butyrometers are all the time held with the NECK POINTING UP.

The fat column should be read from the lowest point of the meniscus of the interface of the acid-fat to the 0-mark of the scale and read the butterfat percentage.

The butyrometers should be emptied into a special container for the very corrosive liquid of acid-milk, and the butyrometers should be washed in warm water and dried before the next use.

Appearance of the test:

- The colour of the fat column should be straw yellow.
- The ends of the fat column should be clearly and sharply defined.
- The fat column should be free from specks and sediment.
- The water just below the fat column should be perfectly clear.
- The fat should be within the graduation.

Problems in test results:

Curdy tests

- Too lightly coloured or curdy fat column can be due to:
- Temperature of the milk or acid or both being below optimum.
- Acid being too weak.
- Insufficient acid.
- Milk and acid not mixed thoroughly.

Charred tests:

- Darkened fat column containing black speck at the base is due to:
- Temperature of milk-acid mixture too high.
- Acid too strong.
- Milk and acid mixed too slowly.
- Too much acid used.
- Acid dropped through the milk.

2.4.5.8 The Lactometer test

Addition of water to milk can be a big problem where we have unfaithful farm workers, milk transporters and greedy milk hawkers. A few farmers may also fall victim of this illegal practice. Any buyer of milk should therefore assure himself/herself that the milk he/she purchases is wholesome and has not been adulterated. Milk has a specific gravity. When its adulterated with water or other materials are added or both misdeeds are committed, the density of milk change from its normal value to abnormal. The lactometer test is designed to detect the change in density of such adulterated milk. Carried out together with the Gerber butterfat test, it enables the milk processor to calculate the milk total solids (% TS) and solids not fat (SNF). In normal milk SNF should not be below 8.5% according to Kenya Standards (KBS No 05-l0:-1976).

Procedure:

Mix the milk sample gently and pour it gently into a measuring cylinder (300-500). Let the Lactometer sink slowly into the milk. Read and record the last Lactometer degree (°L) just above the surface of the milk. If the temperature of the milk is different from the calibration temperature (Calibration temperature may be=20°C) of the lactometer, calculate the temperature correction. For each °C above the calibration temperature add 0.2°L; for each °C below calibration temperature subtract 0.2 °L from the recorded lactometer reading.

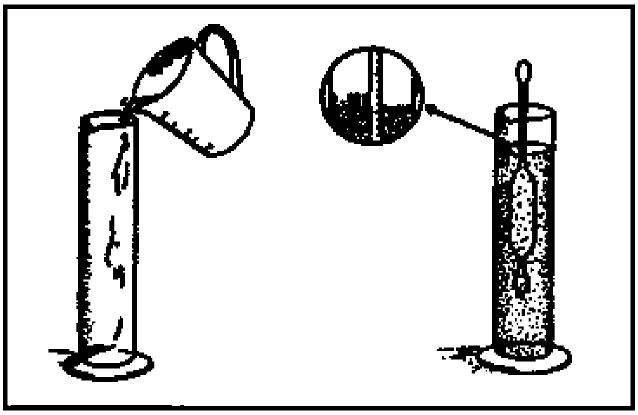

Figure 7: Equipment Used for Determination of Milk Density

Example: Calibration temperature of lactometer 20°C:

Sample	Milk temperature	Lactometer reading	Correction	True reading
No.1	17 °C	30.6 °L	- 0.6 °L	30.0 °L
No.2	20 °C	30.0 °L	Nil	30.0 °L
No.3	23 °C	29.4 °L	+ 0.6 °L	30.0 °L

For the calculations, use lactometer degrees, and for the conversion to density write 1.0 in front of the true lactometer reading, i.e. 1.030 g/ml. Clever people may try to adulterate milk in such a way that the lactometer cannot show the adulteration. But look to see if there is an unusual sediment from the milk at the bottom of the milk can and taste to find out if the milk is too sweet or salty to be normal. Samples of milk from individual cows often have lactometer reading outside the range of average milk, while samples of milk from herds should have readings hear the average milk, but wrong feeding, may result in low readings. Kenyan standards expects milk to have specific gravity of 1.026 -1.032 g/ml which implies a Lactometer reading range of 26.0 -32.0 °L. If the reading is consistently lower than expected and the milk supplier disputes any wrong doing arrange to take a genuine sample from the supplier (i.e. inspect milk right from source).

2.4.5.9 Freezing Point Determination

The freezing point of milk is regarded to be the most constant of all measurable properties of milk. A small adulteration of milk with water will cause a detectable elevation of the freezing point of milk from its normal values of -0.54°C. Since the test is accurate and sensitive to added water in milk, it is used to detect whether milk is of normal composition and adulterated.

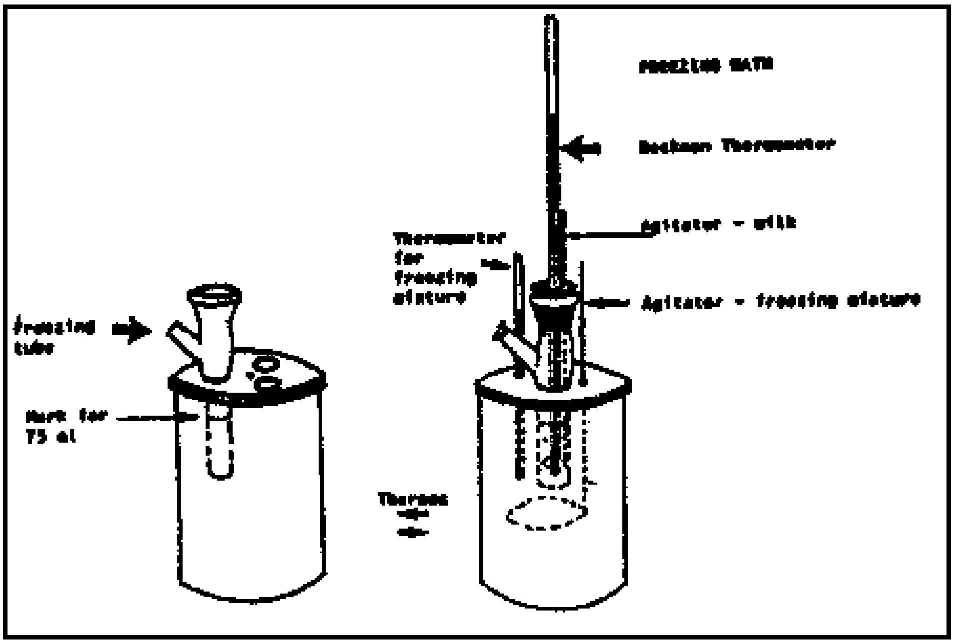

Figure 8: A Cryoscope is used for Determination of Freezing Point of Milk

2.4.5.10 Inhibitor test

Milk collected from producers may contain drugs and/or pesticides residues. These when present in significant amounts in milk may inhibit the growth of lactic acid bacteria used in the manufacture of fermented milk such as *Mala*, cheese and yoghurt, besides being a health hazard.

<u>Principle of the method:</u>

The suspected milk sample is subjected to a fermentation test with starter culture and the acidity checked after 3 hours. The values of the obtained titrable acidity are compared with titrable acidity of a similarly treated sample which is free from any inhibitory substances.

Materials:

- Test tubes
- Starter culture
- Pipette
- Water bath
- Material for determination of titrable acidity (see **Figure 9**)

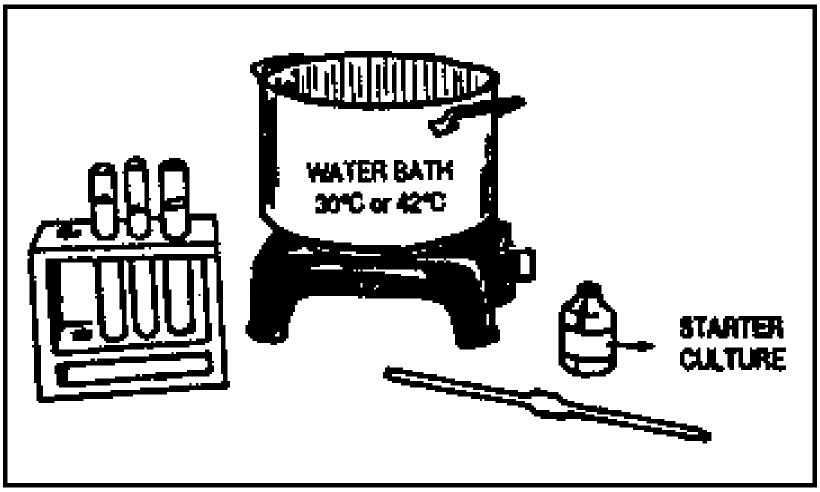

Figure 9: Materials Used to Test Inhibitory Substances in Milk

Procedure:

Three test tubes are filled with l0 ml of sample to be tested and three test tubes filled with normal milk. All tubes are heated to 90oC by putting them in boiling water for 3 - 5 minutes. After cooling to optimum temperature of the starter culture (30, 37, or 42ºC), 1 ml of starter culture is added to each test tube, mixed and incubated for 3 hours. After each hour, one test tube is from the test sample and the control sample is determined.

Assessment of results:

- If acid production in suspected sample is the same as the normal sample, then the suspect sample does not contain any inhibitory substances;
- If acid production as suspect sample is less than in the normal milk sample, then, the suspect sample contains antibiotics or other inhibitory substances.

3. Quality Control of Pasteurized Milk

When milk is pasteurised at 63ºC for 30 min in batch pasteurizer or 72ºC for 15 seconds in heat exchanger, continuous flow pasteurizers, ALL PATHOGENIC BACTERIA ARE DESTROYED, there by rendering milk safe for human consumption. Simultaneously various enzymes present in milk, and which might affect its flavour, are destroyed. In order to determine whether or not milk has been adequately pasteurised, one of the enzymes normally present in milk phosphatase, is measured. A negative phosphatase result indicates that the enzyme and any pathogenic bacteria have been destroyed during pasteurization. If it is positive, it means the pasteurisation process was inadequate and the milk may not be safe for human consumption and will have a short shelf life.

- Test tubes
- 5 ml pipettes
- 1 ml pipettes
- 100 ml volumetric flask
- 500 ml volumetric flask
- Water bath at 37ºC

Note: All glassware must be rinsed, cleaned, rinsed in chromic acid solution and boiled in water for 30 min.

<u>Reagent:</u>

Buffer solution is mixed with 0.75g anhydrous sodium carbonate and 1.75g Sodium bicarbonate in 500 ml distilled water.

Buffer-substrate solution:

Place 0.15 g of di-sodium paranitrophenylphosphate(the substrate)into a clean 100ml measuring cylinder. Add the buffer solution to make to 100 ml mark. Store this buffer-substrate solution in a refrigerator and protected against light. It should not be used after one week. Prepare a fresh stock.

<u>Procedure:</u>

Pipette 5ml buffer-substrate solution into a test tube, stopper and warm the solution in the water bath at 37ºC. Add to the test tube 1ml of the milk to be tested, stopper and mix well and place in water bath at 37ºC. Prepare a blank sample from boiled milk of the same type as that undergoing the test. Incubate both the test samples and the blank sample at 37ºC for 2hrs. After incubation, remove the tubes and mix them thoroughly. Place one sample against the blank in a Lovibond comparator" ALL PURPOSES" using A.P.T.W. disc and rotate the disc until the colour of the test sample is matched and read the disc number.

Interpretation:

Disc Reading after 2 hrs incubation at 37°C	Remarks
0-10	Properly pasteurised
10-18	Slightly under pasteurised
18-42	UNDER PASTEURISED
> 42	NOT PASTEURISED

References:

- ILCA Manual No.4, Rural Dairy Technology. Experiences from Ethiopia.
- IDF Doc. No.9002, Handbook on Milk collection in Warm Developing Countries. International Dairy Federation, Brussels, Belgium.
- Marshall, R.T. 1992 .Standard Methods for the determination of Dairy Products. 16th ed. Publ. American Public Health Association.

Annex 6.4

Recommended Reading for Devising a Milk Payment System

Poster Paper: The System of Milk Payment in Nepal - Experiences from the National Dairy Development Board (NDDB)[8]

R.M. Upadhayay, Senior Dairy Specialist, Nepal

Introduction

Historically, milk was not supposed to be sold. Probably it was so because every house hold used to produce milk for their own consumption. Milk has, however, been traditionally processed into country butter, Tschurpi, Shergham, etc. and ghee, all indigenous products. Butter milk used to be served to guests in place of water, free of cost. Processed products were bartered or sold for cash within and outside the country. The products from high mountain areas found their market in the north and from plains in the south across Nepalese borders.

Later, as the population started growing and the urbanization process began, milk went into market to serve those who could not afford to keep milking animals. In rural areas milk used to be bartered with rice on one to one basis volume wise. In urban areas milk was sold on cash or credit by producers directly to consumers. Later on middlemen entered into the marketing channel. Milk shops came up in cities like Kathmandu about 100 years ago. It seems that there was no system of price fixation. Prices were bargained between the buyer and the seller and payment was made in cash at the time of purchase or after a week, a fortnight or even a month, as mutually agreed by both parties.

The Evolution of the Milk Payment System

It was only in early 1950s that a pricing and payment system was introduced in Nepal. It was the time when His Majesty's Government (HMG) of Nepal first initiated buying milk from farmers to process it into cheese and other milk products. The Dairy Development Section, under the Department of Agriculture introduced a system of milk payment based on criteria of price determination and frequency of payment.

Experiences from NDDB

Early stages: Slab system:

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[8] *Report on the FAO E-mail Conference on Small-scale Milk Collection and Processing in Developing Countries (29 May to 28 July 2000)*, pp. 66-67. Available at: www.fao.org/ag/aga/agap/lps/dairy/ ECS/Proceedings/proceed.htm. Retrieved from the World Wide Web on June 30, 2003.

Milk price was determined on the basis of fat content in milk. Different rates were fixed for milk containing different ranges of fat, say 4 to 6, 6 to 8, and above 8 percent of fat, with proportional variation. For example, if 4 to 6 percent milk price was Rs. X per unit of milk, the prices for 6 to 8 and above 8 percent fat milk were fixed at Rs 1.5 X and Rs 2 X per unit, respectively.

During those times, all the milk brought to the collecting centers were from buffalo. During the late lactation period buffalo milk tested up to 13% fat (Personal experience from this author). The payment was made at intervals of 15 days (payment is still made at the same frequency).

This system worked fairly well for some time. Later the farmers became clever enough to manipulate the milk in such a way that no milk was received testing more than 8.5%, and almost all the supplies tested nearer to the lower level.

Linear fat percentage system:

Learning lessons from above experiences, a linear fat percentage rate was introduced. For example, Rs X per fat percentage per unit of milk was fixed for all milk deliveries which contained above the minimum fat level fixed at 5%. A penalty rate was fixed for milk testing less than 5% fat. This system worked very well. Farmers realized that they did not gain anything by adulterating the milk. This system was in practice for long time.

Present: Fat + SNF[9] system:

Improved cross bred cows entered into the farming system in 1980s. Farmers selling cow milk got very low rate because of low fat in milk. It was not possible to fix different rates for cow and buffalo milk because it was practically impossible to detect and differentiate between these two types of milk under field conditions. It was even more difficult if the milk was mixed.

Thorough study of this problem was made and a dual axis payment system was introduced. A minimum level of fat and SNF was fixed. Different rates per kg of fat and per kg of SNF were introduced. Different rates per unit of fat and SNF were fixed on the basis of distance and season of procurement. However, the seasonal differences in price are not sufficient to induce farmers for adjusting their breeding system to bring more animals in milk during the lean season.

This double axis payment system has brought many problems of adulteration with sugar soda, starch, urea etc. in order to raise SNF. It is very difficult to detect these adulterations at field level and NDDB is now preparing a proposal for a new payment system.

[9] SNF stands for "Solids-not-fat" content of milk. It is expressed as a percentage of proteins, lactose, minerals, and other water-soluble constituents in the fluid milk.

Quality Payment System:

The present system is based only on fat and SNF. The new, incentive payment system under preparation in NDDB will be based on fat and protein content and on microbiological quality. Milk will be graded according to quality, and high quality milk will be paid a premium price, whilst low quality milk will be paid a penalty rate.

Annex 6.5 Recommended Reading on How to Start a Milk Collection Centre[10]

Starting a Milk Collection Centre

A decision should be made on the number and sites of collection centres that are needed in the area covered by the group. Many factors influence this decision:

- Number of milk producers,
- Milk volume of each producer,
- Total volume of milk,
- Time to transport the milk,
- Distance from members to the collection centre,
- Distance from the collection centre to the processing centre or market,
- Whether milk collection is once or twice per day.

A participatory tool to decide on the numbers and the sites of the collection centres is given in the section titled 'milk production map'. By discussing this map with the group members, you can decide on the best areas for starting a collection centre.

Selecting a Site for a Collection Centre

In selecting the ideal site for a collection centre, consider the following points:

- Reliable supply of clean water,
- Close to the road,
- Accessible for all milk transport vehicles,
- Close to other buildings/activities,
- Good drainage,
- Easy to construct a building or a shade,
- The area should not be dusty,
- Preferably, there should be electricity.

If the group plans to process the milk in the future, you might want to select a site that can also be used as a site for a processing centre. In this case it is essential that electricity is available.

[10] Except where otherwise stated, this section of the annexure has been sourced from http://www.fao.org/ag/aga/agap/lps/dairy/DAP/mpo/chap4-1.htm. Retrieved from the World Wide Web on June 30, 2003.

Constructing a Collection Centre

Whether you are going to construct a building or a shade depends on the funds available. An open shade is often sufficient for collecting the milk, simple testing and transporting to the processing centre. If you want to construct a building, it is best if the floor is a hard washable surface. If the group plans to expand its activities in the future and wants to include milk processing, it might want to construct a building that can also be used for this purpose.

Milk Production Map[11]

A milk production map is a map of the area, indicating all items of interest to the group. A milk production map can be used as a starting point for discussion on, for example where the milk collection centre should be. The map will provide an overview of all items to consider and will facilitate decision making.

Objective: To facilitate the drawing of a map by group members which shows items of interest to milk production in the area of the milk producer group, to identify opportunities for cooperation and facilitate discussion about these opportunities.

When to use: When starting a new group or analyzing an existing group.

Number of members: Groups of 3 - 10 members.

Materials: Naturally occurring materials, large sheets of paper and pens.

Time needed: About 45 - 75 minutes.

How to proceed: First, you have to decide what the object of the exercise is, e.g. finding a central place for the milk collection centre. The members then have to make a list of items to include. These might be roads, the homesteads of milk producers, markets, etc. You can include many things in a milk production map, depending on what you want to know and analyze, for example:

- Households of group members or all producers in the area,
- Milk collection points and collection routes,
- Milk processing units, factories, etc.,
- Possible marketing sites and points,
- Water points,
- Number of dairy animals owned by each milk producer,
- Amount of milk produced/delivered to the collection point,

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[11] Available at: http://www.fao.org/ag/aga/agap/lps/dairy/DAP/mpo/6-2. Retrieved from the World Wide Web on June 30, 2003.

- Home of veterinarians, traditional healers, etc.,
- Grazing land or animal grazing routes.

If necessary, divide the members into groups to produce a map model of the area (see **Figure 1**). You can make a map on the ground or on paper; the advantages of using the ground and natural materials (e.g. stones), is that it can easily be adjusted when necessary. Once the map is finished, you can ask the group to transfer the map onto paper, copying what they see on the ground. You can then ask the group questions and initiate discussion, e.g. on where the collection centre should be.

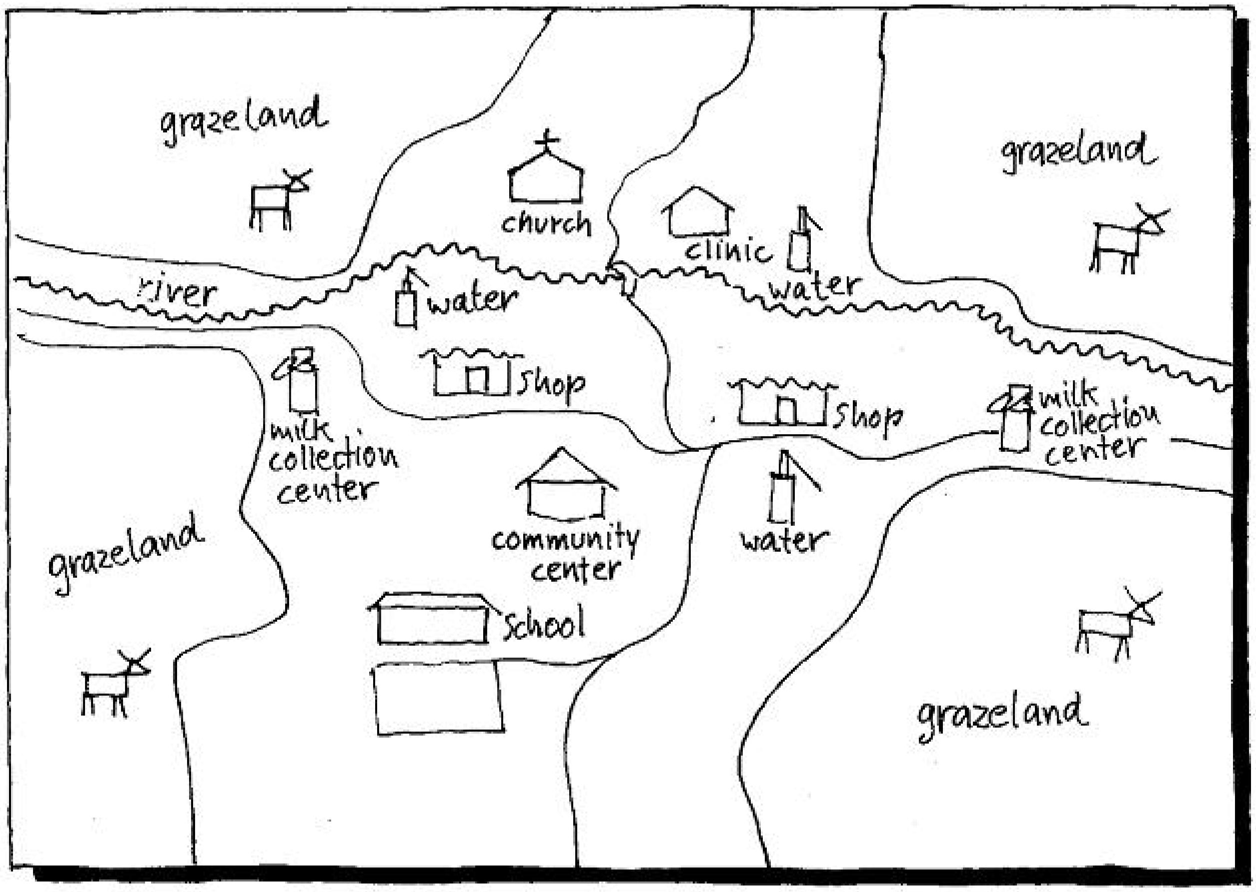

Figure 1: A Map Model of the Area

Annex 6.6 **Table of Contents for the** Manual on the Use of the LP-System in Milk Handling and Preservation[12]

[12] Manual available at: http://www.fao.org/ag/aga/publication/lpm/lpmcover.htm

Annex 6.7 Recommended Reading for Research into New Consumer Dairy Products

New Consumer Dairy products from Membrane Technology[13]

Dr. J. W. Siebert and Mr. A. Lalor, Department of Agricultural Economics, Texas A & M University, Texas, U.S.A.

New dairy products are very important because they have the potential to expand the total consumer demand for milk. For this reason the Southwest Dairy Farmers of Sulphur Springs, Texas sponsored research to assess the potential of membrane filtration technology. When it comes to new products, membrane technology has had tremendous success creating new products from whey. Could similar results be achieved relative to changes in fluid, soft, and frozen dairy products?

Figure 1 shows how various membrane filtration processes work. At the far left of this figure, only small molecules are able to pass through the membrane. Reverse Osmosis (RO) is a tight filtration process which will keep almost all milk component molecules except water from passing through the membrane. Moving to the right in the figure, molecules become larger. Progressively looser membranes such as nanofiltration (NF), ultrafiltration (UF), and microfiltration (MF) are used to separate milk components such as lactose, whey solids, casein, butterfat, and even bacteria.

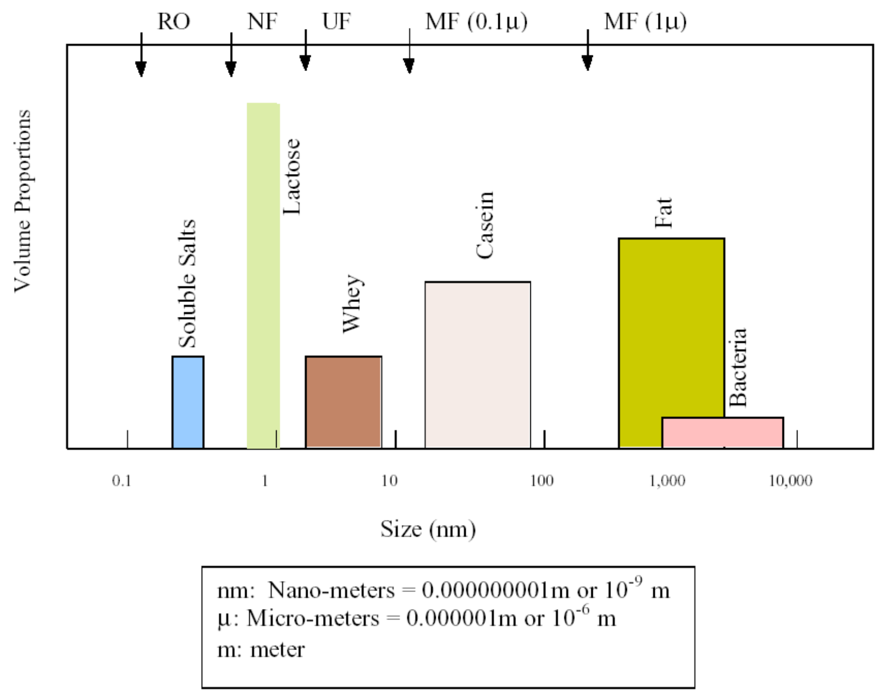

Figure 1: Milk Component Distribution by Size and its Relationship to the Membrane Process

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[13] Available at: http://agecon.tamu.edu/iama/2000Congress/Forum%20-%20Final%20PAPERS/Area%20III/Siebert_John.PDF. Retrieved from the World Wide Web on September 18, 2003.

In this article we will only examining new products created by UF. **Figure 2** shows how UF can fractionate skim milk into both skim milk retentate and lactose permeate.

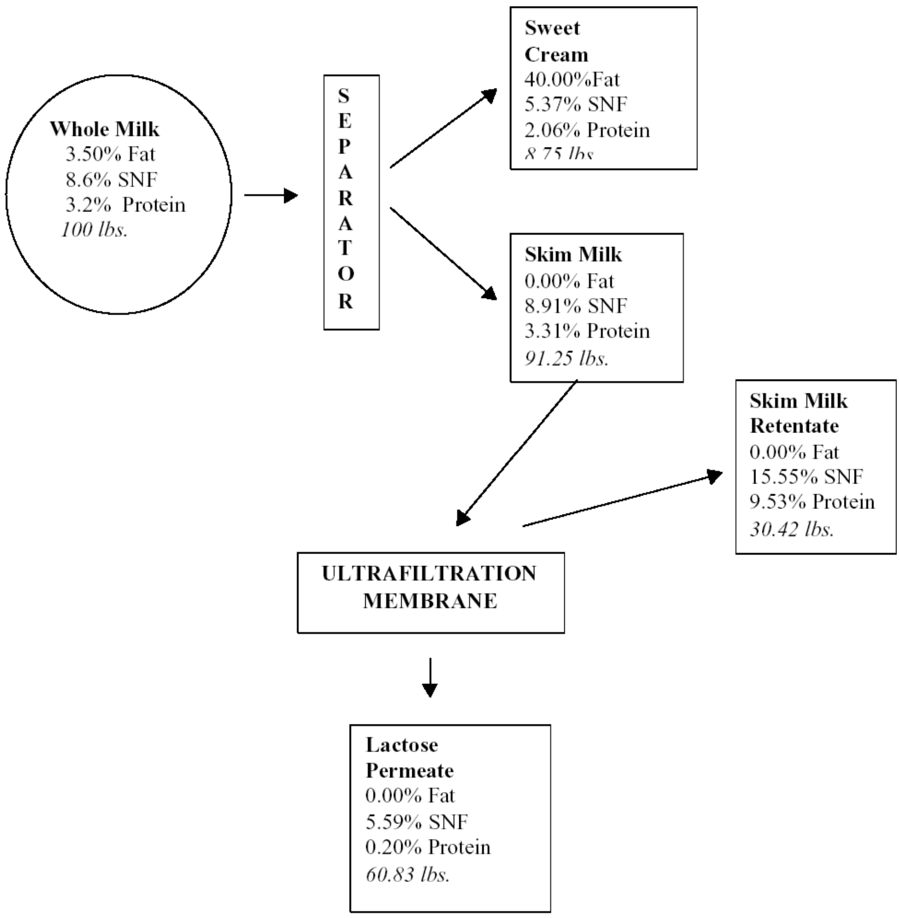

Figure 2: Manufacturing Skim Milk Retentate – The Building Block for New Dairy Products in this Study

The creation of skim milk retentate makes possible the manufacture of new dairy products such as:

- *Protein Fortified Fluid Milk* which can be made by a combination of whole milk, skim milk, and skim milk retentate (see **Figure 3**).
- *High Protein – Low Lactose Ice Cream* which can be made by a combination of sweet cream, skim milk retentate, and non-fat dry milk (see **Figure 4**).

Figure 3: New Product Idea: Manufacture of Protein Fortified Fluid Milk

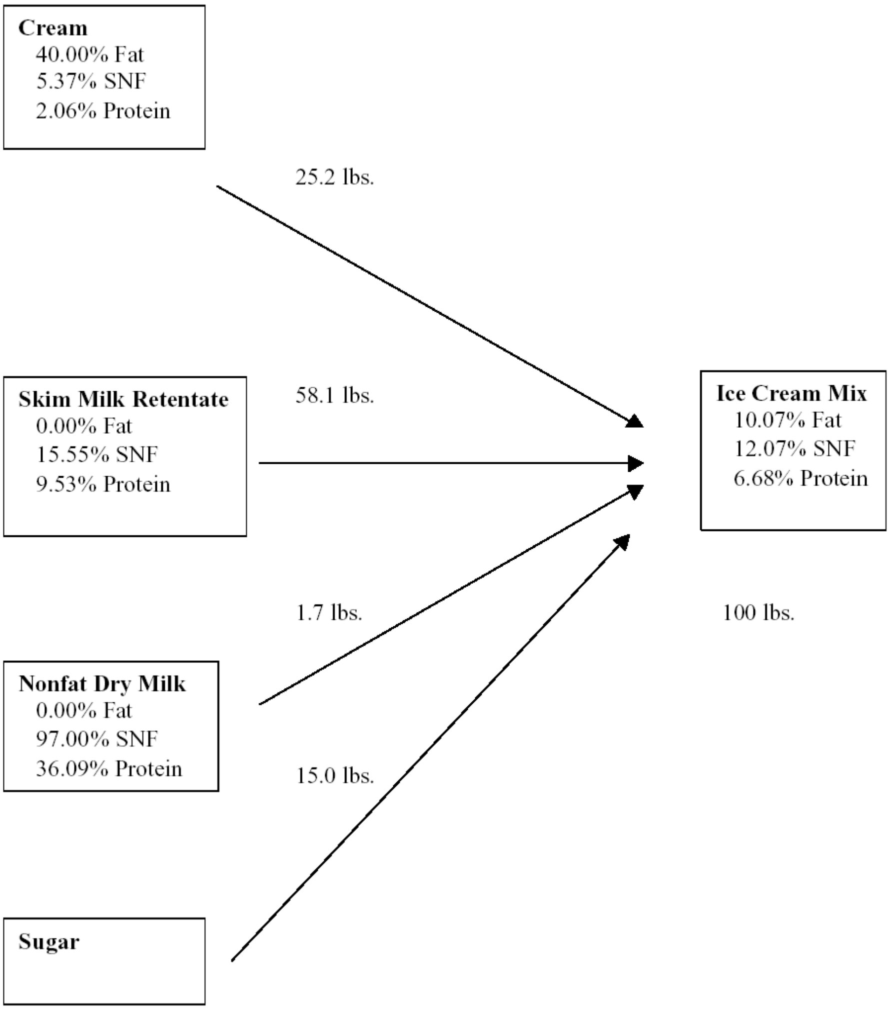

Figure 4: New Product Idea: Manufacture of High Protein, Low Lactose Ice Cream

- *High Protein – Nonfat Yogurt* which can be made with skim milk, skim milk retentate, and nonfat dry milk. This process uses less stabilizers than normally needed to make nonfat yogurt (see **Figure 5**).

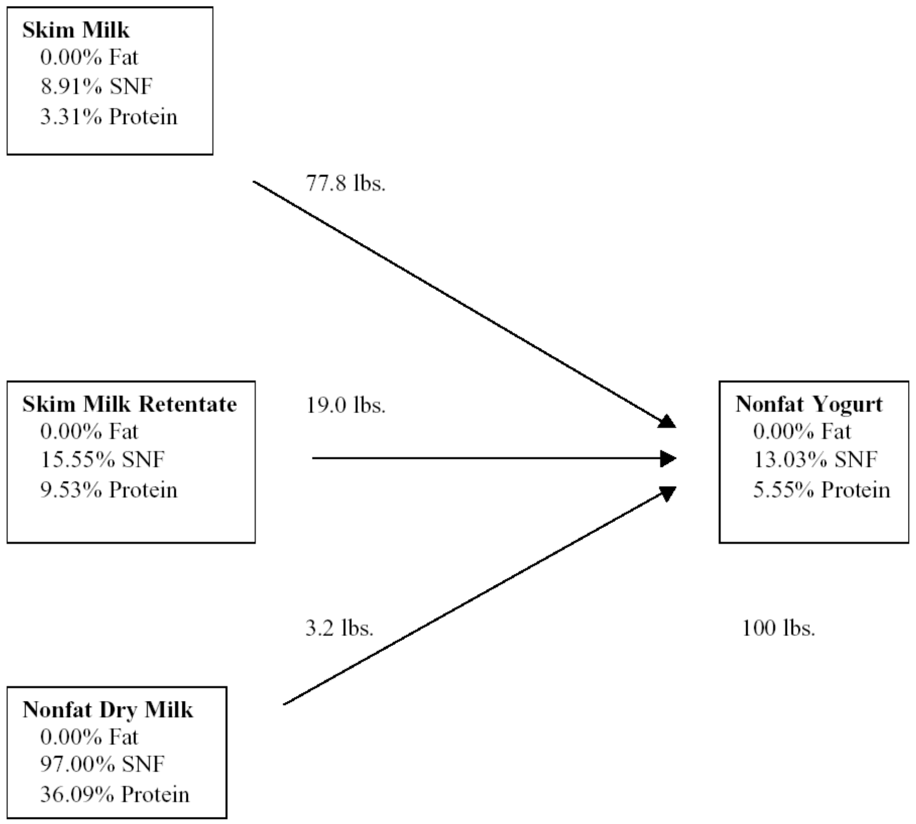

Figure 5: New Product Idea: Manufacture of High Protein, Non-fat Yogurt

Economics

To begin, it was necessary to estimate manufacturing costs for each of these new dairy products. **Figure 6** presents this information for each product. When compared to a regular dairy product, the added cost to make high protein fluid milk equalled \$0.16/gallon. For high protein - lower lactose ice cream this added cost equalled \$0.41/gallon mix. (One gallon of this mix makes six 1/2 gallons of ice cream). For high protein - nonfat yogurt this added cost equalled \$0.19/gallon. (One gallon of this mix makes 17 eight ounce cups of yogurt).

End Product:	High Protein, 2% Butterfat Fluid Milk	High Protein, Lower Lactose Ice Cream Mix	High Protein, Non-fat Yogurt Mix
End Product Output per Day (a)	375,000 lbs. milk	200,000 lbs. mix	100,000 lbs. mix
System Capital Cost	$455,000.00	$1,240,000.00	$455,000.00
10 Yr. Depreciation (b) (312 day basis)	$145.83/day	$397.44/day	$145.83/day
Operating Cost (c)	$675.00/day	$2,025.00/day	$675.00/day
Daily Capital & Operating Cost (b + c)	$820.83/day	$2,422.44/day	$820.83/day
Capital & Operating Cost per Cwt. Finished Product a / (b + c)	$0.22/cwt.	$1.21/cwt.	$0.82/cwt.
Added Milk Component Cost	$1.62/cwt.	$3.59/cwt.	$1.40/cwt.
Total Added Cost	$1.84/cwt. (or $0.16/gal.)	$4.80/cwt. (or $0.41/gal. Mix)	$2.22/cwt. ($0.19/gal. Mix)
Comparison to Estimated Prevailing Retail Price	$2.50/gal.	One gallon of mix will make four ½ gallons of ice cream selling for $3.00 per ½ gal.	One gallon of mix will make 17-8oz. cups of yogurt selling for $0.50 per cup.
Raw Product Cost Increase as a % of Prevailing Retail Price	6.4%	3.4%	2.2%

Figure 6: Increased Costs to Manufacture New Dairy Products

Survey of Milk, Ice Cream, and Yogurt Manufacturers

Armed with this information, survey instruments were developed and sent to dairy manufacturers of beverage milk, ice cream, and yogurt. **Figure 7** presents the results of the survey. A total of 179 firms were contacted of which 80 firms completed the survey for a total response rate of 45%. Note that participating firms were surveyed for only a single product.

Survey Question	Response
Number surveys sent out	179
Number of surveys returned	80
Response rate	45%
Number of firms responding:	
Fluid milk processors	33
Ice cream manufacturers	25
Yogurt manufacturers	22
Total firms	80
Daily processing volume of responding firms:	
Under 6,000 gallons	12%
6,000 to 30,000 gallons	20%
30,000 to 60,000 gallons	24%
Over 60,000 gallons	44%
All firms	100%
Firms' sales accounted for by private label:	
None	26%
Less than 1/3	24%
1/3 to 2/3	28%
Over 2/3	22%
All firms	100%
How often the person completing the questionnaire heard from consumers:	
Less than ten calls per year	11%
Less than ten calls per month	44%
10 to 100 calls per month	39%
Over 100 calls per month	6%
All firms	100%
Percent of firms using membrane technology for dairy purposes:	10%

Figure 7: Summary of Results from New Product Surveys of Fluid Bottlers, Ice Cream Makers and Yogurt Makers

Amongst the firms completing the survey, forty-four percent were in the large size category, having a daily processing volume of over 60,000 gallons. At the other extreme, twelve percent of the firms completing the survey had a daily processing volume under 6,000 gallons. Twenty-six percent of participating firms did not manufacture for private labels. At the other extreme, twenty-two percent of participating firms had more than two-third's of total manufacturing volume accounted for by private labels. When the individual completing the survey was asked how often they heard from the final consumer, the majority said less than ten times per month. However, six percent of respondents heard from consumers more than 100 times per month.

Survey Findings

Our survey covered 33 fluid milk bottlers. When we asked if consumers would be willing to purchase *high protein – lowfat fluid milk,* only 21% of these bottlers said "yes". When these bottlers were asked if they could recommend one thing to insure that this new product would succeed, 38% named no price premium, 27% said superior taste/mouthfeel, and 24% said advertising. Participating bottlers were relatively large with over 39% of them processing an average daily milk volume in excess of 60,000 gallons for all processing purposes. None of the fluid bottlers surveyed were currently working with membrane technology in the manufacture of dairy products.

Our survey covered 25 ice cream manufacturers. When we asked if consumers would be willing to purchase *high protein, low lactose ice cream,* 32% of these manufacturers said "yes". When these manufacturers were asked if they could recommend one thing to insure that this new product would succeed, 76% named superior taste/mouthfeel, 20% named advertising, and only 8% named no price premium. Participating ice cream manufacturers were not quite as large as the milk bottlers. However, 28% of these manufacturers did receive an average daily milk volume in excess of 60,000 gallons for all processing purposes. Sixteen percent of these ice cream manufacturers were currently using membrane technology for dairy purposes.

Our survey covered 22 yogurt manufacturers. When we asked if consumers would be willing to purchase *high protein, nonfat yogurt,* 45% of these manufacturers said "yes". When these manufacturers were asked if they could recommend one thing to insure that this new product would succeed, 68% named superior taste/mouthfeel, 31% named no price premium, and only 5% named advertising. Participating yogurt manufacturers were very large with 68% reporting an average daily milk volume in excess of 60,000 gallons for all processing purposes. Eighteen percent of these yogurt manufacturers were currently using membrane technology for dairy purposes.

Implications

It is evident that most firms are not eager to accept these new products ideas. However, there are some specific individual firms that are interested. Consequently it seems likely that if one of these products (most likely the yogurt) were to gain widespread consumer distribution, it would be because one particular firm spearheaded the marketing effort. Comments made by particular survey respondents are shown in **Figure 8**.

Figure 8: Some Comments of Survey Respondents

Comment	Source
"Our current business is price driven, thus the supplier would have to absorb any price increase.!	*... a bottler in the State of Washington*
"We make a NFDM fortified product. At standard retail price it sells well. However, with a $0.05/gal. premium it does not sell well."	*... a bottler in the State of New York*
"I am not sure customers would understand or care."	*.. an ice cream maker in Wisconsin*
"This would take advertising."	*... an ice cream maker in the high plains*
"Shelf placement is critical."	*... a yogurt maker in Illinois*
"Superior flavor and texture at a competitive price will be a new product requirement."	*... a yogurt maker in Ohio*

Membrane technology, in combination with more traditional technologies, creates the ability to custom tailor the percentage content of all milk components. Regarding protein, FDA has no minimum protein test standard for milk. Consequently, membrane technology has the potential to be used, in the name of efficiency, as a technology to reduce the protein content of dairy products. Such a practice would hurt both dairy farmer income and also deprive consumers of the expected nutritional benefits they expect from dairy products. Thus it is important for dairy farmers to emphasize the positive nutritional attributes of their products. Furthermore, it is important for dairy farmers to take steps to maintain and enhance the standards of identity for their products.

References

- Cheryan, Munir. *Ultrafiltration and Microfiltration Handbook.* Lancaster, PA: Technomic Publishing Co. 1998.
- Siebert, John W. and Alejandro Lalor. *New Consumer Dairy Products From Membrane Technology*. Texas A&M University. September 15, 1999. 48pp.

Annex 6.8 Detailed Description of the MILKPRO Unit, A Low Cost Milk Packaging-Pasteurizing-Chilling System[14]

Food and Agriculture Organization (FAO/TCP/KEN/6611 Project)

One of the main problems facing small scale milk processors in developing countries is the high capital cost of conventional stainless steel equipment for pasteurizing and packaging fresh milk. Conventional packaging materials can also be very expensive, especially if they have to be imported. Many therefore resort to heating their milk in cans or 'boilers' to make the milk safe as well as to extend its keeping quality. The high temperatures used can adversely affect the milk's nutritional properties; and the risk of post pasteurization contamination during ensuing hand packaging is high.

In collaboration with the FAO Dairy Training Programme for the Small Scale Dairy Sector (Government of Kenya/FAO Project TCP/KEN/6611), a new low cost, simple pasteurizing and packaging system was field tested and adapted at the Naivasha Dairy Training Institute for use by groups of small farmers. The results were very promising and the system is now being promoted by the FAO Animal Production Service as a simple and inexpensive technology for the development of small- scale rural producers' groups. Producer groups benefit from the value added by directly marketing the extended-life milk, both locally and to nearby urban centres. There is also the potential to expand to the larger growing urban markets when logistics are organised. The system will soon be in use in more than ten countries. Developed in South Africa the system, known as the MILKPRO, comprises a filler from which the raw milk is gravity fed into pre-formed sachets of the type already produced in Kenya and most other developing countries (see **Figure 1**).

Figure 1: Gravity Feeding of Raw Milk into Pre-formed Sachets

[14] Available at: http://www.fao.org/ag/aga/agap/lps/dairy/MPR/Milkpro/milkpro.htm. Retrieved from the from the World Wide Web on June 30, 2003.

The sachets are manually sealed and placed in a batch pasteurizer. Here they are treated at 65°C for 30 minutes (see **Figure 2**). The heating process is automatically controlled.

Figure 2: Sachets of Milk Placed in a Batch Pasteurizer

After pasteurizing, the sachets are cooled down to 5°C in a chilling unit (see **Figure 3**).

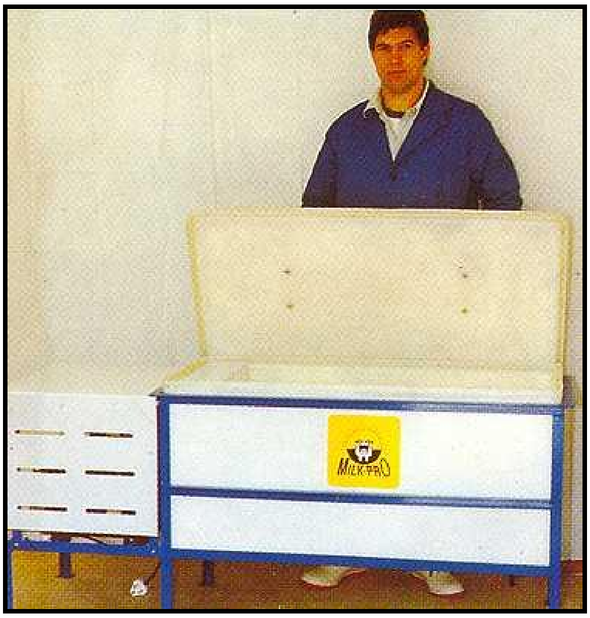

Figure 3: Cooling of Pasteurized Sachets in a Chilling Unit

The MILKPRO system can handle up to 100 litres of milk an hour. It costs under US$10,000 plus freight. At a daily throughput of 750 litres, the payback period can be as little as 12 months. The system is operated simply by plugging it into a standard 240 volt electrical power point or by using a small diesel or petrol engine. It is especially designed for easy cleaning and maintenance.

Because the milk is pasteurized in the sachet, the system has been found to be extremely effective and consistently pasteurizes milk to a standard well above the legal requirement. Post pasteurization contamination is minimised and a refrigerated shelf life of up to two weeks is possible compared with the more usual 2 to 5 days. And, because the pasteurization temperature is lower than the more conventional systems or 'boiling', the milk retains more of its 'fresh from the cow flavour' - a good selling plus in the highly competitive marketplace.

For more information contact:

Brian.Dugdill@fao.org or write to: Animal Production and Health Division, FAO, 00100 Rome Italy (Fax: 0039-06-57055749).