SEAM Project

Food Processing Sector, Egypt

Cleaner Production Opportunities

Ministry of State for Environmental Affairs
Egyptian Environmental Affairs Agency
Technical Cooperation Office for the Environment

***En*tec UK Ltd**
UK Department for International Development

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SEAM Project
Implemented by:

Egyptian Environmental Affairs Agency
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and
Entec UK Limited

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A SECTOR REPORT PRODUCED BY THE SEAM PROJECT

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Preface

A. The SEAM Project - An Introduction

Support for Environmental Assessment and Management (SEAM), is a multi-disciplinary environmental project being funded by Britain Department for International Development (DFID). This Project is being implemented by the Egyptian Environmental Affairs Agency (EEAA) through the Technical Cooperation Office for the Environment (TCOE) and *En*tec, a UK based engineering and environmental consultancy.

The SEAM Project is made up of 5 components, focusing on environmental management issues. These include Industrial Pollution Prevention/Cleaner Production, Environmental Impact Assessment, Solid Waste Management, Environmental Action Plans and development of an Environmental Database.

B. The Industrial Pollution Prevention/Cleaner Production Component

The main goal of the Industrial Pollution Prevention/Cleaner Production component is to show that significant financial savings and environmental improvements can be made by relatively low-cost and straightforward interventions. These consist of pollution prevention through good housekeeping, waste minimisation, process modification and technology changes. This approach has two benefits - valuable materials are recovered rather than wasted and factories are moved towards legislative compliance. This work is being undertaken in support of the National Industrial Pollution Prevention Programme (NIPPP) and has focused on three sectors: textiles, food processing and oil & soap.

Industrial auditing of 32 factories identified in excess of 200 low cost/no cost pollution prevention measures. Commonly occurring issues were then developed as demonstration projects for each sector, whose aims were to show the financial and environmental benefits of the pollution prevention approach.

Thirteen demonstration projects have been implemented in 21 sites as follows:

Textile Sector

- Eco-friendly Processing for an International Eco-label.
- Water and Energy Conservation.
- Combined Processing: Scour and Bleach.
- Bleach Clean-Up using Enzymes.
- Sulphide Reduction in Sulphur Dyeing.

Food Processing Sector

- Installation of Milk Tank Level Controls and Valves.
- Water Conservation in Food Factories.
- Energy Conservation in Food Factories.
- Reducing Waste by Improved Quality Control.
- Recovery and Use of Whey as Animal Feed.

Oil and Soap Sector

- Waste Minimisation in an Edible Oil Factory.
- Oil and Fat Recovery.
- Improving Raw Water Quality to Reduce In-Plant Losses.

Outputs from these projects include industry workshops and seminars, demonstration projects with supporting Guidance Notes and Manuals (to enable other factories to implement similar projects themselves), case studies incorporating cost-benefit analyses to demonstrate project feasibility, detailed Sector Reports and Guidelines describing how to carry out industrial audits.

C. Industrial Pollution Prevention/Cleaner Production Documents

(i) General Documents

‚Guidelines for Industrial Audits, - A description of the methodology followed in the auditing of 32 factories, 10 of which were in the textile sector.

(ii) Sector Reports

A description of 3 industrial sectors in Egypt, including information on pollution prevention/cleaner production opportunities, the findings of the industrial audits and demonstration projects.

‚Textile Sector, Egypt. Cleaner Production Opportunities.‚

‚Food Processing Sector, Egypt. Cleaner Production Opportunities.‚

‚Oil and Soap Sector, Egypt. Cleaner Production Opportunities.‚

(iii) Case Studies

‚Case Study: Textile Sector. Ecofriendly Processing and Achieving Ecolabels‚. Misr Spinning and Weaving Co., Mahalla and Giza Spinning, Weaving, Dyeing and Garments Company.

‚Case Study: Textile Sector. Sulphur Black Dyeing: A Cleaner Production Approach‚. El Nasr Co. for Spinning and Weaving, Mahalla El-Kobra, Dakahleya Spinning and Weaving Co., Mansoura and Amirtex Co., Sadat City.

‚Case Study: Textile Sector. Water and Energy Conservation‚. El Nasr Company for Spinning and Weaving, Mahalla El-Kobra and Misr Beida Dyes, Alexandria.

‚Case Study: Textile Sector. Bleach Clean-Up in Cotton Textile Processing using Enzymes‚. Dakahleya Spinning and Weaving Co., Mansoura and Amirtex Co., Sadat City.

‚Case Study: Textile Sector. Combining Preparatory Processes - A Low Cost, High Productivity Solution‚. Giza Spinning, Weaving, Dyeing and Garments Company and Misr Beida Dyes, Alexandria.

‚Case Study: Food Sector. Reduction of Milk Losses‚. Misr Company for Dairy and Food, Mansoura.

‚Case Study: Food Sector. Water and Energy Conservation‚. Edfina Preserved Foods, Alexandria and Kaha for Preserved Foods, Kaha.

‚Case Study: Food Sector. Recovery of Cheese Whey for Use as Animal Feed.‚

‚Case Study: Food Sector. Integrated Quality Assurance and HACCP Approach to Waste Reduction in Food Processing.‚

‚Case Study: Oil and Soap Sector.‚ Waste Minimisation at Sila Edible Oil Company, Fayoum.

‚Case Study: Oil and Soap Sector.‚ Pollution Prevention in Tanta Oil and Soap Company, Tanta.

(iv) Guidance Manuals

These manuals give a step-by-step description of how the demonstration projects were implemented, to allow other interested factories to implement similar projects by themselves. These are illustrated with examples from the demonstration projects and also include detailed cost-benefit analyses.

,Cleaner Production for Textiles: Sulphur Black Dyeing,. The elimination of 2 hazardous chemicals from the sulphur black dyeing process, resulting in a better quality product, reduced pollution and improved working conditions.

,Cleaner Production for Textiles: Combining Preparatory Processes,. This describes how the desize and scour or the scour and bleach steps could be combined to save money, reduce processing time and reduce environmental pollution.

,Cleaner Production for Textiles: Ecofriendly Wet Processing of Textiles,. How to improve textile processing so that it could be awarded an ,ecolabel, certificate, which guarantees that the fabric meets specific quality criteria.

,Cleaner Production for Textiles: Water and Energy Conservation,. How to identify and prioritise water and energy losses.

,Integrated Quality Assurance and HACCP Approach to Waste Reduction,. How to improve food quality and reduce wastage by improving quality assurance procedures and establishing a quality management plan which incorporates HACCP principles.

,Cleaner Production for Food Processing: Water and Energy Conservation,. How to identify and prioritise water and energy losses.

(v) Workshops and Training

,Industrial Auditing - A Workshop for Auditors,. A 5 day workshop describing the auditing process and review potential barriers and how to overcome them.

,Industrial Auditing for Companies - A Workshop for the Textile Sector,. This consisted of 2 parts, one to brief senior management on the benefits of auditing and one to describe the audit process to selected technical staff and a nominated ,Environmental Champion,.

,Industrial Auditing for Companies - A Workshop for the Food and Oil & Soap Sector,. This consisted of 2 parts, one to brief senior management on the benefits of auditing and one to describe the audit process to selected technical staff and a nominated ,Environmental Champion,.

,**Cleaner Production and Pollution Prevention. A Workshop for the Pulp and Paper Sector**,. This 5 day workshop illustrated how significant financial and environmental savings could be made through the identification and implementation of low-cost Cleaner Production interventions.

,**Cleaner Production and Pollution Prevention. A Workshop for the Metal Finishing Sector**,. This 5 day workshop illustrated how significant financial and environmental savings could be made through the identification and implementation of low-cost Cleaner Production interventions.

1.0 Introduction

The food processing sector is large and has many subsectors, themselves having numerous subdivisions. Companies range from large, publicly owned factories to small ,cottage industries, and use a range of technologies, making generic comparisons difficult. These technologies vary from the very simple (e.g. crushing of fruit) to the latest in membrane and evaporator technology. Treatment options range from sophisticated on-site anaerobic digesters with co-generation facilities to zero treatment.

The size of many food processing operations and the fact that they are usually located close to other land uses, especially domestic uses, means that some impacts are especially unacceptable, e.g. odour, noise, water pollution and this is driving the need for change in many companies.

The sector is known for its high water consumption and wastewater generation - the Environmental Action Plan of Egypt (1992) states that throughout industry, this sector consumes 46% of raw water and generates 50% of wastewater. The wastewater is often characterised by a high Biological Oxygen Demand (BOD) and suspended solids (SS) with a high tendency to putrefy if not properly treated. Thus the damage to water bodies from food industry discharges can be great and environmental and social amenity is diminished.

As well as simple organic materials such as foodstuffs, the sector also uses some materials which are hazardous or dangerous to health or the environment, from caustic soda to chlorine and other dangerous chemicals, often from cleaning or preserving activities. There are air emissions as well as aqueous ones, and also land discharges.

Other issues which are becoming increasingly important include air emissions (especially Volatile Organic Compounds, VOCs), noise and workplace safety. There is also increasing pressure being applied to Egyptian food factories to discontinue the use of mazot and switch to solar or natural gas.

1.1 Cleaner Production - Concept and Definition

Traditionally, pollution prevention has been approached using end of the pipe controls. This continues to be the predominant tool in practice in a number of developing countries even today. An alternative approach is to eliminate the problem at the source, which will prevent or minimise the generation of pollutants. Unlike end-of-pipe solutions alone, this can also generate significant financial savings.

Cleaner Production (CP) can be defined ,the continuous improvement of industrial process, products and services to reduce the use of natural resources, to prevent - at the source - the pollution of air, water and land and to reduce waste generation - at the source - in order to minimise risks to the human population and to the environment, (UNEP, 1990).

At a factory level, this means that:

- For **production processes**, Cleaner Production includes conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes before they leave a process.
- For **products,** the strategy focuses on reducing impacts along the entire life cycle of the product from raw material production to the ultimate disposal of the product.
- For **services**, the strategy incorporates environmental concerns into designing and delivering services.

At present there is a distinct lack of general information in Egypt related to process and environmental technologies and their effects on the environment. There is a lack of baseline data and a lack of best performance data. The information is generally not readily available and the need is therefore ignored, often by the persons who are responsible for the design and construction of the plant. This has pushed environmental management and especially pollution prevention down the ladder of priorities in the firm and often resulted in unnecessary waste of resources and energy in this sector.

There are many reasons for both general and Cleaner Production information not being readily available, from there being limited demand to difficulty in collection to confidentiality issues. The food sector operates in an extremely competitive environment and has traditionally used the environment as a repository for its wastes.

Throughout the world, society is starting to reject the notion that either the generation of wastes or their emission is a natural part of the business cycle. More and more food companies in many sectors are examining their performance, looking at Cleaner Production options and investigating environmentally and economically preferred options. They recognise that a waste eliminated has a double saving - reduced inputs and minimisation of wastes generated. Factories recognising that this will have a significant and lasting effect on their performance and long term profitability. This attitude will be increasingly adopted by industry to improve and maintain profitability, but the rate of this uptake needs to be accelerated.

1.2 The Benefits of Cleaner Production for the Food Industry

The Cleaner Production concept radically differs from the traditional end-of-pipe approach, in that Cleaner Production makes no division between production and the wastes generated by production. It is an integrated approach which attempts to conserve resources by increasing production efficiency whilst meeting environmental requirements. By minimising wastage, the required capacity of any wastewater treatment plant will be greatly reduced, thus reducing capital, operating and maintenance costs.

By adopting the Cleaner Production approach, waste reduction automatically starts to occur. As a result, the overall resource utilisation factor improves, leading to increased profitability and competitiveness. Against the rising costs and procurement difficulties of resources, these benefits may even be greater than the savings made on waste treatment costs.

Cleaner Production approaches recognise that change has to come from within and sustainable change cannot be imposed from external sources against the needs or desires of the firm. Cleaner Production almost inevitably generates substantial economic benefits which can be directly related to any interventions made. These benefits include:

- Saving money.
- Preventing pollution.
- Complying with environmental legislation.

1.2.1 Saving Money

The easiest to conceptualise, saving money has an instant acceptance and results from an attention in the Cleaner Production programme to:

- Reducing costs.
- Increasing firm efficiency.
- Increasing the competitive ability of the firm.
- Comparing the firm turnover required to generate a net profit versus direct savings from the programme.

1.2.2 Improving Efficiency

A Cleaner Production programme is also a **leaner production** mindset. The firm from the manager down looks to do more with less. As a spin-off, the meticulous attention to detail and data gathering allows attention to be paid to:

- Reduction of defective products, rework and downtime.
- Improved work practices - production, maintenance, cleaning.
- Reduction in paperwork involved in monitoring and record keeping.
- Improved employee morale and involvement.

1.2.3 Marketing Advantage

Every firm today (unless they have an absolute monopoly) has to have some kind of customer focus as it is always operating in a highly competitive environment. Any advantage that the firm can get from its business activities can be used to generate more profit. In the case of Cleaner Production, the number of customers who are aware of environmental considerations is increasing; this group is prepared to buy products based on that knowledge. This can generate:

- Better image with customers.
- Increased sales / profits.
- Income from sale of by-products, recyclables.
- New product / business development

Quality considerations are paramount in the food sector: the customer is discerning and aware of poor quality and may buy accordingly. Quality issues can have a big impact on waste production; international programs such as the ISO series will have extensive repercussions for the industry here both for local and export markets. Energy is also a major input into the production process, for many sub-sectors. Energy savings may have marked effects on the profitability of the firms, reflecting as they do a transfer of funds straight to the bottom line.

1.2.4 Environmental Performance

Application of a Cleaner Production approach can lead to:

- Reduction in discharges of wastes to the environment.
- Lower impact on local/global environment and community and reduced risk of causing environmental harm.
- Increased legislative compliance.
- Better relationship with community and regulators.

1.3 The SEAM Project in the Food Industry

The SEAM Project carried out audits of 10 food processing manufacturing plants. The factories audited included fruit and vegetable processing plants, dairy product factories, confectionery production, soft drink bottling and fish processing. These audits focused on identifying low-cost interventions with fast payback periods - over 130 such interventions were identified, with implementation costs ranging from LE0 to LE350,000. Savings from implementing these actions ranged from LE1,150 to LE822,500, with payback periods ranging from less than 1 month to 2 years. A summary of the types of interventions identified follows:

Type of Intervention	Capital Costs (LE)	Annual Savings (LE)	Average Payback Period (months)
Water Conservation, Recycling and Reuse	200-20,000	1,550-155,000	12
Energy Conservation	4,000-200,000	6,316-822,500	7
Process Modification	4,000-350,000	75,000-200,000	9.5
Product / By-product Recycle and Reuse	0-80,000	3,600-400,000	4.5
Raw Material Substitution	6,000-200,000	8,600-75,000	21.5

This auditing work was supported by training given to the audit teams and to factory personnel. These took the form of 3 workshops:

- **Senior management of the factory** - this workshop outlined the financial and economic benefits of implementing Cleaner Production and broadly described the audit process. The management were also requested to nominate a member of staff to act as the Environmental Champion and point of contact for the audit team.
- **Middle management and technical factory staff** - this workshop was aimed at personnel who would be directly involved in the audit. The aim of the workshop was to demonstrate the benefits of auditing and explain the auditing process. It was also used to brief the factories on the needs of the audit teams.
- **Audit teams** - this workshop presented the audit methodology to the auditors and explained how findings were to be described and quantified. It also outlined the needs and concerns of the factories in relation to the audit process and emphasised the importance of confidentiality.

1.4 Food Processing Factories participating in the SEAM Project

The SEAM Project focused on 11 factories (10 of which were audited, 1 which was not) from the following sectors:

- Fruit and Vegetable Processing;
- Dairy Products (including ice cream);
- Confectionery;
- Fish processing;
- Soft drinks.

A summary of the main characteristics of each of these follows.

El Ahram Beverages Company, Zagazig is a public company which was constructed in 1985 and privatised in 1997. It occupies a 16.6 feddan (70,000m^2) site and employs 1,200 staff. It produces a range of carbonated soft drinks under license, including a range of colas, lemonades, orange and apple flavoured drinks. Approximately 7 million cases are produced annually (1996), with summer production rates normally 10 times higher than in the winter.

Alexandria for Chocolate and Confectionery Company Corona, Alexandria is a public sector company, which was established in 1962. It is made up of 2 separate factories - Royal Factory, which produces a range of chocolates and biscuits and the Nadler Factory which produces boiled sweets, chewing gum and fruit syrup. Average annual production levels (1997) for Royal Factory is 5,431tons and 3,289tons for Nadler Factory. The 2 factories occupy an area of 5.2 feddans (21,700m^2) and employs 1,700 staff.

Dolce Company for Food Industries, 6th October City is a private sector company, which was opened in 1971 and taken over by Nestle in 1995. The main products include a wide range of ice cream products (including cones, gateaux and ice cream deserts) and savoury snacks. It occupies a 25 feddan (105,000m^2) site. Monthly production levels (April 1995) of these ice cream products total 2,088 tons.

Edfina Company for Preserved Foods, Alexandria and constructed on a 13.3 feddan (56,000m^2) site in the Ras El-Soda area of Alexandria. The main products of the factory include fruit juices, jams, preserved fruit and vegetables, depending on seasonal availability. Total annual production is around 13,800 tons (1996 production levels). It was established in 1958 and is at present a public sector company, although there are plans to privatise it in the next few years.

Edfina Company for Preserved Foods, Damietta occupies a 1.9 feddans (8,000m^2) site in Ezbat El-Burg City, 12km away from Damietta. The main products of the factory include canned fish (either mackerel or sardines), dried fish meal and fish oil, totalling 1,900tons per annum (1998 production levels). Frozen vegetables and fruit juice concentrate are produced when fish processing is not being carried out. It was established in 1960 and is at present a public sector company, although there are plans to privatise it in the next few years.

Kaha for Preserved Foods, Kaha was established as a public sector in 1976 and was then privatised in 1998. The main products of the factory are processed fruits and vegetables, including a range of jams and juices, tomato paste and frozen vegetables. It occupies a site of 20 feddans (83,800m^2) and has a workforce of around 700. Total annual production (1996/97) is 4,832 tons.

Misr for Milk and Food, Cairo was established in 1962 as a public sector company on a 7 feddan (29,400m^2) site with around 700 employees. Approximately 30-35 tons of raw milk are received daily, which are processed to produce a range of cheeses, ice cream, yoghurt, ghee, packaged milk, mourta (a by-product of ghee) and mish is (produced from downgraded products).

Misr for Milk and Food, Damietta was built in 1966 and is one of the largest dairy food producers in Egypt. Approximately 8,250 tons raw milk is processed annually (1998/99) to produce 3,300 tons of cheeses, ghee and mish.

Misr for Milk and Food, Mansoura is a public sector company which was constructed in 1965 and has a workforce of around 420. It occupies an area of 5 feddans (21,000m^2) The factory annually processes an average of 7,200 tons of milk, producing mainly pasteurised milk, white cheese, blue cheese and mish. Yoghurt, sour cream, ghee and processed cheese are also produced.

El Nasr Company for Agricultural Dehydration Products, Sohag was established in 1959, whose main product is dehydrated onions, either in flaked or powdered form. A small amount of onion oil is also produced. In 1995, the factory was working at nearly 100% capacity, producing 10tons of dehydrated onions per day and 400kg onion oil per year. The production season is limited by onion availability from mid-December to mid-October, with the remaining 3 months being used for maintenance activities.

El Nasr Bottling Company, Mansoura is a private sector company, constructed in 1988. It has around 500 employees and produces a range of soft drinks under license, including a range of colas, lemonades, orange and apple flavoured drinks. Approximately 480,000 bottles (192ml and 245ml) are produced daily (June 1997), although this value varies according to season - in general highest production levels occur in the summer.

1.5 SEAM Demonstration Projects

The audit findings were assessed to identify the most common and acute problems facing the Egyptian food processing industry. A total of 4 projects were implemented in 4 different factories:

Demonstration Project	Factory Name	Location
Reducing Milk Losses	Misr for Milk and Food	Mansoura
Water and Energy Conservation	Kaha for Preserved Foods	Kaha
	Edfina for Preserved Foods	Alexandria
Use of Whey as an Animal Feed	Misr for Milk and Food	Damietta
Waste Reduction through improved Quality Control	Misr for Milk and Food	Mansoura
	Edfina for Preserved Foods	Alexandria

The findings of the audit programme and of the demonstration projects are presented in the following sections of this report.

Part A

THE FOOD PROCESSING SECTOR

Part A: The Food Processing Sector

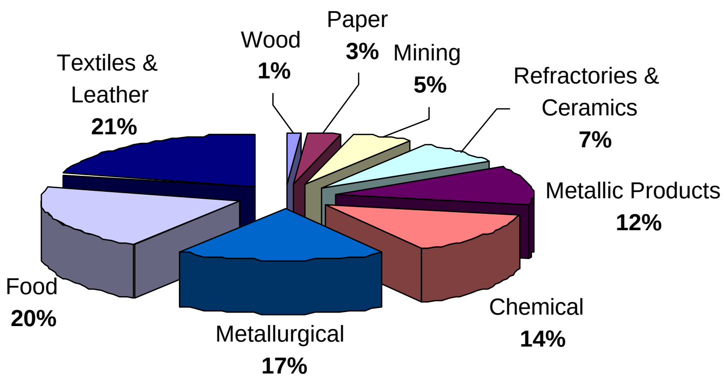
2.0 The Egyptian Food Processing Industry - A Profile

2.1 Introduction

The Egyptian 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 (i.e. those having a minimum manpower of 200) accounted for 20% of the total production value of the country, as shown in Figure 2.1. These establishments can be classified according to ownership; publicly owned factories, private factories and jointly owned factories. Most of the public food processing companies are affiliated to the Holding Company for Food Industries. The exceptions to this are:

- Grain-milling factories (affiliated to the Holding Company for dehusking and milling).
- Meat and poultry factories (affiliated to the Holding Company for agricultural development).
- Alcoholic beverages (affiliated to the Holding company for Tourism).

Figure 2.1
Distribution of Production Values by Sector (EP3 Report, 1995)



A privatisation plan has been set up by the government, in which most public sector food processing companies are to be sold either in the stock market or to investors. Dolce and Al-Ahram Beverages companies have been successfully privatised and Kaha for Preserved Food has been recently privatised. The privatisation plan specifies that money-losing factories are to be given priority in privatisation.

Public sector companies are labour intensive, which results in high overheads. Therefore, the privatisation process necessitates about 60% cut in manpower. This is manifested in the industrial establishments by a high degree of anxiety among workers, unclear chains of command and some confusion in responsibilities. Large and rapid changes are taking place which are affecting the morale of workers and managers.

These companies are facing a very big challenge: that of increasing their profit so they would not have to be sold. The management will therefore oppose any expenses however small unless absolutely necessary either by law or for maintenance purpose.

Private food processing sector companies are divided into:

- Big companies with large investments: these would usually have up-to-date equipment or have the necessary funds to renovate and rehabilitate old plants acquired from the public sector.
- Small enterprises: in the food processing industry: there are a large number of small facilities employing less than 10 persons and operating primitive dairy factories, or poultry and fish facilities.
- Medium scale factories: these could have either up-to-date equipment or obsolete technology.

2.2 Description of the Sector

2.2.1 General Structure

Three main sources of information have been used to develop this Food Processing Sector Report:

- Central Agency for Public Mobilisation and Statistics (CAPMAS).
- SEAM Project: Food Industry Sector Study, 1995 and factory audits, 1995-97.
- The Energy Conservation and Environmental Projects/ the Environmental Pollution Prevention Project (ECEP/EP3).

The Central Agency for Public Mobilisation and Statistics (CAPMAS), (1997) based on 1996 census. In this data the food sector (SIC code 15) is divided into subsectors based on type of product. The number of industrial establishments in a specific Governorate and the total manpower are provided for each subsector and classified by establishment size. The number of employees is chosen as an indicator to size of establishment. The data is repeated for all the Governorates.

Table 2.1 presents sector and subsector code definitions. This information is valuable for representing size distribution of facilities as well as geographic distribution. However, there is no financial data or type of ownership (public/private/joint).

Table 2.1
Code definition for sectors and subsectors

Sector code	Subsector code	Code definition
15		Food and beverages industry
	151	Fish and meat production and preservation
	152	Dairy products industries
	153	Grain milling, starch and animal fodder
	154	Other food industries
	155	Beverage industries

The SEAM Food Processing Sector Report incorporates information from a wide range of sources to show the status of the sector in 1995. It also describes how individual factories (described in section 1.4) were selected to take part in the SEAM Project. Industrial audits were also carried out in 10 food processing factories.

The Energy Conservation and Environmental Projects/ the Environmental Pollution Prevention Project (ECEP/EP3) produces the Egypt Industrial Profile. The profile covers a total of 637 plants (both public and private). The criteria for plant selection is a minimum manpower of 200 employees. Data collection was completed in 1995. This classification, in the food sector, includes tobacco industries. Table 2.2 defines the codes used and the type of production related to each code. This data provides information about capital cost and production value and is useful in comparing the public and private sectors.

Table 2.2
Subsector code definitions and type of products for the food sectors

Subsector Code	Description	Products
11	Slaughtering, preparation and preservation of meat poultry	Processed meat, frozen chicken, chicken broth
12	Dairy products	Ice cream, cheese butter, pasteurised yoghurt, dairy products
13	Canning and preservation of fruit/vegetables/cereals	Dehydrated vegetables, canning, preservation of foodstuffs, dried onions, potato chips, processed corn, preserved fruit/vegetables,/ cereals, jam, fruit juices, vegetables preparation, honey
14	Preparation, canning and preservation of fish/shellfish	Preserved fish
15	Animal & vegetable oils & fats	Linseed oil, edible oil, hydrogenated vegetable oil, ghee, laundry soap, glycerine, greasy acid, oil cake, oil extraction, palm oil, animal, vegetable, oil, fructose
16	Grain milling	Grain milling, flour
17	Baked goods	Baked goods, ice cream, bread, pastries, biscuit, cake, noodles
18	Sugar extraction & refining	Sugar, soap odours, perfumes, alcohol, yeast, molasses
19	Cocoa, chocolate & sweets	Chewing gum, sweets, chocolate, halawa, tahina, biscuits, tea, flour, jelly, homosiya, semsemiya
21	Other food products	Glucose, starch, crude vegetable oil, tea packing, food flavourings, fine sodium sulphate powder, detergent, yeast, jelly, custard, baking powder, packed food stuffs
22	Animal fodder	Animal fodder
33	Beer	Beer, malt
34	Non-alcoholic beverages	Carbonated water, soft drinks
40	Tobacco products	Tobacco, cigarettes, cigars, chewing tobacco

Table 2.3 provides an insight to the financial status of some large public sector companies. More detailed information about size and geographic distribution as well as the relative contribution of the private sector in production is presented in the following sections.

Table 2.3

ood Industries

Code	Name	Products	Financial Data in Millions of LE		
			Turnover	Exports	Imports
F09	Misr Milk & Food Company	Milk, various kinds of ghee (hard, white, soft, and processed), ice cream, natural ghee, yoghurt.	19	0.9	6.5
F10	Edfina Company for Preserved Foods	Canned fruit juices, jams, vegetables, tinned, jarred fish, frozen vegetables and fruit.	74	13	13
F11	Kaha Company for Preserved Foods**	Natural juices, jams, honey, natural and industrial syrups, dry dates, raisins, frozen fruits, salted vegetable pickles, tomato products, tins	97	16	16
F12	Egyptian Company for Food (BISCOMISR)	Biscuits, wafers, chocolates, confectioneries, chewing gum, mint.	115	5.5	3.5
F13	Alexandria Confectionery, Chocolate Company	Chocolate, confectioneries, biscuits, wafers, sweets	34	1	4
F14	Egyptian Starch, Yeast & Detergents Company	Glucose, sodium sulphate, starches for textile sizing, edible starch, detergents (high and low foam), active and dry yeast, textile auxiliaries	73	0.6	12
F15	Egyptian Starch & Glucose Manufacturing Company	Food, starch, glucose	133	3.9	70
F16	El Nasr Company for Dehydrating	Dehydrated chopped onion, sliced onion, and onion powder, dehydrated garlic and leeks, tomato powder, onion oil	25	24.5	0.5
F17	Egyptian Company for Fish Marketing	Fish	*	*	*
F18	North Cairo Flour Mills	Flour	*	*	*
F19	Middle Egypt Mills	Flour	*	*	*
F20	Egyptian company for Packaging & Distribution of Food Stuffs (SHEMTO)	Food packaging materials	*	*	*

* Information not available
** Companies privatised since 1996

2.2.2 Size Distribution of Enterprises

The data of the Central Agency for Public Mobilisation and statistics (CAPMAS), have been used to represent the size distribution of the food processing facilities according to manpower and number of facilities.

Figures 2.2a and 2.2b represent the size distribution in terms of number of facilities and manpower respectively for the whole food processing sector, whereas Figure 2.3 gives the distribution of the subsectors as well. It is clear from Figure 2.2 that the majority of the food processing enterprises, fall in the small scale category.

These figures also demonstrate that a large number of facilities (9,785) are operated with a manpower from 5-9 persons per facility. In total, these have the highest number of workers (62,470) in the sector. Medium scale enterprises range from 50-499 employees, representing 19% of total food sector manpower. Small-scale enterprises having from 1 to 49 workers employ a manpower of (166,085), representing 55% of the total food sector manpower. 26% of employees work in large-scale factories with over 500 employees each.

Most of the large-scale factories are labour intensive. Public facilities are expected to reduce their manpower in the next couple of years. This will increase the contribution of the small and medium enterprises in economic activity and employment.

Figure 2.2a
Sizing of the Food Processing Sector by Number of Facilities

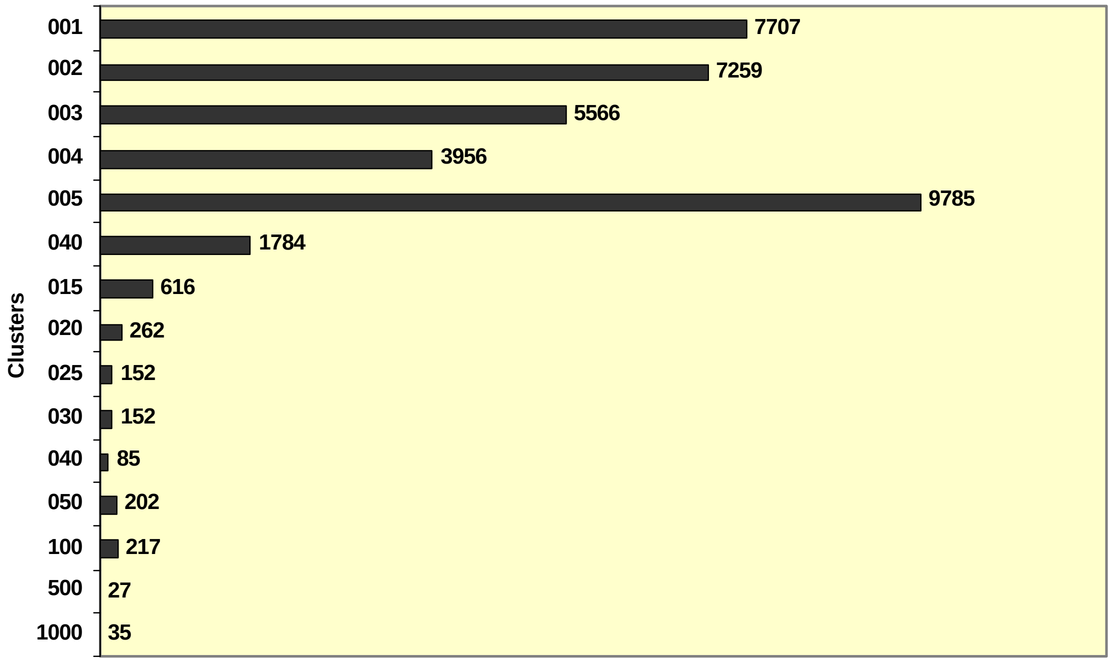


Figure 2.2b
Sizing of the Food Processing Sector by Manpower

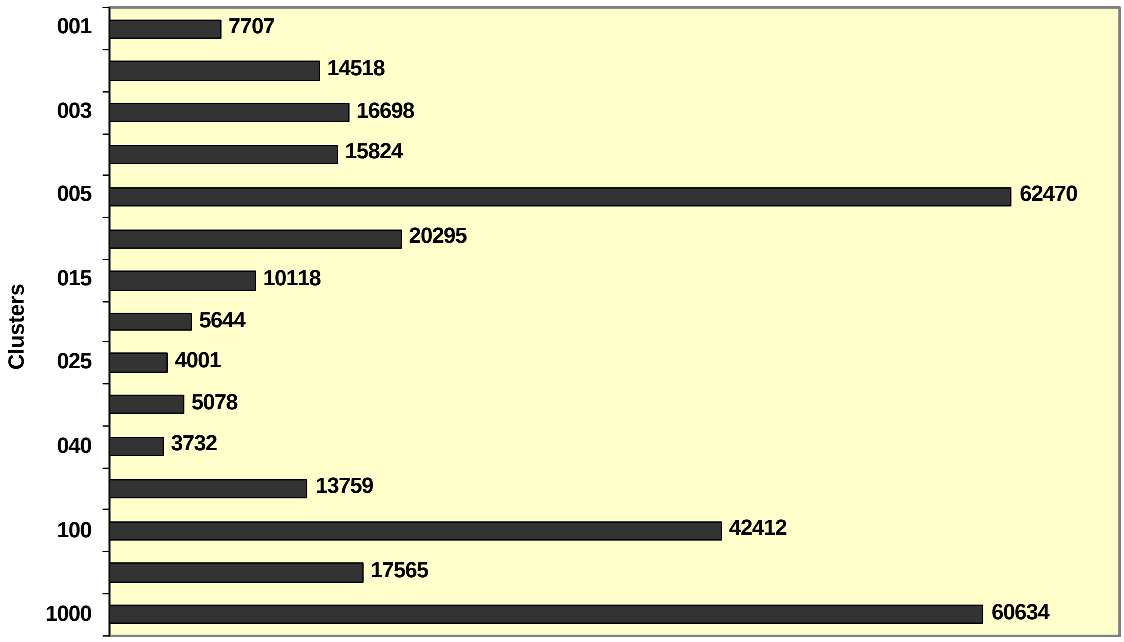
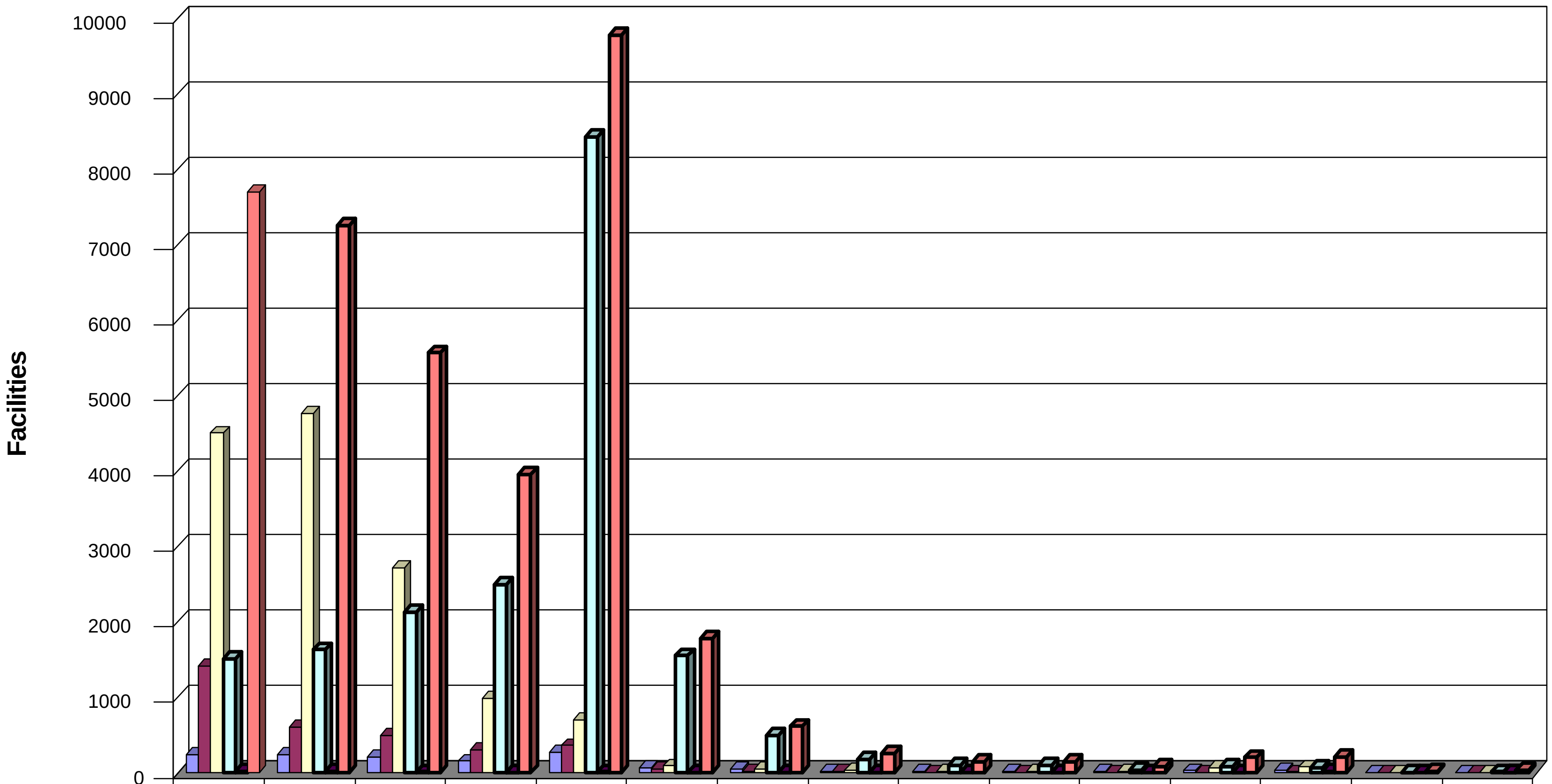
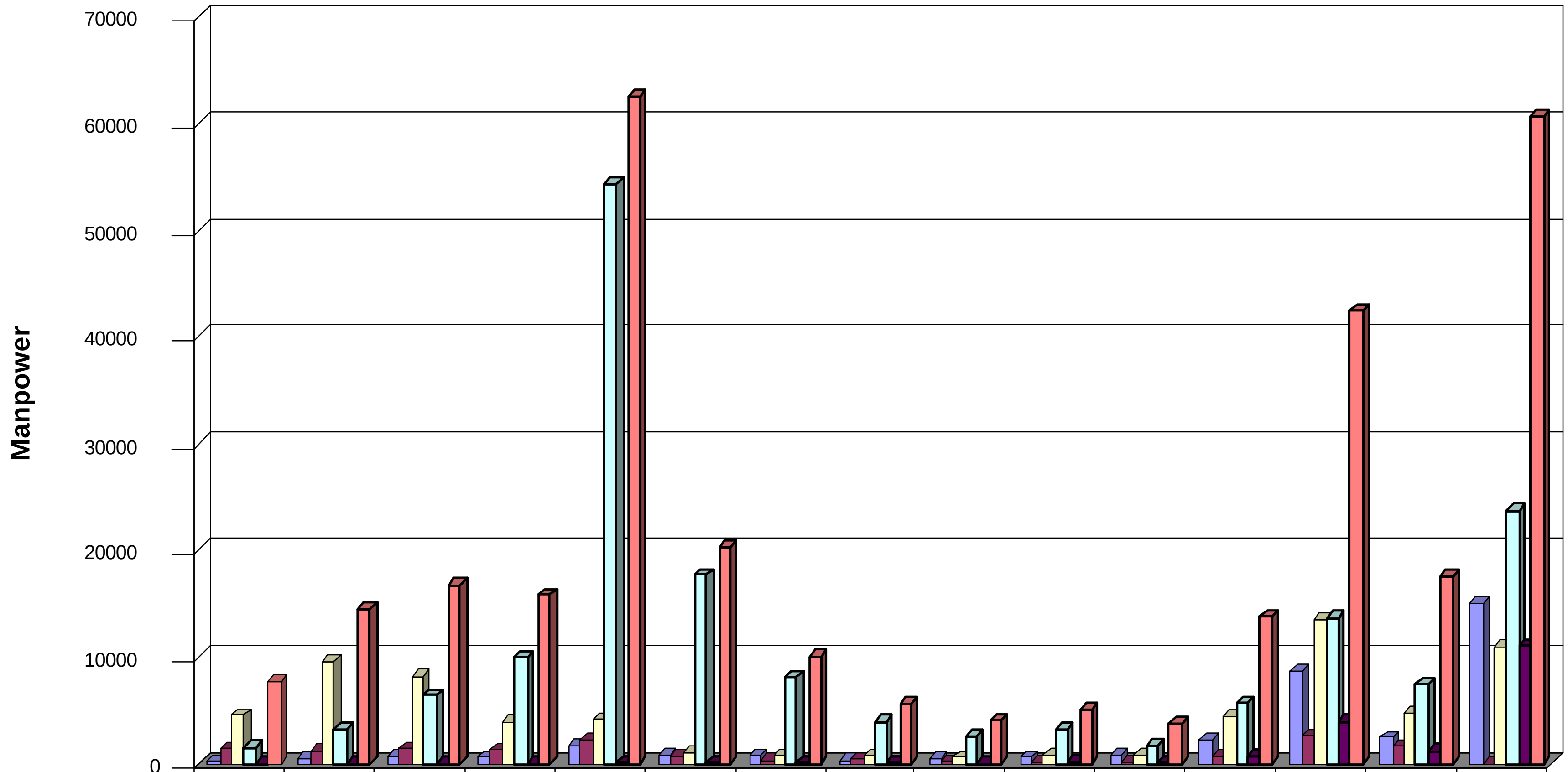


Figure 2.3a Size Distribution of Sub-Sectors in Terms of Number of Facilities



	1	2	3	4	5	10	15	20	25	30	40	50	100	500	1000
151	244	244	214	157	278	74	49	18	21	17	19	31	40	4	7
152	1419	603	494	312	362	57	21	20	10	6	4	11	12	3	0
153	4506	4761	2718	989	700	92	48	37	24	26	21	64	77	7	6
154	1516	1631	2128	2491	8430	1554	492	183	97	98	39	85	72	11	15
155	22	20	12	7	15	7	6	4	0	5	2	11	16	2	7
15	7707	7259	5566	3956	9785	1784	616	262	152	152	85	202	217	27	35

Figure 2.3b Size Distribution of Sub-Sectors in Terms of Facilities



	1	2	3	4	5	10	15	20	25	30	40	50	100	500	1000
151	244	488	642	628	1733	847	795	380	561	579	819	2187	8716	2485	14987
152	1419	1206	1482	1248	2169	643	336	434	258	184	181	732	2659	1635	0
153	4506	9522	8154	3956	4179	1052	773	794	622	881	906	4392	13517	4814	10912
154	1516	3262	6384	9964	54291	17671	8115	3951	2560	3263	1731	5722	13641	7420	23690
155	22	40	36	28	98	82	99	85	0	171	95	726	3879	1211	11045
15	7707	14518	16698	15824	62470	20295	10118	5644	4001	5078	3732	13759	42412	17565	60634

2.2.3 Geographic Distribution

The geographic distribution of the food processing sector (SIC 15) among Governorates is shown in Figures 2.4a and 2.4b in terms of number of facilities and in terms of manpower. A breakdown by subsector is shown in figures 2.5a and 2.5b. The Luxor, Aswan, Sinai, Matrouh and Red Sea Governorates currently have a negligible number of food processing industries.

Figure 2.4a
The Geographic Distribution of Food Processing Sector in Terms of Number of Facilities

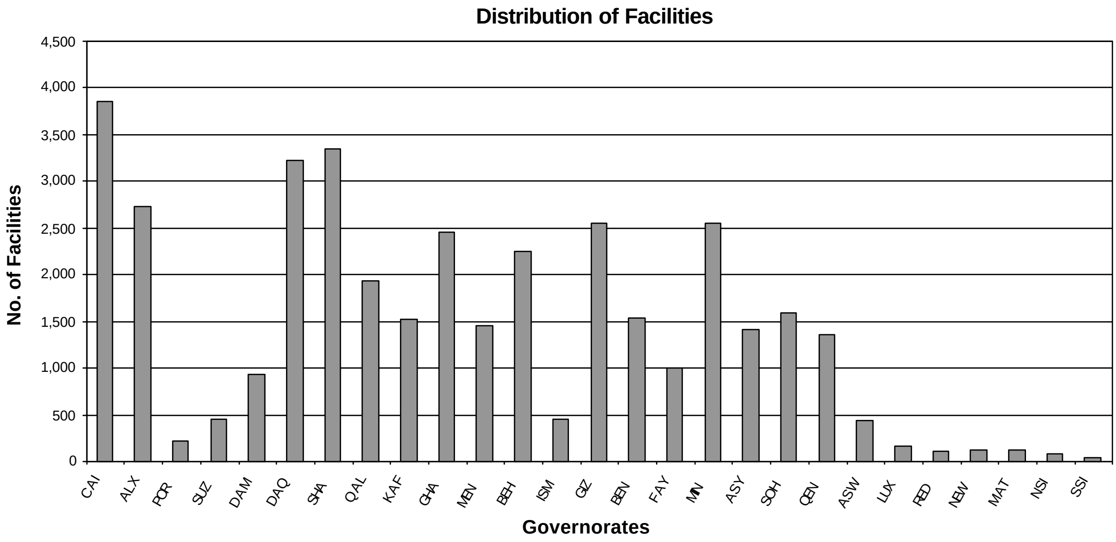


Figure 2.4b
The Geographic Distribution of Food Processing Sector in Terms of Manpower

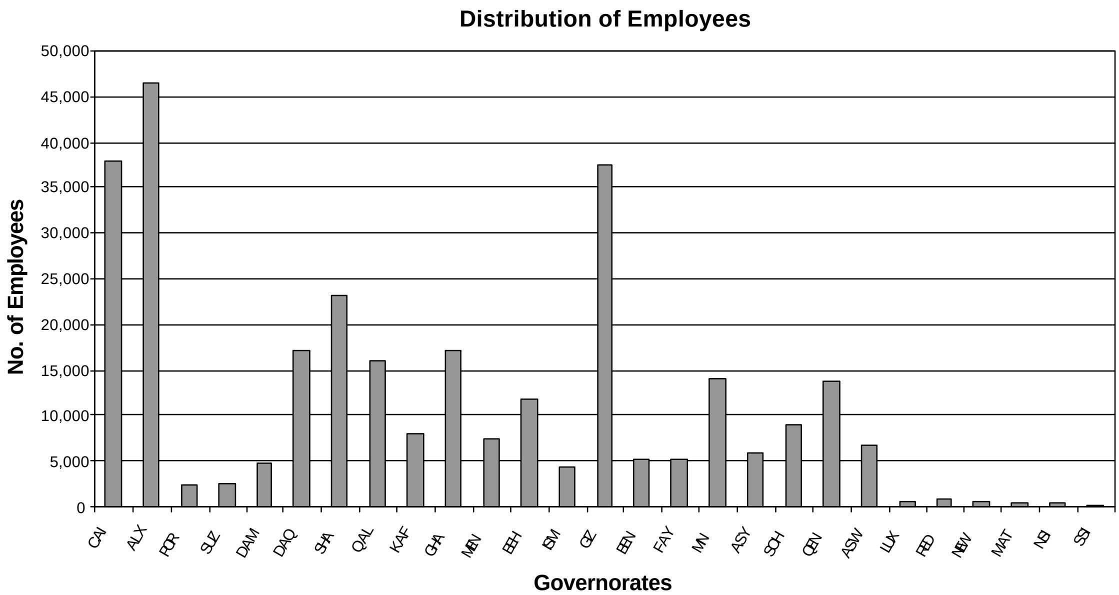
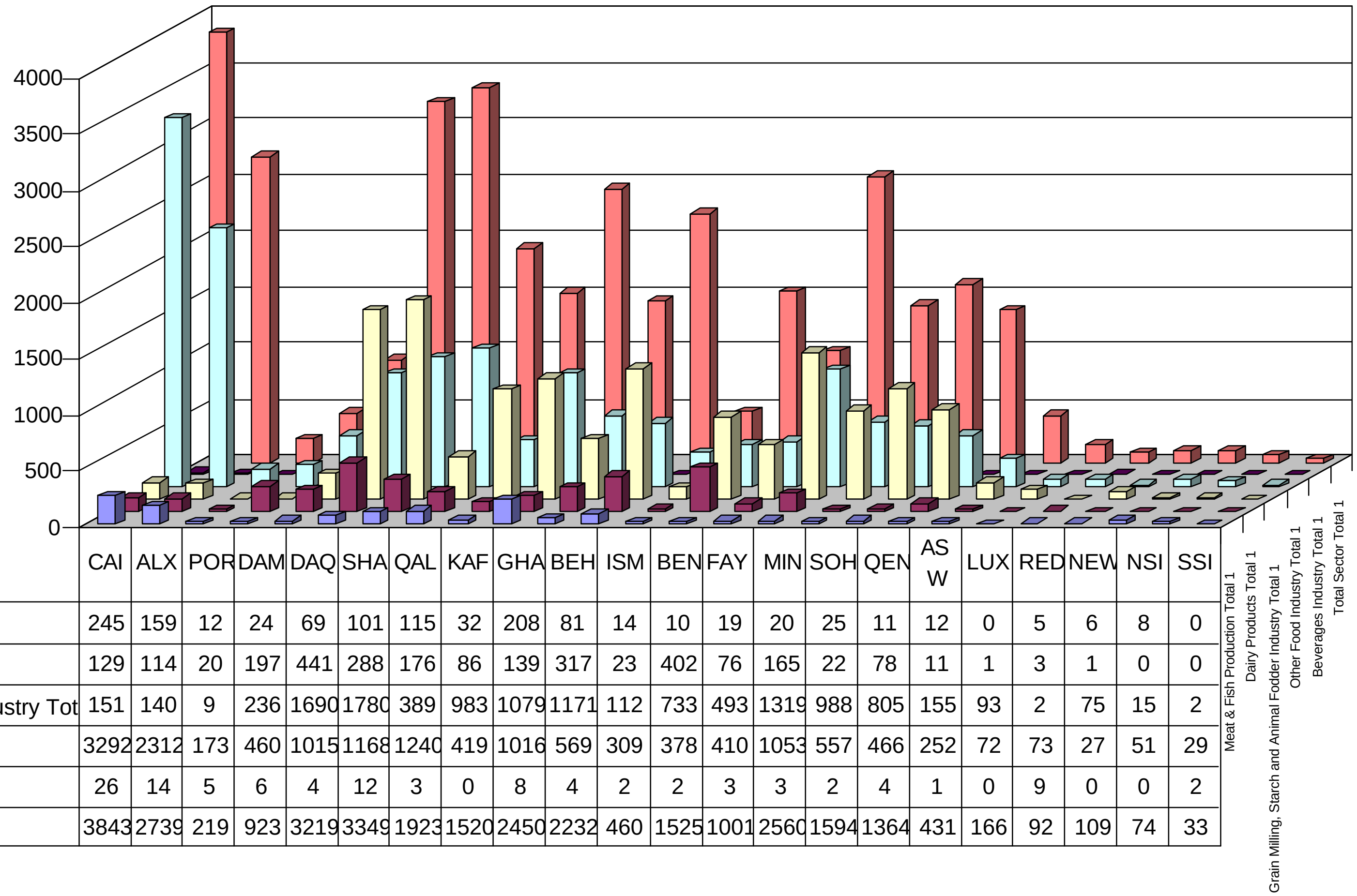
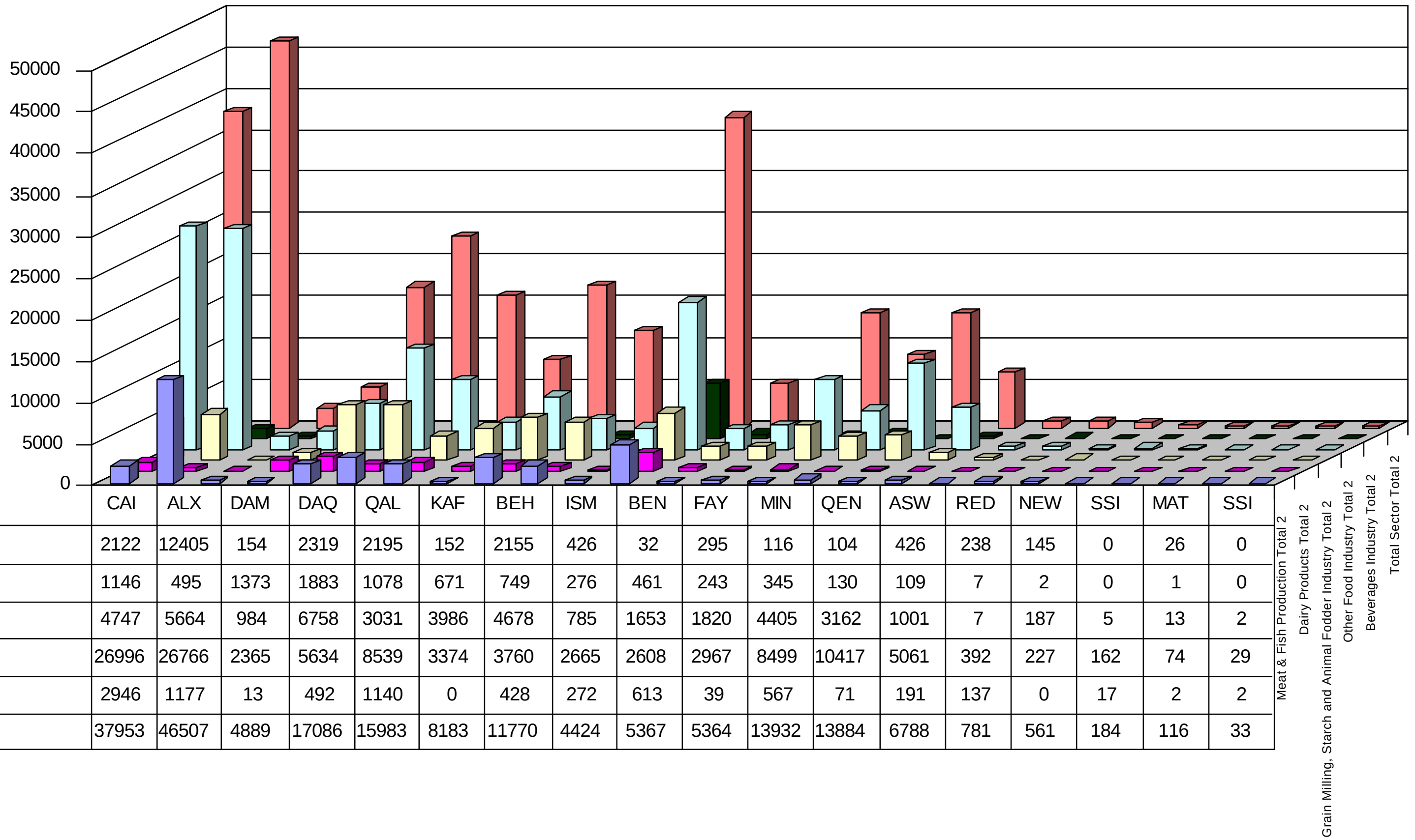


Figure 2.5a Three Dimensional Distribution for Facilities and Sub-Sectors per Governorate



	CAI	ALX	POR	DAM	DAQ	SHA	QAL	KAF	GHA	BEH	ISM	BEN	FAY	MIN	SOH	QEN	AS W	LUX	RED	NEW	NSI	SSI
Meat & Fish Production Total 1	245	159	12	24	69	101	115	32	208	81	14	10	19	20	25	11	12	0	5	6	8	0
Dairy Products Total 1	129	114	20	197	441	288	176	86	139	317	23	402	76	165	22	78	11	1	3	1	0	0
Grain Milling, Starch and Animal Fodder Industry Tot	151	140	9	236	1690	1780	389	983	1079	1171	112	733	493	1319	988	805	155	93	2	75	15	2
Other Food Industry Total 1	3292	2312	173	460	1015	1168	1240	419	1016	569	309	378	410	1053	557	466	252	72	73	27	51	29
Beverages Industry Total 1	26	14	5	6	4	12	3	0	8	4	2	2	3	3	2	4	1	0	9	0	0	2
Total Sector Total 1	3843	2739	219	923	3219	3349	1923	1520	2450	2232	460	1525	1001	2560	1594	1364	431	166	92	109	74	33

Figure 2.5b Three Dimensional Distribution for Manpower and Sub-Sectors perGovernorate



	CAI	ALX	DAM	DAQ	QAL	KAF	BEH	ISM	BEN	FAY	MIN	QEN	ASW	RED	NEW	SSI	MAT	SSI
Meat & Fish Production Total 2	2122	12405	154	2319	2195	152	2155	426	32	295	116	104	426	238	145	0	26	0
Dairy Products Total 2	1146	495	1373	1883	1078	671	749	276	461	243	345	130	109	7	2	0	1	0
Grain Milling, Starch and Animal Fodder Industry Total 2	4747	5664	984	6758	3031	3986	4678	785	1653	1820	4405	3162	1001	7	187	5	13	2
Other Food Industry Total 2	26996	26766	2365	5634	8539	3374	3760	2665	2608	2967	8499	10417	5061	392	227	162	74	29
Beverages Industry Total 2	2946	1177	13	492	1140	0	428	272	613	39	567	71	191	137	0	17	2	2
Total Sector Total 2	37953	46507	4889	17086	15983	8183	11770	4424	5367	5364	13932	13884	6788	781	561	184	116	33

2.2.4 Public/Private Affiliation

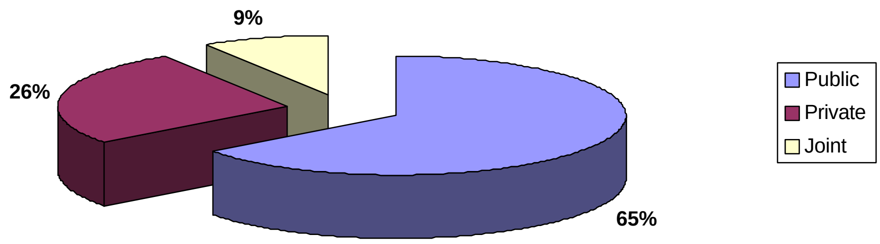
For facilities with a minimum manpower of 200, about 60% belong to the public sector, 34% to the private sector and 6% are jointly owned (Egypt Industrial Profile, 1995).

Figure 2.6 shows the manpower distribution among public, private and joint ownership facilities. Figures 2.7 and 2.8 present the capital cost and product value distributions respectively. These figures show that 65% of the manpower is employed by the public sector and illustrates the difficulties encountered in privatisation when reducing manpower. However comparison between the production value per worker in public factories (LE 0.8/worker), joint ventures (LE0.67/worker) and private sector facilities (LE1.5/worker) shows the importance of the privatisation step.

The fixed assets are also much larger in the public sector with respect to the share in production value, which is also an added cause in favour of privatisation. However, most of these fixed assets are in the form of land owned by these companies in areas, which have been increasing in value.

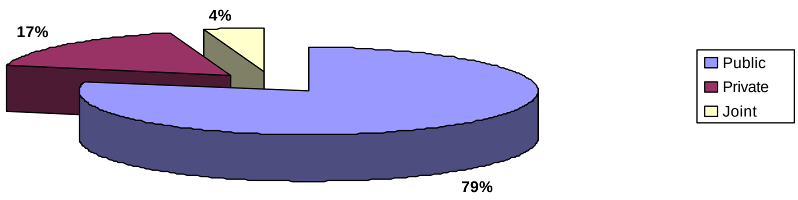
Figure 2.6

Manpower Distribution by Type of Ownership



Total Manpower	
Public	34,865
Private	14,100
Joint	4,837

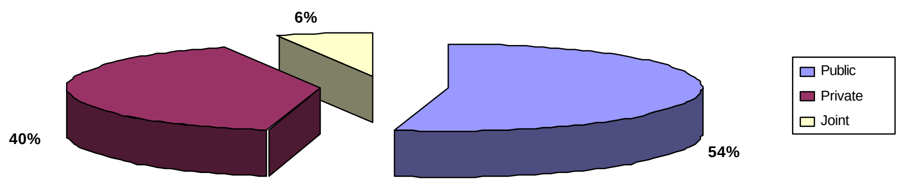
Figure 2.7
Capital Cost Distribution by Type of Ownership



Capital Cost (LE)	
Public	2,702,855,623
Private	593,903,784
Joint	146,015,509

Figure2.8

Product Value Distribution by Type of Ownership

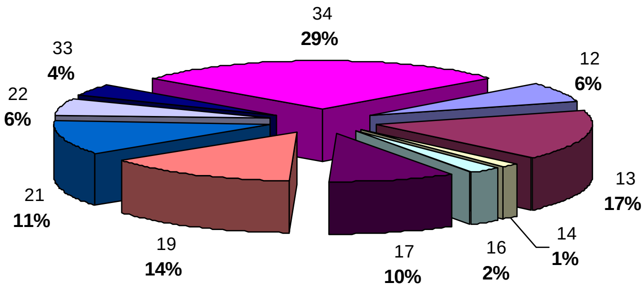


Product Value (LE)	
Public	1,525,348,081
Private	1,158,305,493
Joint	177,993,950

2.2.5 Economic Activity and Profitability Comments

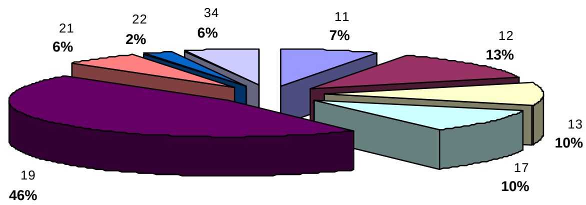
According to Figures 2.9 - 2.11, the biggest employer is the non-alcoholic beverage subsector with respect to the public and joint sectors. With respect to the private sector, the chocolate and sweets subsector is the largest in number of terms of employees.

Figure 2.9
Manpower Distribution for Public Ownership Facilities



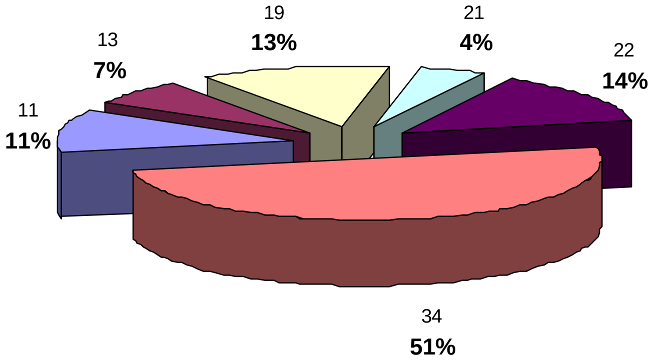
Subsector	Description	Total Manpower
12	Dairy Products	2,264
13	Fruit and Vegetable Canning	5,908
14	Fish	465
16	Grain Milling	851
17	Baked Goods	3,325
19	Chocolate and Sweets	5,027
21	Other Food Products	3,813
22	Animal Fodder	1,953
33	Alcoholic Beverages	1,391
34	Non-Alcoholic Beverages	9,868
	Total	**34,865**

Figure 2.10
Manpower Distribution for Private Ownership Facilities



Subsector	Description	Total Manpower	%
11	Meat and Poultry	1,029	7
12	Dairy Products	1,772	13
13	Fruit and Vegetable Canning	1,437	10
17	Baked Goods	1,442	10
19	Chocolate and Sweets	6,526	46
21	Other Food Products	801	6
22	Animal Fodder	303	2
34	Non-Alcoholic Beverages	790	6
	Total	**14,100**	**100**

Figure 2.11
Manpower Distribution for Joint Ownership Facilities

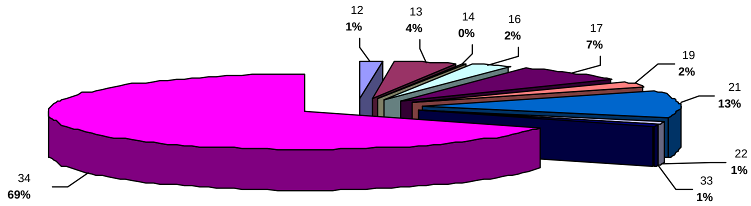


Subsector	Description	Manpower	%
11	Meat and Poultry	540	11
13	Fruit and Vegetable Canning	332	7
19	Chocolate and Sweets	638	13
21	Other Food Products	204	4
22	Animal Fodder	683	14
34	Non-Alcoholic Beverages	2,440	51
	Total	**4,837**	**100**

The most important subsector with respect to capital employed (Figures 2.12 - 2.14) is non-alcoholic beverages for the public sector and chocolate and sweets for both the private and joint sectors. However, the food products sectors in case of public facilities, chocolate and sweets in case of private facilities and animal fodder in case of the joint ownership facilities (figures 2.15-2.17).

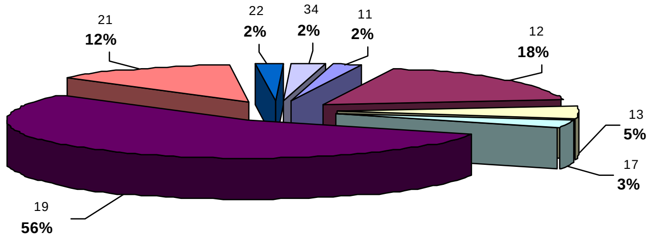
Figure 2.12

Capital Cost Distribution for Public Ownership Facilities



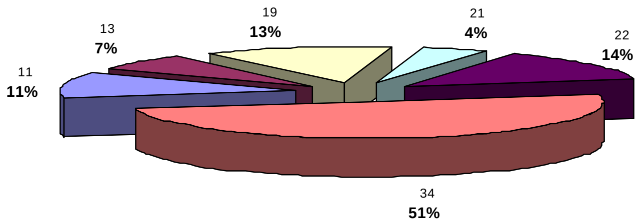
Subsector	Description	Capital Cost (LE)
12	Dairy Products	35,410,846
13	Fruit and Vegetable Canning	109,644,967
14	Fish	2,039,550
16	Grain Milling	66,901,319
17	Baked Goods	201,712,685
19	Chocolate and Sweets	67,380,458
21	Other Food Products	316,731,557
22	Animal Fodder	36,854,245
33	Alcoholic Beverages	22,785,460
34	Non-Alcoholic Beverages	1,843,394,536
	Total	2,702,855,623

Figure 2.13
Capital Cost Distribution for Private Ownership Facilities



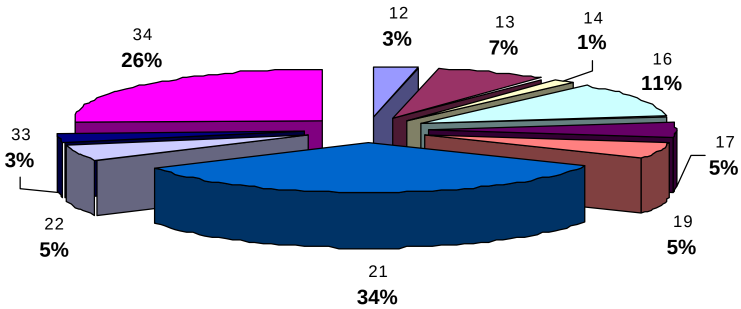
Subsector	Description	Capital Cost (LE)	%
11	Meat and Poultry	10,892,350	2
12	Dairy Products	109,397,205	18
13	Fruit and Vegetable Canning	27,616,313	5
17	Baked Goods	20,001,726	3
19	Chocolate and Sweets	328,841,698	56
21	Other Food Products	71,903,839	12
22	Animal Fodder	11,358,793	2
34	Non-Alcoholic Beverages	13,891,860	2
	Total	**593,903,784**	**100**

Figure 2.14
Capital Cost Distribution for Joint Ownership Facilities



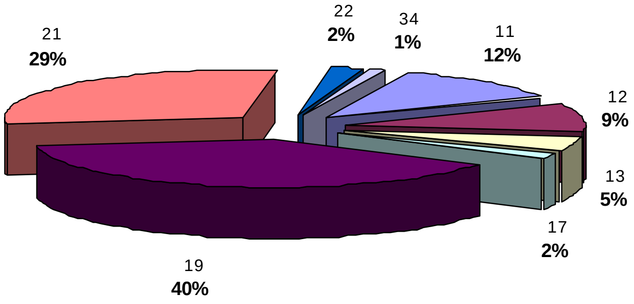
Sector	Description	Cost (LE)	%
11	Meat and Poultry	29,682,123	20
13	Fruit and Vegetable Canning	14,763,009	10
19	Chocolate and Sweets	49,515,000	34
21	Other Food Products	5,444,000	4
22	Animal Fodder	11,698,365	8
34	Non-Alcoholic Beverages	34,913,012	24
	Total	**146,015,509**	**100**

Figure 2.15
Product Value Distribution for Public Ownership Facilities



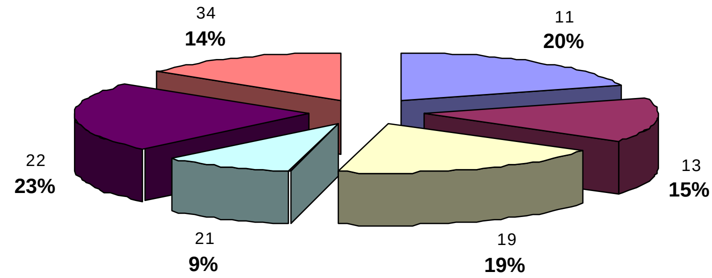
Subsector	Description	Product Value (LE)
12	Dairy Products	48,440,910
13	Fruit and Vegetable Canning	107,518,323
14	Fish	20,650,000
16	Grain Milling	171,188,686
17	Baked Goods	76,167,082
19	Chocolate and Sweets	78,339,750
21	Other Food Products	510,815,373
22	Animal Fodder	72,441,777
33	Alcoholic Beverages	48,265,916
34	Non-Alcoholic Beverages	391,520,264
	Total	1,525,348,081

Figure 2.16
Product Value Distribution for Private Ownership Facilities



Subsector	Description	Product Value (LE)	%
11	Meat and Poultry	141,649,000	12
12	Dairy Products	107,733,588	9
13	Fruit and Vegetable Canning	55,962,431	5
17	Baked Goods	21,119,220	2
19	Chocolate and Sweets	453,806,254	39
21	Other Food Products	340,512,000	29
22	Animal Fodder	24,123,000	2
34	Non-Alcoholic Beverages	13,400,000	1
	Total	**1,158,305,493**	**100**

Figure 2.17
Product Value Distribution for Public Ownership Facilities



Subsector	Description	Product Value (LE)	%
11	Meat and Poultry	350,00,000	20
13	Fruit and Vegetable Canning	264,40,205	15
19	Chocolate and Sweets	333,53,000	19
21	Other Food Products	164,15,000	9
22	Animal Fodder	409,78,745	23
34	Non-Alcoholic Beverages	258,07,000	14
	Total	**177,993,950**	**100**

3.0 Food Processing Industry: A Sub-Sector Analysis for Selected Sectors

CAPMAS data are used as a basis for sub-sector analysis. Tables 3.1 and 3.2 show that greater Cairo and Alexandria have about 25% of the food processing facilities with 40% of the total manpower employed in the food processing sector. Greater Cairo and Alexandria

clear that the Delta region has the highest number of industrial facilities and manpower. Developments of Upper Egypt with provide a better distribution with higher employment opportunities.

Table 3.1
Nation-wide Distribution of Facility Type, by Governorate

Governorate	Meat and fish	Dairy	Grain milling, starch, animal fodder	Other foods	Beverages	TOTAL	%
Cairo	245	129	151	3,292	26	3,843	10.17
Sharkeya	101	288	1,780	1,168	12	3,349	8.86
Dakahleya	69	441	1,690	1,015	4	3,219	8.51
Alexandria	159	114	140	2,312	14	2,739	7.25
Minya	20	165	1,319	1,053	3	2,560	6.77
Giza	138	198	305	1,898	19	2,558	6.77
Gharbeya	208	139	1,079	1,016	8	2,450	6.48
Behira	81	317	1,171	659	4	2,232	5.90
Qalubeya	115	176	389	1,240	3	1,923	5.09
Sohag	25	22	988	557	2	3,843	4.22
Beni Suef	10	402	733	378	2	1,525	4.03
Kafr El-Sheikh	32	86	983	419	0	1,520	4.02
Minya	45	211	543	644	3	1,446	3.82
Assyut	15	14	786	593	2	1,410	3.73
Qena	11	78	805	466	4	1,364	3.61
Fayoum	19	76	493	410	3	1,001	2.65
Damietta	24	197	236	460	6	923	2.44
Ismailia	14	23	112	309	2	460	1.22
Suez	17	221	9	202	0	449	1.19
Aswan	12	11	155	252	1	431	1.14
Port Said	12	20	9	173	5	219	0.58
Luxor	0	1	93	72	0	166	0.44
Matrouh	26	1	13	74	2	116	0.31
New Valley	6	1	75	27	0	109	0.29
Red Sea	5	3	2	73	9	92	0.2
North Sinai	8	0	15	51	0	74	0.20
South Sinai	0	0	2	29	2	33	0.09
TOTAL	**1,417**	**3,334**	**14,076**	**18,842**	**136**	**37,805**	**100**

Source: 1996 Census

Table 3.2
Nation-wide Distribution of Labour, by Governorate

Governorate	Meat and fish	Dairy	Grain milling, starch, animal fodder	Other foods	Beverages	TOTAL	%
Cairo	2,122	1,146	4,747	26,996	2,946	37,957	12.63
Sharkeya	3,084	967	6,698	12,315	96	23,160	7.71
Dakahleya	2,319	1,883	6,758	5,634	492	17,086	5.69
Alexandria	12,405	495	5,664	26,766	1,177	46,507	15.48
Minya	116	345	4,405	8,499	567	13,932	4.64
Giza	4,705	2,362	5,896	17,798	6,655	37,416	12.45
Gharbeya	2,988	875	5,278	6,449	1,511	17,101	5.69
Behira	2,155	749	4,678	3,760	428	11,770	3.92
Qalubeya	2,195	1,078	3,031	8,539	1,140	15,983	5.32
Sohag	458	101	2,926	4,800	653	8,938	2.97
Beni Suef	32	461	1,653	2,608	613	5,367	1.79
Kafr El-Sheikh	152	671	3,986	3,374	0	8,183	2.72
Minya	267	526	2,132	4,272	241	7,438	2.48
Assyut	109	113	2,332	3,360	2	5,916	1.97
Qena	104	130	3,162	10,417	71	13,884	4.62
Fayoum	295	243	1,820	2,967	39	5,364	1.79
Damietta	154	1,373	984	2,365	13	4,889	1.63
Ismailia	426	276	785	2,665	272	4,424	1.47
Suez	702	586	227	1,193	0	2,708	0.90
Aswan	426	109	1,001	5,061	191	6,788	2.26
Port Said	416	68	109	1,570	234	2,397	0.80
Luxor	0	16	312	420	0	748	0.25
Matrouh	56	4	51	312	122	545	0.18
New Valley	145	2	187	227	0	561	0.19
Red Sea	238	7	7	392	137	781	0.26
North Sinai	22	0	146	260	0	428	0.14
South Sinai	0	0	5	162	17	184	0.06
TOTAL	**36,091**	**14,586**	**68,980**	**163,181**	**17,617**	**300,455**	**100**

Source: 1996 Census

3.1 Fruits and Vegetables

A wide range of citrus fruits is grown in Egypt, including oranges, tangerines, clementines, satsumas, grapefruits, lemons and limes, in addition to pineapples, bananas, apricots, apples, melons and watermelons, mangoes and guavas, as well as other exotic fruits such as kiwi-fruit and papayas. The volumes produced in Egypt from 1987-1992 are shown in Table 3.3.

Table 3.3
Production of Fruits and Vegetables, 1987-1992 (1,000 tonnes)

Type of Crop	1987	1988	1989	1990[a/]	1991[a/]	1992[b/]
Apples	31	44	45	173	176	
Apricots	29	33	42	38	25	
Bananas	278	355	388	408	442	
Dates	542	494	572	542	603	
Figs	25	31	39	88	78	
Grapes	510	557	621	694	636	
Guavas	196	184	235	265	263	
Lemons	208	235	238	411	418	
Mangoes	106	99	129	144	152	
Olives	29	31	32	62	65	
Oranges	1,387	1,199	1,389	1,636	1,964	
Peaches	32	33	33	74	89	
Pears	62	52	73	55	52	
Plums	35	35	49	46	27	
Pomegranates	20	17	24	24	28	
Strawberries	20	24	26	43	30	25
Sweet lemons	1	1	1	2	3	
Tangerines	134	151	170	278	298	
Other	42	34	38	36	29	
Fruits total	**3,687**	**3,609**	**4,144**	**5,019**	**5,378**	
Artichokes	53	45	83	74	67	43
Aubergines	431	371	364	385	415	343
Cabbages	431	460	347	381	424	436
Carrots	116	94	94	92	93	90
Cauliflower	113	101	71	86	83	96
Green peppers	261	262	242	271	282	234
Haricot beans, dry	28	19	21	24	31	20
Haricot beans, fresh	157	122	114	123	148	129
Kidney beans, dry	7	6	5	7	10	5
Kidney beans, fresh	21	28	13	15	16	23
Lettuce	132	124	111	121	118	125
Marrows	436	419	368	347	396	342
Melons	163	163	183	138	138	132
Okra	64	60	56	64	67	65
Parsley	43	41	44	65	64	67
Peas, dry	6	7	7	3	1	3
Peas, fresh	89	96	90	100	101	174
Radishes	15	17	14	15	13	15
Cucumbers	275	265	290	267	278	298
Spinach	50	51	37	39	40	36
Sweet potatoes	63	116	55	102	128	90
Taro	107	93	125	99	118	128
Tomatoes	4,921	4,212	3,997	4,234	3,806	4,697
Turnips	756	81	52	49	53	58
Water melons	1,370	1,165	1,000	1,007	894	712
Other	228	223	209	286	250	282
Vegetables Total	**10,336**	**8,641**	**7,992**	**8,394**	**8,034**	**8,643**

Source: Central Agency for Public Mobilisation and Statistics (CAPMAS).

Notes: (a) Including Nobaria area
(b) Preliminary estimates

Vegetable cultivation is extensive, and the favourable climatic conditions in the country allowing the production of two or more crops a year. Glasshouse cultivation, along with the use of irrigation on reclaimed land is also expanding, as private-sector investments in agriculture are liberalised. Crops include tomatoes (4.7 million tonnes in 1992), carrots, cauliflowers, cabbages, aubergines and green beans. Sugar production, using both cane and beet, is also rising, and amounted to about 1 million tonnes by the end of the 1980s.

The production of preserved vegetables rose significantly from 7.3 million tonnes in 1986/87 to 10.7 million tonnes in 1990/91, but declined marginally to 10.2 million tonnes in 1991/92. The production of canned vegetables also recorded a similar trend, rising significantly for several consecutive years until 1990/91 (see Table 3.4).

Table 3.4
Production of preserved and canned vegetables, 1952-1991/92 (tonnes)

	1952	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
Preserved vegetables	-	7,238	8,484	9,689	9,324	10,700	10,225
Canned vegetables	600	7,430	4,941	5,118	7,162	8,061	7,960

Source: Central Agency for Public Mobilisation and Statistics (CAPMAS)

There are two large public sector companies for fruit and vegetable processing. Kaha Company for Preserved Food and Edfina Company. Each includes a number of factories (6 for Kaha and 5 for Edfina).

These companies produce canned vegetables and beans, fruit juices, tomato paste and frozen vegetables. There are also a number of private facilities producing juices, tomato paste and frozen vegetables. The processing steps are very similar throughout the sub-sector:

- Fruits and vegetables are sorted and washed, and then peeled and squeezed as necessary. Cooking is carried out in pressure cookers using steam. The old production lines use open sterilisers which release large amounts of steam causing hot, humid working conditions.
- More modern equipment uses closed sterilisers with proper ventilation systems. These industries are characterised by the generation of large amounts of solid organic wastes: fruit and vegetable peels, discarded material.
- Wastewater has relatively high COD, BOD, and suspended solids.
- Tight process control on the equipment will reduce loss of products as waste by producing higher quality goods.

3.2 Dairy Products

According to the data from the bureau of statistics the number of dairy product facilities is about 9% of the overall food sector (SIC code 15) and 15.9% in terms of manpower.

Stocks of cattle numbered 1.95 million and of water buffalo 2.65 million in 1989. Buffaloes account for around 55 68% of total milk production. Local Baladi cows and imported Friesian cows account for 45 dairy herd. Small farmers owning less than 3 acres of land account for over 70 total milk production. Large commercial dairy farms sell much of their output to Misr Dairy, a state-owned enterprise manufacturing dairy products. Currently, local production meets only 60% of domestic milk requirements. There is a need to expand large-scale commercial dairy farms in order to cope with the rising demand for dairy products.

Problems in obtaining sufficient feed are thought to have reduced commercial stocks of sheep and goats, which were estimated to have numbered 1.32 million and 1.65 million respectively in 1989, although there are some indications that villagers with access to home-grown corn supplies actually expanded their livestock. Stocks of both cattle and of water buffalo were less severely hit, as farmers bought more expensive feedstuffs, such as berseem, to replace the previously subsidised imports.

Production of milk during 1980-1990 rose to 2.3 million tonnes, up from 1.2 million tonnes, and of eggs from 2 to 3 billion. Removal of subsidies on imported feed for poultry caused output in this subsector to decline sharply in 1988, but production had rebounded to about 250,000 tonnes in 1989, exceeding the peak of 216,000 tonnes achieved in 1987 when output was heavily dependent on imported feed.

Data obtained from the Chamber of Food Industries, as reported by its members, show production, export and import figures in volume and value terms for the year 1989/90, the latest year for which reliable data is available (see Table 3.5). Apart from fresh milk production, cheese production constitutes an important processing activity. A large

production of cheese. The major share of total cheese production is made on farms for local consumption. Both commercial and home-made white cheese account for over 80% of cheese production in Egypt. According to rough estimates, local production of cheese stood at 295,000 tonnes in 1992 and an output of 300,000 tonnes was forecast for 1993.

Although butter is produced on a large commercial scale, Egypt currently imports 30,000-35,000 tonnes of butter annually. Imports include around 14,000 tonnes of butter oil, most of which originates from the European Union. Domestic consumption of butter rose significantly from 44,000 tonnes in 1992 to 50,000 tonnes in 1992. Public-and private-sector companies have the installed capacity to turn out 1.9 million tonnes of dairy products per year, but current production is only 500,000 tonnes.

Table 3.5
Output, Imports and Exports of Milk and Dairy Products, 1989/1990[a/]
(quantity in tonnes and value in thousand LE)

	Output		Imports		Exports	
	Quantity	Value	Quantity	Value	Quantity	Value
Fresh milk	21,877	16,919			52	544
Sweetened powder milk			1,105	6,072	3	9
Unsweetened powder milk			13,138	82,436	1	4
Sweetened condensed milk					4	54
Unsweetened condensed milk					4	4
Yoghurt	3,667	5,076				
Soft cheese	3,667	5.0	27,600	78,954	1,787	6,159
Hard cheese	9,908	68,617	4,224	20,909	708	4,968
Processed cheese	2,308	11,604				
Ice cream	2,651	6,387				
Butter and natural butter oil			48,099	273,464	35	207
Fresh, not concentrated or sweetened, milk and cream			22	135	63	68
Preserved or concentrated or sweetened or powder milk and cream			14,243	88,507	12	72

Note: Data in this table refers only to quantities produced and traded by members of the Chamber.
Source: Chamber of food industries, Cairo

The progressive expansion of the private sector is an important feature of the dairy industry. After the dairy industry was opened to private investment in 1974, private investment expanded rapidly and quickly captured 80% of the market of the public-sector enterprise, Misr Dairy Products.

One of the major constraints is the country limited land base with no permanent pastures. Animals are fed in confinement with high capital and input costs. Shortage of good quality feed is yet another constraint on the development of dairy farms. To keep pace with the steadily rising demands of the growing population, the government is endeavouring to develop an efficient and sustainable dairy industry. Recently the EU has embarked on a project in collaboration with Egypt Animal Production Research Institute. Since December 1991 a leading consulting firm is working on artificial insemination, fodder production, improved milking and milk handling, cheese production, and on the use of modern technology. Around ECU 43 million has been sanctioned as credit for the private sector to encourage profitable investments in dairy products and livestock.

One of the largest Dairy Products Company (public sector) is Misr Dairy and Food Company (Siclam Dairy) producing cheese, yoghurt, butter, oil and other dairy products. The raw material is fresh and powdered milk.

Spoiled fresh milk and cheese whey are the two major sources of wastewater pollution. At the same time, they represent a source of valuable products. However, the recovery of these products can be economical only if a large amount of whey is processed. The recovery and use of whey has been addressed by the SEAM Project and is described in more detail in Chapter 9.

3.3 Confectionery

The production of sweets and confectionery products depends heavily on imports of sugar, cocoa beans, oils, fats, coconut milk, nuts, dried fruits etc. The cost of imports rose significantly in the late 1980 due to the depreciation of the Egyptian pound and successive increases in duties on essential imports, including packaging materials.

Production figures as reported by the members of the Chamber of Food Industries show that the production of Halawa, Egypt popular confection, stood at 25,927 tonnes in 1989/90 (see Table 3.6). The production of Halawa increased dramatically since 1975, with a number of varieties based on imported almonds and nuts.

Table 3.6
Output of Confectionery Products, 1989/1990 (Tonnes)

Halawa	25,927
Toffee	929
Caramels	802
Chocolate, cocoa and butter	3,068

Source: Chamber of Food Industries, Cairo, 1990, as reported by the members of the Chamber of Food Industries)

Enterprises affiliated to the Chamber of Food Industries produced 3,068 tonnes of chocolate, including cocoa and butter, in 1989/1990. The open-door policy led to a spurt in chocolate manufacturing which was further triggered by a surge in the demand for a variety of chocolates. In the mid-1970s the country had only five public-sector chocolate manufacturing enterprises, equipped with obsolete capital stock. By the end of 1993 the number of chocolate factories rose to over 500, with the emergence of a large number of private enterprises to tap the country lucrative chocolate market. Competition between public and private chocolate manufacturing enterprises seems to be most intense in the production of wafers.

High customs duties levied on essential imports are a major constraint on the cost competitiveness of confectionery products. In the wake of rising production costs, most of the major private dealers seem to have worked hard to establish a foothold in external markets and Egyptian chocolates are still quite competitive in Africa and in Arab states. Egypt confectionery industry is now one of the principal items on the country export profile of food products. New companies using international brand names continue to step up production to satisfy the growing home market and to meet ambitious export targets.

3.4 Fish Processing

The annual fish catch currently averages about 300,000 tonnes a year, compared to 295,155 tonnes in 1990 (see Table 3.7), according to official figures. A major clearing operation at the Damietta power station in February 1992 seems to have resulted in some 475 tonnes of fish being killed and caused severe damage to the local fishing industry.

Table 3.7
Fish Catch, 1987-1990 (tonnes)

	1987	1988	1989	1990
Sea fisheries				
Mediterranean Sea	23,002	32,812	32,363	32,128
Red Sea	21,182	25,540	39,581	36,295
Suez Canal	253	342	288	443
Lakes				
El-Manzala	46,987	69,256	50,353	57,195
El-Boroulles	22,510	24,274	38,070	52,520
El-Barduil	1,398	1,542	1,600	2,761
Edco	7,580	8,236	7,511	8,043
Maryott	5,514	6,991	3,205	1,731
Qarun	2,352	1,927	1,143	1,617
High Dam	22,518	21,865	22,835	22,034
Port Fuad	500	521	300	300
Rivers and Canals				
Nile, canals and drainage systems	30,067	31,189	38,415	37,882
Fishery Farms	37,700	39,410	41,454	42,206
Total	221,563	263,905	277,118	295,155

Source: Central Agency for Public Mobilisation and Statistics (CAPMAS),1990

Data pertaining to the production, export and import of processed fish products is not readily available for recent years. Information obtained from the Chamber of Food Industries, as reported by its members, is presented in Table 3.8. The output of preserved fish stood at 3,207 tonnes in 1989/90 against huge imports of 126,872 tonnes.

Table 3.8
Output, Imports and Exports of Processed Fish Products, 1989/90a (Quantity in tonnes and value in thousand LE)

	Output		Imports		Exports	
	Quantity	Value	Quantity	Value	Quantity	Value
Preserved fish	3,207	15,406	126,872	157,750	2,790	193,113
Frozen fish	4,125	14,791	-	-	-	-

Source: Chamber of Food Industries, Cairo, 1990
Notes: (a) As reported by the members of the Chamber of Food Industries.

Egypt has a substantial natural resource endowment for developing both fresh-water and sea-water fisheries. Since much of the fish catch is not subject to a high degree of processing at the moment despite a significant increase in the demand for processed fish products, there is considerable scope for expanding fish-processing activities. Plans are being developed by the government to increase the annual fish catch from an average of about 300,000 tonnes to 700,000 tonnes by the year 2000.

The Egyptian Company for Fish Marketing is the largest public sector Fish Company. It processes about 75% of the fish from Lake Nasser (Aswan). It produces about 12,000 tonnes/ year of frozen fish.

The main pollution problem is caused by fish remains: bones, fins, scales, heads, gills and fish guts. These remains amount to 0.3 tonnes / tonne of product. Most of it is dumped and buried in desert areas causing severe environmental impacts. Wastewater is characterised by high BOD, COD and oil and grease.

Fish remains can be further processed to produce oil and animal fodder serving the dual purpose of preventing pollution and generating a profit.

3.5 Non-Alcoholic Beverages

Fruits and vegetables constitute a substantial resource base for the manufacture of a wide range of beverages although the production of several varieties of soft drinks is based on imported ingredients. Soft drink and juice producers include two large government-owned organisations, the Egyptian Bottling Company (EBC), an affiliate of the state-owned Holding Company for Food Industries, and Nasr Bottling. Subsidies for production, although decreasing, were available to EBC and to Nasr Bottling from the government, but both were privatised in the first stage of the government announced sell-off in early 1994, and bought by Pepsi Co. and Coca Cola respectively. Together, they account for about 70% of the local market.

Large public-sector firms such as Kaha and Edfina dominate the local market for non-carbonated drinks and juices, primarily because of their lower production costs and cheaper retail and wholesale prices. Private companies such as Juhayna and Nile Food - which broke the government monopoly in the sector when they began operation in 1983 - produce higher quality, but more expensive, products. Another firm, Tasty Foods, operates in the sector as a joint venture with Pepsi Co., which holds 50% of the equity. Nile Food exports about 10% of its output, but also relies on other products, such as ice creams, to maintain profits. Juhayna reported net sales of US$10 million in 1991, about 20% of which came from exports.

In addition to fruit and vegetable juices, Egyptian production of beverages includes mineral and bottled waters, soft drinks, and the processing and packaging of imported tea and coffee as well as alcoholic products such as beer, wine, brandy, rum and ouzo. Water is abstracted from underground springs and aquifers, as well as from the Nile River and the Delta.

The removal of price controls and the elimination of barriers to imports is already having a dramatic effect on the beverages sector. A wider range of products is now available, especially for those consumers able to pay higher prices, such as supermarkets, hotels, restaurants and tourist resorts. At the more popular end of the market, however, persistent constraints on production by the public-sector companies, rising production costs and a lack of investment are restraining sales.

The prospects for the fruit and vegetable processing sector in general and the beverages industry in particular will depend greatly on the scale and success of the privatisation programme. Egypt fertile soil, favourable climate and improved prospects for citrus fruit production could provide the base for a considerable expansion of output of fruit and vegetable drinks to markets in Europe and the Gulf states, as well as to the United States.

Products such as mango and guava juices could command a premium, once quality, packaging and continuity of supply are guaranteed.

The advent of such huge international concerns such as Pepsi Co. and Coca-Cola producing in the private sector, while posing a short-term threat to local producers, could also help to spread access to better technology, marketing and product development. This will enhance the industry knowledge of, ability to meet wider export opportunities and improving its ability to satisfy local needs.

Given that Egypt domestic market for beverages is sensitive to price rather than quality, only those manufacturing companies which can supply products at reasonable cost will be able to enjoy the economies of scale that will create the profits needed to finance investment to upgrade plant, expand marketing and advertising and enlarge storage and distribution facilities. While small-scale operations cater for the tourist market, urban supermarkets in Cairo or Alexandria, or exporters may be able to operate at a profitable level, the removal of import bans on competitive products is expected to have an adverse effect on existing sales by local manufacturers in the lower-priced domestic market.

The beverages sector in Egypt has, for most of the past decade, suffered from a lack of adequate quality controls, a lack of investment, a high dependence on imported inputs (including bottles and cans, manufacturing and quality-control equipment, and commodity inputs in the case of tea, coffee and certain soft drinks) and from an almost complete lack of modern marketing and management methods. Private-sector firms have sought to overcome the obstacles, but often with only modest success.

A severe constraint exists in the form of subsidiary industries needed to supply the beverages sector. Beer production, for example, suffers from a lack of adequate bottle tops which could prevent flatness; the same applies in the case of corks or capped bottles for the wine and spirits industry; plastic and glass bottles and recyclable, self-opening aluminium cans for soft drinks, juices and bottled waters; carbonated waters for bottling; and distribution services as a whole. Marketing, including store promotions, product design, advertising and graphics is also in great need of investment and development, as are testing and quality-control facilities and production equipment in general.

In general, with Egyptian towns and villages replete with street vendors selling juices of all kinds, and market traders supplying tea and coffee at popular prices, the manufacture and production of beverages requiring costly imports, high-quality ingredients, quality controls, national distribution and/or brand name marketing will, of necessity, need to be targeted either for export or at the small segment of the local market which can bear higher retail prices. Sales to the hotel and catering trade, as well as to the tourism sector, have been growing rapidly in recent years.

The United States Department of Agriculture, for example, has noted that the expansion and increased output of horticultural products from reclaimed desert areas led to a record output of 2.2 million tonnes of citrus products in 1992. Fruit harvests were also up significantly, including high-value export crops such as peaches and strawberries.
being able to harvest, process and market such crops during the April to June period would give it an unbeatable competitive edge in European markets, which currently depend on high-cost imports of such commodities and related products from countries such as Chile and South Africa during this period.

4.0 Process Descriptions and Waste Generation for Selected Sectors

4.1 Fruit, Vegetables Processing, Freezing and Canning

This sector receives a wide range of fruit and vegetables and processes them into final or intermediate products for human consumption. This may require several processes including washing, trimming, peeling, pitting, crushing, fluming, conveying, centrifuging, evaporating, screening, pasteurising and sterilising.

During these processes considerable amounts of wastes are generated which can cause significant downstream effects. All of the waste generation processes can be controlled to a certain extent, but in this particular sector, some waste is inevitable. The goal is to minimise wastes and seek alternative uses as products or substrates.

The industry may be divided into two types - fresh pack and processed. Fresh pack involves the collection of materials from the field, packing in suitable containers, transport to a processing plant, finishing operations which may involve trimming, selection, peeling, pitting, cutting and slicing, washing, sanitising, packing and controlled atmosphere packing. Some of these operations tend to decrease shelf life and others tend to increase it, especially during the final packing operations. Operations are also chosen to add value to the products.

Processed products involve other unit operations such as crushing, centrifuging, evaporating, drying, blending and many other operations to provide diversity in product selection, add value and increase shelf life through pasteurisation, sterilisation by heat or other means. Some processes require several unit operations to complete, others may be discrete steps to the final product. Canning (including can making and varnishing), bottling, preserving, freezing etc. all have their own special wastes.

Waste production occurs during:

- harvesting
- transport
- washing
- stemming, trimming, peeling
- rinsing
- sizing
- pitting
- blanching
- fluming
- sorting
- conveying
- coring
- slicing
- dicing
- pureeing
- juicing
- filling
- sanitising and stabilising

Thus there are many steps which contribute to the formation of wastes which have to be disposed of or possibly recycled. Consumers needs for wholesome, safe food have to be satisfied as well as a requirement for aesthetically pleasing product. There will be some need for treatment or disposal options because these food processing steps above create some unavoidable residuals.

Table 4.1 below from US data (1991) gives an indication of the total losses in the industry.

Table 4.1: Generation of waste materials from the US fruit and vegetable industry

Crop	Input (thousands of tonnes)	Output (thousands of tonnes)	Losses (thousands of tonnes @26.6%)
Main vegetables (snap bean, sweetcorn, cucumber, pea, tomato)	16,130	11,847	4,283
Secondary vegetables (asparagus, broccoli, carrot, cauliflower, sweet potato)	624	458	166
Principal fruits (apple, cherry, orange, pear, grapefruit, apricot, cranberry, olive, peach)	11,212	8,234	2,978

During distribution and consumption there are again inevitable losses associated with this sub-sector of the industry.

- Transport
- Packaging
- Storage and warehousing
- Display
- Purchase and consumption - storage, transport, treatment, preparation, cooking

Subsector Benchmarks

Benchmarks for wastewater generation and selected pollutants for certain fruits and vegetables are shown in Table 4.2:

Table 4.2
Benchmark values for wastewater generation and some pollutants.

Crop	Flow (mean) kl/t	BOD (mean) kg/t	TSS (mean) kg/t	Losses during freezing (%)	Losses during canning (%)
Bean	1.113	6.81	2.8	15	18.1
Carrot	0.88	13.6	7.7	45	25
Pea	1.43	17	5	8	
White potato	0.95	38	58	60	36
Tomato	0.58	4.2	5.5		
Tomato product	0.29	2.1	4.5		35.6
Apple	0.64	8.1	2	40	46
Apricot	1.4	18.2	4.5	22	
Citrus	0.8	4.4	1.7		52
Pear	0.95	22.7	5.5		
Pineapple	0.7	11.35	4.1	50	42

Source: Council of Agricultural Science and Technology, Task Force Report 124, Waste Management and Utilisation in Food Production and Processing, 1995

4.2 Dairy Processing Industry

The dairy industry manufactures a whole range of products including fresh milk, yoghurts, ice-cream, processed milk and cheeses. The industry has been quite innovative in bringing in new products such as protein enriched and calcium enriched drinks and is often at the forefront in employing new technologies in repositioning its products. The industry often produces high volumes and strengths of wastewater because milk and whey, the two principal ingredients of waste streams, are high BOD streams, of the order of 100,000 mg/l. Therefore any loss is likely to result in a high BOD.

Some process steps in the dairy production process are:

- Milk animal, store, collect from farm and transport
- Receive
- Separate cream
- Pasteurise
- Homogenise

- Ferment
- Separate
- Clean
- Pack
- Store and distribute

Particular care must be take throughout the processing stages to minimise the possibility of microbial contamination and growth. One of the most important issues with the dairy industry is the large quantity of water and high temperatures and cocktail of chemicals which are required for proper sanitation.

Whey would seem to be an extremely valuable by-product from processing of milk. However the large volumes produced - with a global annual production of 90 million tonnes, mean that it is difficult to find markets for all this product, especially from smaller operations. Whey consists of 6% solids made up of lactose, protein and minerals. Generally it is the salt content which restricts the value of the whey.

4.2.1 Losses from Farming Practices

The most significant losses will occur in the following areas:

- Milking practices
- Storage
- Washdowns
- Collection and transport

4.2.2 Losses during Production

Best practice losses are 0.5-1%, however losses of up to 2% are considered acceptable. Best practice would involve technologies such as quality control of the herd and milk storage temperatures on farm and in transit; strict temperature and microbiological control in reception and during skimming and reconstitution and homogenisation and rigorous clean-in-place systems which are well controlled and monitored.

It is difficult to nominate all the different operations in the process factory. Some of the most widely used include:

- Receive
- Store
- Homogenise
- Pasteurise
- Clarify
- Centrifuge
- Inoculate
- Membrane filter
- Heat
- Screen/separate
- Acidulate
- Formulate
- Press
- Cook
- Fill
- Evaporate/concentrate
- Spray dry
- Wash

Thus there are many places where wastes are generated both in raw milk production and in products made from milk. The range of animals are used to provide milk also means that several different types of milk are being processed.

Subsector Benchmarks

To try and get a useful manner of describing benchmarks from the diversity of products which can be produced in the dairy industry, there have been comparisons drawn between the equivalency of products, see table 4.3, below.

Table 4.3
Equivalency Factors for Pollutant Load between Different Milk Products

Kg of product	Kg milk equivalent
Butter	21.3
Whole milk cheese	9.9
Evaporated milk	2.1
Condensed milk	2.4
Whole milk powder	13.5
Cottage cheese	7.1
Non-fat dry milk	12.5
Whey	1.1
Dry whey	17.6
Whey cream butter	40.7
Dry butter milk	249.0
Ice cream	2.7

Source: Zadow, 1993

Table 4.4 shows the relative contribution of specific products to a waste stream produced and shows the average production of wastewater from a mixed factory. Average values of BOD in wastewater from integrated processing operations are 1000 - 4500 mg/l. The average amount of water used is about 2.5 kl/kl input milk. Best achievable wastewater production for an integrated plant is believed to be about 1.5 kl/kl input milk.

Table 4.4
The relative wastewater generation from different dairy products

Product	Waste volume coefficient kl water/kl milk	BOD equivalent kg BOD/kg milk equivalent
Milk	3.25	4.20
Cheese	3.14	2.04
Ice Cream	2.80	5.76
Condensed Milk	2.10	7.60
Butter	0.80	0.85
Powder	3.70	2.27
Cottage Cheese	6.00	34.00
Cottage Cheese and Milk	1.84	3.47
Mixed Products	2.34	3.09
Overall	2.43	5.85

Source: Zadow, 1993

4.3 Confectionery

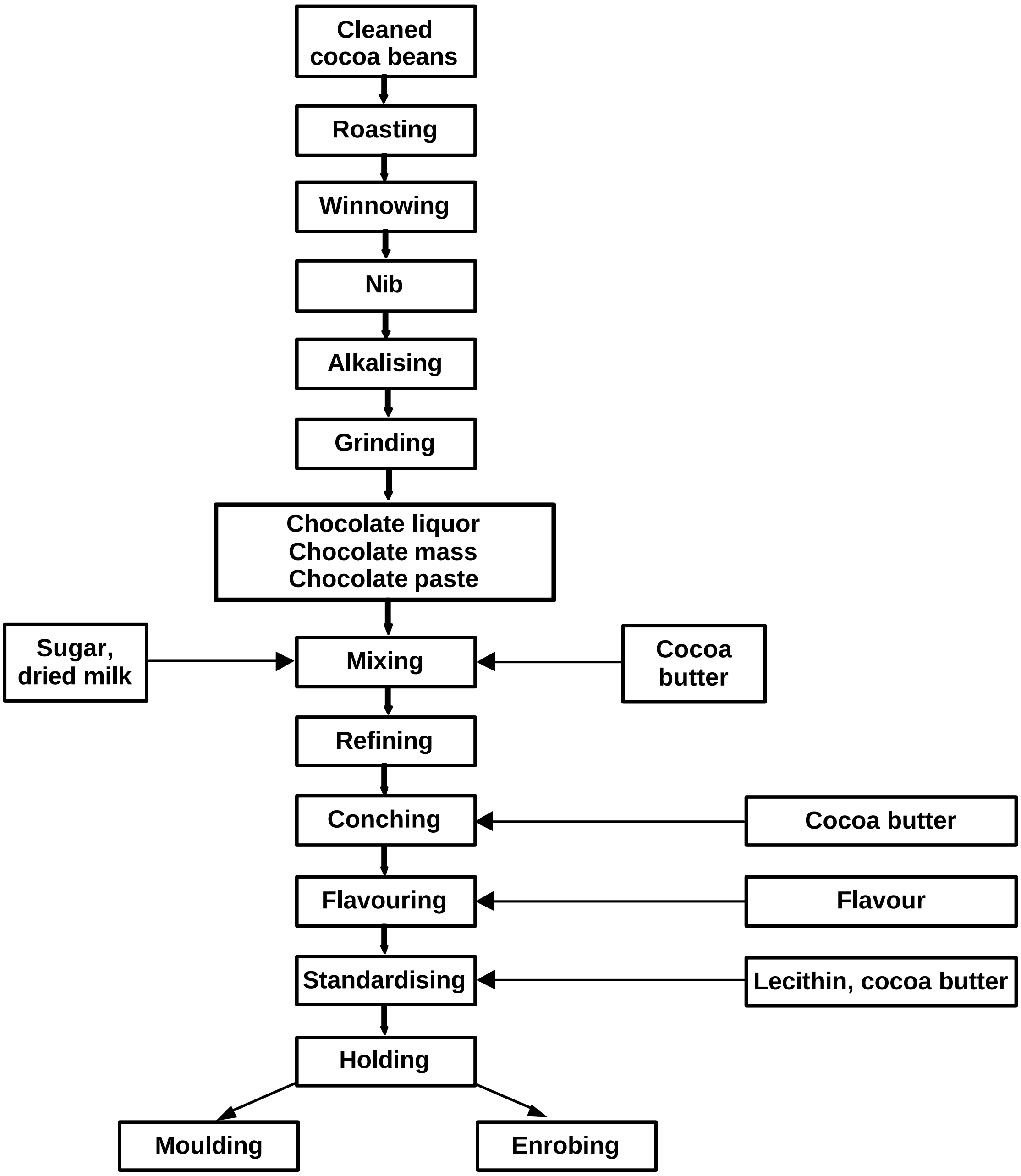
There is a multitude of products produced in this sector, from chocolates of many different grades and presentations to hard candies and chewing gums as well as biscuits, wafers etc. Sugar candies, for example, comprise boiled sweets, toffees, nut products, jellies, pastilles, marshmallows, nougats, fondants, fudges, marzipan, pralines, lozenges and many more. This is a high value-added sector, although it remains competitive because:

i) its saw materials are relatively expensive and

ii) the wastes produced are generally high quality and tend to be more carefully controlled than in some other sub-sectors.

Sugar sweets are made by a diversity of methods which usually involve making a solution of the sugar ingredients and then boiling off water to achieve a final stable crystalline or non-crystalline form. Jellies on the other hand usually have a higher water content than the boiled sweets mentioned earlier and depend on pectin, agar or some other gelling agent such as starches for their characteristics.

The process of chocolate making for example, involves the following steps:



Cocoa beans are fermented in their country of origin and dried. In the factory they are roasted, shelled, and degerminated to give a cacao nib which is ground to a paste. This paste is mixed, with sugar and added cocoa butter, refined and agitated while hot in special conching machines to expose it to air for a period of hours or days. Flavours are added, milk or milk powders may be added at various stages and the mixture tempered.

Although the above diagram appears to be quite simple, in practice the process of producing chocolate at a particular quality level is quite complex and depends on many process control and equipment factors. As can be seen there are many steps in the process, all of which could contribute to waste generation. If conditions are not quite right there may be problems later for example fat blooms may appear on the chocolate.

Subsector benchmarks

Benchmarks are very difficult to find for the sector, however energy benchmarks are:

Best practice - 10 000 MJ/tonne and the industry average is 31 000 MJ/tonne (from Rutgers University, website for the US department of energy (DoE) via personal communication from Strategic Industry Research Foundation (SIRF) in Australia, which is conducting a benchmarking exercise for the food processing industry.

In general, losses throughout the sector consist principally of:

- Doughs
- Powders and dusts from cocoa and other ingredients during receival and dispensing as well as mixing
- Residuals in containers
- Oil spills and losses
- Washings from all process equipment, tanks, mixers etc.
- Pump gland leaks and spills
- Pipe pushings
- Packaging materials
- Syrups during transfer and dispensing
- Butter and other solids
- Poor packaging

However, attention must be paid to energy as this subsector is a very large consumer of energy as the above energy use figures demonstrate.

4.4 Fish Processing

There is a wide range of equipment, technology and methodology to treat the huge diversity of products available from the sea. In the US, according to NDC 1974, 35% of the catch is rendered, 30% marketed fresh, 20% canned, 10% frozen and 1% cured. Frozen fish sales were rising rapidly and it is believed that the trend is still continuing.

Tuna is a major catch and is commonly processed as well as commanding a premium for fresh product in some countries. Other seafoods comprise salmon, prawns (shrimp), crabs, cod and other bottom dwelling fish, crab and sardines.

An approximate listing of operations is:

Harvest	Scale	Eviscerating
Sort	Shucking (shellfish)	Filleting
Wash	Picking, peeling	Skinning
Grade	Heading	Cooking, canning, preserving, bottling etc.

Wastes are generated from virtually all processes and the specific product generates different types of wastes. Crabs may generate up to 90% by weight of waste and even many fishes such as tuna can give 30-50%. The main sources of seafood wastes are described in Table 4.5.

Table 4.5: Sources of Seafood Wastes

Process	Waste
Catch	Unwanted organisms (by-catch)
At-sea treatment	Cuttings, bones, blood, off-spec., by-catch
Transport and marketing	Off-spec., spoilt product
Receival and thawing	Spoilt materials, thaw-water, melted ice
Butchering and processing, including canning	Off-cuts, viscera, bones, skins, suspended and dissolved solids, sauces, brines, fish oils, other oils
Quarantine, storage and distribution	Off-spec. materials, spoilt materials, damaged cans

Some environmental performance parameters (approximate) for the industry are given in Table 4.6. With the high use of water and the high rates of BOD generation, there is a lot of pollution potential in such streams, which become malodorous and noxious very rapidly.

Subsector Benchmarks

Benchmarks used for the seafood industry are given in Table 4.6.

Table 4.6: Some environmental performance parameters for the seafood industry

Water usage	8 Kl/tonne
Solid waste generated	433 Kg/tonne
BOD	23 Kg/tonne
Grease	7 Kg/tonne
COD	59 Kg/tonne
SS	26 Kg/tonne
fish wastes	0-85% of product

(Source: modified from NDC 1974)

NDC (1974) suggests that up to 65% of the tuna in the canning process may be lost as waste. The same article suggests that only 35% of processed salmon is wasted. This waste consists of heads, collars, tails and fins, livers, milt, heart and digestive organs. Crabs on the other hand have very high values of waste - up to 85% or so, consisting mostly of the exoskeleton.

4.5 Non-Alcoholic Beverages

Although the brewing industry is not large in Egypt, there is still some significant production of both alcoholic and non-alcoholic beverages as well as a burgeoning carbonated and non-carbonated soft drinks industry.

4.5.1 Juices

The basic unit operations in juice production are:

- washing
- crushing
- extraction
- clarification

- heating
- refining
- bottling/packing

Effluents arise from all these steps and from cleaning of the bottles and packaging lines, equipment, floors etc. Usually most juices contain a large concentration of sugar and often this is augmented, therefore BOD discharges are high.

Subsector Benchmarks

Values for apple processing follow in Table 4.7.

Table 4.7 Specific wastewater generation and COD load from apple juice production (Beuthe, 1977, reproduced in Barnes, 1984)

Process stage	Wastewater volume (m^3/t)	COD settled		
			Range	
		Average (kg/t raw juice)	Low (kg/t raw juice)	High (kg/t raw juice)
store, wash, press	2	3	5	1.5
refine, separate, filter, store	1	1.5	2	1
store, outstore, mix, filter	1	0.7	1.5	0.5
fill	2	1	1.5	0.5
Total	6	6	7	5

(Source: Barnes, 1984)

Barnes also presented data for other aspects of the operations and for other fruits. The author points out that removal of solids from effluent streams is critical as they can contribute up to 400 g/l of BOD. The use of the solids for other purposes (such as animal feed) is recommended.

4.5.2 Soft Drinks

Bottle washing and loss of syrups will contribute most to the BOD arising from these operations and the standard methods to combat these losses as mentioned above. As syrups are valuable then most companies take care to reduce losses of syrups and to maximise yields. However there is usually significant opportunity, especially in older plants and ones with inadequate filling lines where over/underfilling is a problem and manual operations are used with resultant higher losses.

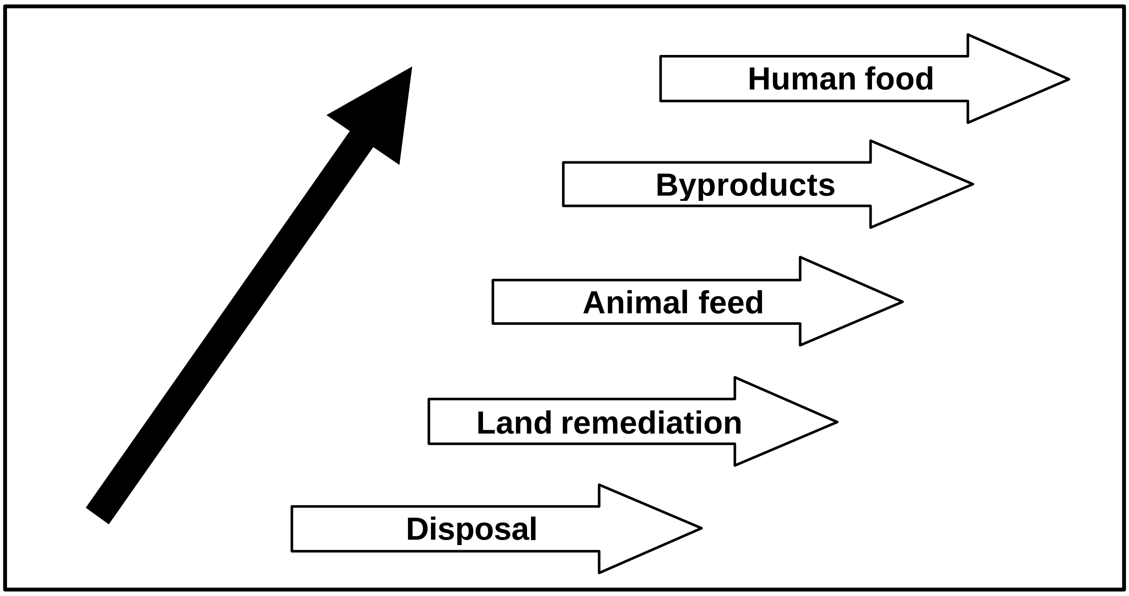
5.0 The Food Processing Sector: Business and the Environment

5.1 Introduction

Food processing companies operate in competitive environments ranging from high value-added niches to the larger market for low margin/low value-added products. Currency fluctuations can play a major role in the profitability of the sector, especially where exports are involved. Generally, food processing companies have a relatively large labour force which is low skilled, marked by rapid turnover and low morale; incentives for workplace change are few and empowering the workforce is difficult. Shober (1988) points out that the hierarchy of value is important for the food processing company - as much of the incoming product should be transferred to human food rather than to other products (Figure 5.1).

Also, there are many opportunities for residuals recovery from the sector, for example as animal feed. The practicality of implementing these options will be governed by economics of scale, availability of appropriate technical skills, availability of capital and a range of other factors. However waste recovery should always be considered.

Figure 5.1
: higher up, higher value



Source: Shober, 1988

Despite the logic of the above hierarchy, the value of pollution prevention or Cleaner Production is frequently unrecognised and the concept is often alien to the business. Thus there is still the need to promote Cleaner Production and its advantages to industry. The techniques of identifying Cleaner Production options, both within the food processing sectors and within industry as a whole are broadly similar. These generic strategies may be applied over a range of situations and comprise: process modifications, product modification, good housekeeping, raw material substitution and selection and on site recycling. Within these general groups, interventions that will be common throughout the sector include water reuse and recycling, potential for energy savings, potential for hazardous chemical replacements and potential for source reduction. These options will be examined in detail in subsequent chapters.

5.2 Strategic Position

The business environment in which the company operates needs to be defined when trying to bring in and consider environmental issues - company profitability, product margins, market stability, barriers to entry etc. This includes carrying out a full analysis of the products, the market share, plans for growth, type of management, company structure, the reporting structure and as much supporting information as is available. However, such detailed information is unlikely to be available for a Cleaner Production assessment, but such information provides a picture of the business environment in which decisions are made.

There is a need to find out if environment is an issue in company management, if there is someone responsible for pollution and emissions and the level of environmental skill, awareness and knowledge in the firm. The general business risks and liabilities associated with environmental issues are often overlooked. In Egypt, the implications of government involvement with some companies and possibilities for privatisation and corporatisation must be considered in the strategic planning of the company and the investment climate.

5.3 The Need for Information

Does the company perceive a need for information and does it actively solicit data for environmental concerns? This can be understood by determining whether or not the company has environmental data already and if it collects information on environmental issues.

Other questions that need to be answered include:

- Does the company appreciate how its production processes in general and specifically interact with the environment and create residuals?
- Does the company need information to upgrade or to improve the efficiency of its wastewater treatment system, for example?
- Does it have access to adequate information on technologies and processes which have an environmental consequence?
- Finally, does it care about this information or does it need to care?

These questions will reveal how important Cleaner Production may or may not be to the firm and how low the starting point for change may be.

5.4 Process Considerations

The following points need to be considered:

- Does the company have flow diagrams, Piping and Instrumentation (PID) diagrams etc. available and are they adequate and up to date?
- Are there maintenance schedules, input/output schedules, monitoring and measurement?
- What is the present quality regime - any Hazard Analysis and Operability (HAZOP) study carried out for risk management or a Hazard Analysis Critical Control Point (HACCP) system in place, or is there any certification to any standard or code of practice, for example ISO 9000 series?
- What is the ability to carry out measurements of process parameters and interpret them? For example is there a process laboratory and what kind of tests are required, what instruments are available and how are records kept?
- Is process instrumentation functional and maintained? Often suppliers provide appropriate instrumentation, for example temperature measurement and recording and with time it breaks down and is forgotten about.
- Is there a materials flow diagram showing movement of materials, inventory available and are good records of materials maintained? Many modern companies are making huge environmental and cost savings from advanced process control systems which have become quite affordable.

These are just some of the type of site specific questions which must be addressed in considering a Cleaner Production programme. Answers to these questions give some idea of the environmental status of participating firms and indicate the amount of effort which will have to be put into a full Cleaner Production programme. It must be said that having an adequate supply of this type of information is rare and it is expected that there will be a need to gather information in any Cleaner Production programme. However a rapid appreciation can be gained of the environmental and efficiency status of the company from such data.

5.5 Supplier Involvement

The eventual success of the transfer capacity of Cleaner Production options will depend heavily on the integration of supplier data into a technology database and obtaining extra data from suppliers to reflect Best Available Technology options and provide best practice information for local conditions. Ideally, this would include a file of skilled consultants, suppliers of both process technology and treatment technology for the sector and possibly environmental performance data from the equipment, which will not be easy. Local suppliers should be encouraged to supply environmental data, although at present, it seems that local suppliers of much technology-based equipment are not customer focused or driven, but are simply list keepers for foreign firms. They are possibly not capable or willing to provide the support functions which are usual in some countries.

5.6 Background Environmental Information and Data Support

As stated previously, there is generally a lack of good data which is transferable across the food processing industry and can be used profitably for Cleaner Production progress when the SEAM Project is completed. There is a wealth of information on the Internet, but it tends to be site and region specific. Data such as is generated from this project will be invaluable in capacity building across the Egyptian economy. The SEAM Project successes should be widely transmitted so other companies and the regulators can learn from SEAM activities.

5.7 Capacity Building and Organisational Change

Integral parts of the SEAM process were capacity building and training of service providers, consultants, and factory staff involved in industrial auditing and demonstration project implementation. For Cleaner Production to be sustainable, comprehensive and effective training programs are of particular importance and therefore, one of the most important parts of a Cleaner Production programme is developing educational and training programs to build capacity across the industry.

Mulholland (1995) sees organisational change, which is required for effective Cleaner Production needing the following steps:

COMMUNICATION to let employees know what the process is about.
ORIENTATION to put changes in context.
INDUCTION to train employees and get them involved.
MORALE building to work on improving participation.
SATISFACTION with the workplace and management activities.

All leading to:

ORGANISATIONAL CHANGE which will integrate Cleaner Production.

This set of steps may not be entirely appropriate for Egyptian needs, but it does provide a guideline within the firm for how to bring about change management which is one of the most important aspects of Cleaner Production. Industry in Egypt seems to be happy with the concept of capital investment in technology options, however less happy to institute programs such as total quality management or quality maintenance. There is a good argument for concentrating heavily on management issues to bring about changes in company operations to prevent pollution.

5.8 Regulatory Framework

Consensus is that without regulations there is little incentive for environmental improvement or environmental technology gain. At many levels, there is realisation that despite all the good words linking profit with better environmental management, it is regulation and policed regulation which succeeded in changing practices. Prosecutions have been successful in obtaining environmental improvements. Despite the rhetoric about Cleaner Production making sense, helping the bottom line and improving profitability, there is a huge credibility gap for firms - regulators have a strong role in providing Cleaner Production incentives. In the food processing industry, voluntary programs such as HACCP which are linked to food exports can be worked in with Cleaner Production schemes.

5.9 Treatment Technologies

There are a large number of treatment technology options available for different subsectors and for different needs. For Cleaner Production to be successful it needs to assess what is being used at the moment and take into account the geographic location, the site aspects, the energy inputs as well as alternatives to site treatment such as sewer disposal and future trends which may need consideration.

Wastewater treatment in the food processing industry can range from no treatment at all through screening and sedimentation to quite complex on-site biological systems which may be in package plants, home-made plants or ponds and lagoons. Each technology has its preferred treatment stream and waste treatment information is generally readily available and

treatment is not counted as a Cleaner Production option, it should be included as a pollution prevention issue for this sector, once all practical waste minimisation options have been adopted. This will ensure that wastewater volume and load are minimised, so that capital, maintenance and operating costs of a treatment plant are kept to a minimum. Any treatment plant can be considered during a full Cleaner Production assessment and the efficiency, reliability and costs of treatment, for example, can be assessed, and environmental improvements can be made.

Similarly there are many solid wastes which are often amenable to product recovery or reuse and recycle. There are often opportunities for by-product recovery where economics change regularly and should be reconsidered from time to time, e.g. flavour recovery.

5.10 Wastes and BOD

There is still the perception, both within and outside the food processing industry, that food processing industry wastes are harmless to the environment. This misconception has arisen due to the wastes being essentially natural in origin (e.g. fruit skins, whey, etc.) rather than manufactured. This may be true if the wastes are appropriately treated before release to the environment or are appropriately disposed of, however this is often not the case.

However most wastes can be readily reused, treated by simple biological systems or minimised by waste reduction measures. Thus the scope for intervention by the use of Cleaner Production, appropriate technology inputs or educational and economic inputs is high. Cost, capital availability and economics is the deciding factor in such technology uptake.

Wastes from the food processing industry are to a certain extent an inevitable part of the business. When these wastes, which are fairly wet and high in carbon, are left untreated, they become a breeding ground for micro-organisms, which are everywhere in the environment. As these proliferate, so the material starts to decay and smell. Harmful micro-organisms (pathogens) may also grow in the material. Wastes can also give a dirty, untidy appearance to a factory.

BOD (Biological Oxygen Demand) is an indicator of pollution load. It refers directly to the uptake of oxygen by any carbon (and some nitrogen) entering a water stream. It represents a direct measure of the pollution potential of a waste stream and is measured in mg/l (milligrams of oxygen per Litre of solution). BOD is measured in laboratories by working out how much oxygen a water sample uses up over a five day period at a certain temperature.

Clean water in a stream may have a BOD of 15-20 mg/l; an average factory effluent has a BOD of 2-3000 mg/l and milk a BOD of >100,000 mg/l. Most living things need oxygen for survival so anything that removes or depletes oxygen in water means that fewer organisms can survive there. Fish and higher organisms for example, need quite high dissolved oxygen levels to survive.

Part B

CLEANER PRODUCTION AND THE SEAM PROJECT

6.0 Cleaner Production Audits

6.1 Introduction - What is A Cleaner Production Audit?

A ,Cleaner Production Audit, can be defined as:

,A systematic review of a company's processes and operations designed to identify and provide information about opportunities to reduce waste, reduce pollution and improve operational efficiency.,

A good Cleaner Production Audit will:

- Present all available information on unit operations, raw materials, products, water and energy usage.
- Define the sources, quantities and types of waste generated.
- Clearly identify where process inefficiencies and areas of poor management exist.
- Identify environmentally damaging activities and report on legislative compliance (A list of applicable Egyptian legislation and regulations is shown in Appendix 1).
- Identify where Cleaner Production opportunities exist, outline how much these will cost to implement and quantify the benefits.
- Prioritise the Cleaner Production opportunities identified. Priority should be given to low cost/no cost measures and those with relatively short pay-back periods.
- Incorporate an ,Action Plan,, which will describe how the Cleaner Production measures can be best implemented at the factory.

The SEAM Project carried out Cleaner Production audits in 10 food processing plants. These audits focused on identifying low-cost interventions with fast payback periods - a total of 130 such interventions were identified, with implementation costs ranging from zero to LE350,000. Savings ranged from LE1,550 to LE822,500, with payback periods ranging from 4.5 - 21.5 months

6.2 Carrying out a Cleaner Production Audit: A Step by Step Description

A key word in the Cleaner Production Audit definition is ,systematic,. A systematic approach will ensure that as much information as possible is collected and assessed to develop financially and technically feasible Cleaner Production opportunities. A step-by-step guide to carrying out a Cleaner Production Audit follows.

Step 1 Management Commitment

The key to success of any Cleaner Production audit depends on the interest, support and commitment of top management. This will only be gained if they are convinced of the benefits and can see that it will reduce costs. Top management support and commitment is essential in:

- Allocating appropriate human resources for carrying out the industrial audit and implementing the viable Cleaner Production options.
- Facilitating the release of detailed process and financial information from all departments to the Team.
- Encouraging the factory staff to implement any changes identified.
- Providing the financial resources for Cleaner Production implementation where necessary.

Step 2 Appointing a Cleaner Production Team

Before any work can be carried out, a Team needs to be formed which will carry out the Audit and identify Cleaner Production opportunities. The size and composition of the Team will vary depending on factory size and organisational structure, but should include representatives from each production and support department. An external consultant with experience in identifying and implementing Cleaner Production interventions may also be a useful Team member.

Once the Team has been formed, specific roles and responsibilities should be assigned, including a Team Co-ordinator who will be responsible for managing the various responsibilities and tasks.

A general guide to Team composition and general duties (using the team developed at Misr Dairy as an example) follows:

Audit Team Member	Main Inputs and Duties
Production Departments: ■ Milk reception. ■ Raw milk packaging. ■ Processed milk departments.	Flow diagrams, raw material use and transfer from storage to process, production schedules, process descriptions and recipes, operating manuals, cleaning and routine maintenance.
■ Stores and Purchases Department(s).	Volume and frequency of raw materials (including milk) purchased, storage, inventory control, main users of each material.
■ The Quality Control Department (including a representative from the laboratory).	Quality control procedures, product quality information, analytical capabilities.
■ The Utilities Department.	Types, production and consumption rates of water, energy and steam etc., wastewater treatment cleaning and routine maintenance.
■ The Maintenance Department.	Maintenance schedules and records, identification of areas needing high levels of maintenance.
■ The Financial Department.	Purchasing costs (raw milk, flavourings, colourings, machinery, etc.), selling costs, downgraded products. Assist with cost-benefit calculations.
■ The Environmental Department (if this exists).	Air emissions, solid and liquid wastes, legislative compliance, safety records.

For each department, individuals having the best understanding of the department as a whole should be selected as the representative. This individual will be in the best position to describe and quantify the processes carried out, as well as being in the best position to make estimates where necessary.

Note: It may not always be possible to get precise information but it is the function of the Audit Team to make their best judgements and estimates if specific data are not available.

Step 3 Collection of Baseline Information

All information that is readily available in the factory should be collected by the Audit Team. This information may consist of:

- Site layout and plans showing buildings and functional units, location of drains and sewers, chimneys, vents and discharge points.
- Listing of all processes carried out and process flow diagrams (if available), including materials storage and handling information, product packaging and dispatch. Cleaning processes, particularly where these involve the use of chemicals, should also be included.
- Operating manuals of machinery, particularly with reference to the design conditions as recommended by the manufacturer.
- Maintenance records.
- Inventories of raw material and product information, including by-products.

- Analytical data - product quality and wastewater analyses.
- Financial information, including purchase costs of chemicals and utilities, product and by-product selling prices (including downgraded products), operating and maintenance costs. A summary of the cost elements in the total production costs would also be useful.
- Environmental information, for example wastewater quality, details of existing wastewater treatment system, air emissions, the production and fate of solid wastes and environmental reports and licenses.
- Health and Safety records.

This information may not be readily available and in some cases, may be scattered throughout the factory. It is important that as much information as possible is collected at this stage, to minimise the amount of investigative work needed later.

It is important that the information collected is as accurate as possible - where assumptions have been made, these should be clearly stated.

Step 4 Understand Factory Operations and Processes

This following general information will need to be obtained or derived:

- A general flow diagram showing all process steps that are carried out, from receipt and storage of raw materials to storage and dispatch of the final product(s). This should show all inputs and outputs associated with production.
- Construction of a flow diagram for each process (example given as Figure 6.1). This should identify all steps that are carried out and list all of the inputs (including raw materials, process chemicals, steam, water and energy, etc.), outputs (products, by-products, solid, liquid and gaseous emissions) and any recycling steps. If flow diagrams have already been collected in the ‚Collection of Baseline Information‚ step, they will need to be carefully checked for recent and/or unrecorded modifications. Particular care must be taken to identify particularly toxic or hazardous chemicals - these are easy to miss if they are only used intermittently, or in very small volumes.
- The information gathered so far should then be verified by conducting a ‚walk through‚ of the factory. This walk through can also be used to identify and record obvious losses that are occurring, such as leaks and spills. High noise levels should also be noted as these may indicate that equipment maintenance is required. The information gathered should also be discussed with Production staff from each department, as they will be able to give a good account of actual operating conditions and problems. This activity will also help in gaining support for the Cleaner Production audit and make implementation of improvements easier, as the staff will have been involved throughout.

Note: A walk through, or discussions with production staff should be carried out whenever data is missing, or there appears to be a conflict between two different sources of data.

- If on-site laboratories exist, they should be assessed to determine what can be analysed and which specific tests can be carried out, for example:
  - ⇒ raw milk quality (e.g. pH, bacterial count);
  - ⇒ quality of the finished products (e.g. bacterial count) and
  - ⇒ wastewater quality (e.g. pH, BOD, COD, heavy metals).

Examples of Questions for Production Staff:

⇒ How much time is needed to complete each stage of the process?
⇒ What are water and energy requirements for each step?
⇒ What raw materials are used for each product? How are these weighed and transported to the production area?
⇒ What rejects are there and what is their volume? What happens to these rejects?
⇒ How close are operating conditions to design conditions?
⇒ Are there any problems with the process/machinery that you are aware of?

Figure 6.1: Example of a Process Flow Diagram (White Cheese Processing)

Inputs	Process Steps	Outputs	NOTES
	Pasteurised milk		
•Electricity •Pasteurised milk •Water (washing between deliveries). •Cleaning chemicals (washing between deliveries).	Receiving tank for heating	•Condensate •Wastewater (from washing) •Heat	Condensate recycled to boiler
•Water •Steam (for indirect heating of water). •Heated milk •Water (washing)	Ultrafiltration	•Permeate (to drain). •Hot water •Concentrate •Wastewater (from washing) •Condensate	Hot water recycled within ultrafiltration system.
•Concentrate •Electricity	Homogenisation and pasteurisation	•Heat •Treated concentrate	
•Salt •Rennet •Treated concentrate	Mixing	•Cheese curds	
•Cheese curds	Incubation	•Final product	
• •Packaging materials •Cheese •Brine (filling)	Packaging	• •Wasted packaging •Product spillage •Final product	Off-specification products used to produce mish (obtain volume and value of loss and sale price o mish).

Step 5 Define Inputs

Using the process flow diagrams developed in Step 4, the inputs for each department need to be quantified. This should include, where possible, design and actual inputs such as:

- The amount of electrical power supplied;
- The amount of fuel that is directly consumed by each department (the largest consumer here will probably be the boiler house);
- The volume of steam consumed (steams of different pressures should be accounted for separately);
- The amount of process raw materials and chemicals used;
- The amount of other chemicals used (e.g. cleaning chemicals);
- The volume of water consumed (the different types of water consumed should be separately recorded e.g. city water, softened water, groundwater, water pumped from the river, canals or lakes);

Current levels of reuse and/or recycling both within each department and between departments.

The units used for each of these must be clearly identified.

If specific data are not available, ,best estimates, should be used and the basis for these estimates clearly stated. Other issues that should be quantified include storage and handling losses of raw materials and existing reuse and recycling steps.

Step 6 Define Outputs

The outputs identified in the process flow diagram need to be quantified. As with the inputs, if specific data are not available, ,best estimates, should be used and the basis for these estimates clearly stated. It may also be possible for measurements to be taken to obtain some of these values (see section 6.3). The following outputs should be considered:

- Process outputs, including final and downgraded products (quantity and quality), spillage losses, evaporation losses, reusable wastes.
- Wastewater sources, the units that they come from, their volume and concentration. Examples include washes and rinses within the processes, boiler blowdown, floor washing. Combined wastewater flows should also be clearly identified in terms of their origin, where in the factory this takes place and how they are combined (e.g. into a balancing tank, combined in main drain, etc.).
- Solid wastes, including information on where they come from, what they consist of, their volume and their eventual disposal route (e.g. segregated and sold, recycled, disposed as a waste off-site).
- Gaseous emissions, including in-process sources, vents and chimneys.

Note: A checklist can be used as an aide memoire in collecting the information described in steps 3-6. The checklist used in the SEAM Project is given as Appendix 2.

Step 7 Prepare Material and Energy Balances

Material and energy balances give a detailed account of all inputs and outputs, so that problem areas can be identified and losses quantified. They will also clearly identify and ***Prepare*** quantify previously unknown losses or emissions.

Material and Energy Balances for each Process Unit. These are normally presented as flow diagrams, which simply show the nature and volume of total inputs against the outputs. These can be prepared for:

- process units, to quantify consumption and losses for each process and
- important and/or expensive and/or hazardous resources.

Identify Discrepancies. When a material balance is first attempted, inputs usually exceed outputs, indicating that data are either incomplete or missing. The source(s) of these discrepancies must be identified and where possible, quantified (see section 6.3). Common causes of discrepancies include inaccurate data, different units of measurement being compared, missed discharges or waste streams and missed recycling steps.

Sources of Information for Material/ Energy Balances

The majority of this will already have been collected during steps 3-6.

- Sample analyses and measurement of raw materials, products and wastes.
- Raw materials purchase records and inventories.
- Emission inventories.
- Equipment cleaning procedures.
- Processing recipes.
- Product specifications.
- Operating logs.
- Standard operating procedures and operating manuals.

Refine Material Balance to a satisfactory Level of Accuracy. High levels of accuracy in material balances are usually difficult to achieve - an accuracy of ±10% should generally be acceptable. However, if hazardous and/or expensive substances are involved, a higher level of accuracy should be targeted. Once the material balance has been satisfactorily completed, this information can be used to calculate:

the value of the losses incurred. This can be calculated using the cost of the raw material and the corresponding volume and value of the lost product.

⇒ the amount of resources consumed in the production of 1ton of product.

the volume of waste generated in the production of 1ton of product.

Step 8 Benchmarks and Standards

The values derived for resource consumption and wastes generation can then be compared to national (where they exist) and international averages, known as ‚benchmarks‚, to show how well the factory is performing. These benchmarks can also be used to set targets for the factory to achieve in order to reduce wastage and optimise production. Specific benchmarks for each of the different sub-sectors are given in Chapter 4.

At present, no benchmarks have been developed specifically for Egypt.

Step 9 Identification of Potential Cleaner Production Options

Using the previously gathered information, the Team are now in a position to identify a large number of potential improvements. Specific actions that have been carried out in Egyptian factories are described in Chapter 9.0.

1. ***Identify Obvious Improvement Measures***. Most of these will have been identified during the factory walk through. Examples of such measures include:

   - Eliminating unnecessary water usage.
   - Recycling of slightly contaminated washwaters.
   - Improving existing storage facilities to minimise damage to raw materials and final products.
   - Stopping leakages and spillages.
   - Segregation of wastes for recovery, recycling or sale.

   These measures are generally easy to implement, with little or no capital investment.

2. ***Identify particularly Hazardous or Polluting Wastes***. Pollution in wastewater is an indicator that valuable raw materials, products or potential by-products are being wasted. Highly polluted wastewaters may also be toxic and hazardous, difficult to treat and its discharge into the environment can cause significant damage, as well as exceeding legislative discharge standards.

3. ***Develop Other Improvement Measures***. These can include:

   - Substitution of raw materials which have been identified as toxic, hazardous or otherwise unsuitable.
   - Modification of existing processes to optimise the amount of processing carried out or to improve the processing method.
   - Changing operating practices to ensure that wastage is minimised.
   - Recovering previously wasted by products (e.g. whey from cheese processing).
   - Installation of more efficient machinery, new processes, new technology.

Step 10 Assess Costs and Benefits of Cleaner Production Options

At this stage, a large number of Cleaner Production options will have been identified. The next step is to identify those options which will be of most benefit to the factory, both financially and environmentally. Following is a description of the sort of information that needs to be considered - the amount of detail required will vary on the overall size and complexity of the proposed action.

1. ***Technical Feasibility.*** The aim of this step is to determine that the intervention will work. It will describes the proposed intervention in detail and evaluates how the proposed measure will affect the process, product, production rate etc.. For each option proposed, the technical benefits that will result should be clearly identified (e.g. improved product quality, reduced energy consumption, improved productivity). These can then be quantified in the assessment of financial viability.

2. ***Financial Viability***. This step establishes the costs and benefits of implementation. The information required includes present production costs, capital and operating costs associated with each intervention and value of any savings made. Priority should be given to the evaluation of low-cost/no-cost options, which may only require the calculation of a payback period. Higher cost options may need a more detailed assessment to evaluate economic feasibility.

Environmental Benefits. Where possible, an environmental assessment of the selected options should be carried out, even if some of the benefits cannot be quantified. This should include effect on wastewater volume and toxicity (and hence reduced treatment costs and movement towards legislative compliance), reduced generation of solid wastes (improved site appearance, reduced disposal requirements) and improved working conditions.

Note: In the SEAM Project, the technical, financial and environmental assessments were presented in the form of ‚Project Concept Notes‚ (see section 9.6).

Step 11 Prioritising Cleaner Production Options

It is unlikely that all of the options identified can be implemented immediately. Therefore, once all of the realistic opportunities have been identified, the next step is to prioritise them. A suggested method of prioritisation follows:

Priority 1: Factors where there are significant polluting effects or a strong probability of an incident which will require urgent and effective action OR where the company is acting illegally OR significant benefit to the company will result through reduced costs or improved efficiency. This group will include most of the ‚Obvious Improvement Measures‚ described in Step 9, which will be very easy and cheap to implement. ***The financial benefit to the company will exceed the cost of implementation within a short time (less than 1 year).***

Priority 2: Factors where there are apparent polluting effects or a probability of an incident which will damage the environment OR is a significant risk to the health and safety of staff OR the ***benefits to the company will result through investment in the medium term (1-3 years).***

Priority 3: Factors which will not have immediate adverse consequences but where the company can expect benefits in the longer term through reduced costs or better employee, customer or public relations.

Step 12 Developing Cleaner Production Action Plans

The Action Plan should describe when and how the prioritised actions should be implemented. This will allow the factory to match the proposed actions to any budget constraints that exist, as well as identifying critical actions, such as eliminating the use of banned or hazardous chemicals. This should be supported by a monitoring programme which will record the actual benefits made.

The Action Plan should also identify when the next Cleaner Production Audit is to be carried out and how often this should be done.

Step 13 Implementation of Proposed Cleaner Production Options

Once the options have been assessed and prioritised, implementation can commence. Most Priority 1 options can be implemented immediately - of these, the lowest cost options should be completed first. The remaining options may require some planning if implementation is to be successful. Again, the amount of detail required will vary on the overall size and complexity of the proposed action.

Preparation - This will require:

- A Team to be set up which will be responsible for implementation and a Team Leader, who will co-ordinate the tasks and monitor progress.
- The preparation of technical documents that describe what the project is, where it is located and what work needs to be carried out. This may include a ‚Bill of Quantities‚‚ which itemises equipment which has to be purchased.
- A workplan which describes all the tasks that need to be carried out and an estimate of how long each task will take to complete. This will also allow work to be scheduled to minimise disruption to the normal working day.

In order to achieve the best results, it is important that staff are kept informed of the changes going on and provided with training if required.

Implementation - the workplan developed in the planning stage should be used as a guide for implementation. Each task in this should be assigned to the most appropriate member of the Team, with individual tasks being co-ordinated by the Team Leader. If any significant delays occur, the workplan should be modified, so that tasks can be rescheduled. Progress reports can also be provided to senior management and other Team members to keep them informed of project developments.

Once implementation has been completed, the new work procedures should be documented in the form of revised work instructions. Staff training may be required to ensure that these are understood and can be easily followed. Revised instructions to other departments may also be necessary. For example, if one chemical has been substituted by another, revised instructions to the purchasing department will be required.

Monitoring and Evaluation - this will need to be carried out once implementation has been completed to ensure that the project is performing normally and that the expected benefits are being realised. This will help identify - and solve - any unforeseen problems at an early stage, as well as informing management of progress.

6.3 Sampling and Analytical Requirements

(i) Water and Wastewater Flow Measurements

Ideally, continuous measurement of liquid flow rates should be carried out with fixed equipment. If this does not exist, then estimates of flow have to be made by simple methods by using, for example, a calibrated collecting vessel and stopwatch. Crude estimates can be made from pipe dimensions, judgements of flow rates etc..

(ii) Wastewater Sampling

In most factories there will be considerable variability in wastewater quality over time; sampling therefore needs to be carried out to minimise this:

- A series of single ‚grab‚ samples can be manually collected. These can either be tested independently or combined to give a composite, time-averaged sample. Automatic time-average samplers for wastewaters are available commercially.

- Flow proportioned samples are desirable but in practice are difficult to take.

Samples should be taken from the end of discharge pipes where possible.

Certain chemical parameters require the sample to be stabilised, for example, by the addition of acid for heavy metal analyses. In some cases the sample has to be taken into glass containers rather than plastic.

Before any sampling is carried out, it is advisable to discuss and finalise what is required with the laboratory which will be carrying out the analyses.

(iii) Sample Storage and Transportation

Once taken, the samples should be delivered to the testing laboratory as soon as possible after sampling, preferably within the same working day and always within 24 hours. If there is any delay, samples should be kept cool by storing them in insulated boxes with freezer packs.

(iv) Wastewater Analyses - Laboratory Analyses

Wastewater may need to be tested for one or more of the following parameters:

- Biological Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Suspended Solids and Total Solids.
- Heavy metals. Analyses would only be required for specific metals based on the chemical substances used in the factory.
- Organics such as pesticides, hydrocarbons, oil & grease.

The need for chemical analyses should be carefully assessed, as it is usually complex and expensive.

(v) Wastewater Analyses - ,in situ, Measurements

The following parameters can be measured at the discharge point itself, using portable meters:

- Temperature.
- Conductivity.
- Turbidity.
- pH.

(vi) Measurement of Gas/Vapour Flow Rates

Gas/vapour flow rate measurements may be necessary at vent entries and exits or within ducts, although the latter may be problematic because of access difficulties. Where access is possible hot wire anemometers can be used for flow rate measurements.

Flow rate should be measured where it is least affected by bends etc. and a number of measurements taken in the centre and towards the sides of the duct. Before ducts are breached, consideration must be given to the potential release of hazardous materials and the way in which the duct can be effectively sealed after measurements have been made.

(vii) Air and Flue Gas Composition

In the absence of suitable electronic equipment, boiler efficiency can be assessed based on such factors as plume colour (e.g. Ringelmann chart shade), fuel usage and length of time since previous checks. The concentration of many gases can also be estimated using Draeger tubes.

(viii) Noise

Noise needs to be considered in relation to environmental nuisance or as an occupational hazard. The maximum allowable sound level (Law 4) is 90 decibels. Prolonged exposure to noise above 80 decibels can result in permanent damage to hearing.

6.4 Sustaining and Developing Cleaner Production

The advantages gained by the implementation of Cleaner Production options need to be monitored to ensure that the new practices are followed by factory staff. This could be encouraged by the establishment of reward and recognition schemes to ensure that employee interest and motivation is maintained. Staff involvement throughout the entire process will also help ensure that their interest and participation in the implemented projects is maintained.

In order to identify new Cleaner Production options, this audit process should be carried out again after 1 year or so. If possible, the original Audit Team should be used, in order to take advantage of their newly acquired knowledge and skills in the identification and implementation of Cleaner Production options.

7.0 Cleaner Production Options in Food Processing - An Overview Of Opportunities

All food processing factories can generate pollution and that pollution is both a risk to the firm and a cost to the firm. It is impossible to quantify that risk for the sector as a whole, except by saying that major international companies recognise various attributes of their individual risks and take actions to avoid, mitigate or eliminate them.

The Egyptian food processing industries seem to carry significant environmental risks in that:

- They produce large quantities of wastes.
- The wastes become putrid and objectionable very quickly.
- The wastes find their way into watercourses.
- The wastes are often not treated.
- The quantity of wastes is unknown and uncontrolled.
- The wastes constitute a potential resource in some cases.
- The wastes can constitute a health hazard.
- The waste of energy reduces the viability of a company's operations.
- The waste of water represents a major resource issue to Egypt.

Therefore, in the food processing sector there are numerous options for intervention. The practicality of these options will depend on the business cycle, the business situation of the firm and numerous other factors. Generally these options will fall into a few categories:

- Good Housekeeping.
- Energy Savings.
- Water Conservation, Reuse and Recycle.
- Raw Materials and Input Changes.
- Chemical Substitution.
- On site Recycle and Reuse.
- Product Redesign.
- Worker Training Programmes.

7. 1 Good Housekeeping

There are many opportunities for good housekeeping options in almost all food processing operations. Every factory, especially the older, publicly-owned operations, have a host of poor practices which result in food being converted to waste and a loss of revenue. Every site and every operation is different, but some options are given below for the fruit/vegetable sectors. These options are easy to implement, require little capital and can be seen to make sense. As well as this they sometimes save considerable sums of money and improve staff morale.

Some examples include:

- Install drip trays to stop food hitting the ground.
- Prevent leaks and repair them.
- Store dry materials appropriately.
- Prevent vermin ingress.
- Minimise clean out waste by increasing batch size.
- Improve inventory management.
- Avoid shut-down losses.

- Avoid combining different waste streams.

7.2 Energy Savings

There are many options for energy savings in most food production plants which range from stopping simple energy losses and leaks through to complex computer control operations. Often a specialist is required to examine the energy balance of the site and to bring a novel perspective to the task. Energy, like water, is often taken for granted in production operations and not fully costed into the products.

Energy use and wastage appears to be an issue around the world, approaching the level of interest shown in the energy crisis of the 1970s. In Egypt, site visits demonstrated that energy wastage was significant - there was a large problem in controlling steam leaks, lack of condensate recovery, lack of boiler maintenance and there was significant energy losses from lines and tanks etc. Ongoing monitoring and measurement as part of the SEAM Project have corroborated this. However this is not unique to Egypt, but the scale of the energy inefficiencies may be greater.

7.3 Water Conservation, Reuse and Recycle

The options for water reuse and recycle in a food plant are diverse. However success will depend very heavily on the costs of purchasing raw water and treating wastewater, as well as the desire of the plant to become more environmentally efficient. There are many generic methods for attempting to harness wastewater in the factory and reuse and recycle it. Carawan (1996) has listed many methods of determining how water can be saved in different food processing factories and shown that significant cost savings are made. The projects that Carawan has assessed range from dairies to shrimp processing factories and have indicated that large savings in water costs can be made. This depends of course on water and wastewater costs as drivers for change and environmental improvement.

Today there is a world-wide shift towards encouraging in-plant water conservation, recycle and reuse. However, site visits in Egypt indicated that low or zero rated water charges and wastewater charges and a resigned attitude to water leaks and water losses did not help the conservation cause, or force change in the plant. It may be that the economics of water and wastewater will have to change before any significant impetus towards water conservation result.

7. 4 Raw Materials and Input Changes

This is an area where substantial environmental and pollution prevention benefits can be gained by choosing a more environmentally suitable feedstock. However, there can be substantial difficulty in changing raw materials as real choice is often outside the ability of the company to manage. This type of change involves long term strategic decisions, which may impact directly on the profitability of the firm. Huge successes have been gained in both environmental improvement and profitability improvement from the more effective management of the supply chain in general and inputs in particular.

The SEAM audit programme revealed significant savings could result from improved transport processes and better care from farm to factory - just looking after the input product would result in better process results and lower wastes. Such changes may require considerable non-technical involvement to implement and may not be as simple as they appear to be at first glance.

7.5 Chemical Substitution

There is no straightforward methodology which can be used for identifying chemical substitution opportunities in a food processing factory. Sometimes there are obvious places where a simple substitution can be made (such as sulphuric acid, caustic soda and freon), otherwise considerable research may be necessary to identify likely candidates. Obviously dangerous chemicals such as some sanitisers are priority listed, but there may be many others which go unnoticed without an environmental scan. Therefore it is recommended that a full Cleaner Production or Toxic Use Reduction type assessment be carried out, with management input, to investigate the ability of any company to reduce its environmental risks by this method.

Many companies audited stated that there were no toxic chemicals used on-site. However, an inspection of the inventory and storage areas showed that toxic and hazardous chemicals wee present, possibly indicating that there is a significant misunderstanding of what a toxic chemical actually is.

7.6 On site Recycle and Reuse

There are many possibilities for this strategy in a food processing company from development of new products to different qualities of products. Most companies are aware of many possibilities in the recycle area and attempt to recover as much of their reject, spoilt materials and other materials.

Off-site reuse/recycle is an obvious environmental benefit and it may bring about significant environmental and commercial improvements. The use of whey as an animal feed for example, may be viewed in this way.

7.7 Product Redesign

In the food processing industry, there is little written material on product modification for enhanced environmental management, however some customer preferences can be harnessed. For example brown sugar may be considered environmentally preferable to white, similarly white vs. brown rice and wholemeal vs. white bread. Controlled atmosphere packaging is resulting in the ability to manage shelf life and repackage products and reposition them in the marketplace, as is cold chain management.

Better knowledge of how to sanitise, pasteurise and sterilise has caused big improvements in product shelf life and reduced spoilage, waste and improved customer safety. Thus there is scope for this kind of intervention in Cleaner Production programs resulting in better products and better profitability.

7.8 Worker Training Programmes

As an essential part of any Cleaner Production programme, at any level, for any firm, a worker training and awareness programme is essential. Although management commitment is equally essential, without staff involvement and their sense of need, then the gains made by Cleaner Production will be minimised. Without worker training, involvement, and a sense of ownership, the Cleaner Production programme will be relatively unsuccessful in the longer term.

There are many different types of worker training programme which depend heavily on the needs of the organisation, its size and management structure. Where Cleaner Production awareness does not exist or is relatively low, a programme which introduces the general concepts would be most appropriate. Any such training should also assist factories to identify individuals and build up teams who would take the concept forward. Thus Cleaner Production can be used as a management tool for change as well as involving the workforce.

8.0 Cleaner Production Options identified through SEAM

Examples of specific actions identified by the industrial audits under the SEAM Project are described in the following sections for each of the different sub-sectors. Other interventions which may also be of interest have also been included.

8.1 Fruit and Vegetables

8.1.1 Cultivation Waste Reduction Measures

(i) Use of Chemicals in Farming

At one of the factories audited, there was some concern that lead (Pb) and residual pesticides were present in the raw materials, which might have been getting into the final product, although this could not be verified. To completely avoid this problem, consideration should be given to reducing or eliminating all toxic chemicals used at the farm. If this is not possible, all incoming raw fruit and vegetables must be thoroughly washed and regularly tested to ensure that they have not been affected.

Field monitoring to assess water needs and to supply precisely monitored qualities of water and nutrients is very effective in reducing pollution and costs. Field ripeness monitoring, nutrient status and appropriate nutrient delivery can also make great savings. Similarly, integrated pest management techniques to reduce chemical use can save large amounts of money as well as reducing environmental impacts.

(ii) Cleaning and Preparation of Raw Fruit and Vegetables at Source

If cleaning can be carried out in the field or on the farm it will reduce the amount of material which has to be transported and which will eventually have to be disposed of by the factory.

If crop grading, trimming, selection, culling and inspection can take place in the field, the amount of solid wastes generated by the factory will be further reduced. A further advantage to the producer is that these residues may be usefully employed in situ, for example as fertiliser or for animal feed.

(iii) Quality of Incoming Raw Materials

The industrial audits carried out during the SEAM Project showed that the raw fruits and vegetables delivered to the factories were often damaged. This was particularly noticeable with soft fruits, some of which were bruised, crushed and sometimes rotting. In addition to costing the factory money due to lost raw materials, these losses will also unnecessarily increase the pollution load and increase the untidiness of the factory. Tainting of the final product may also occur. This can only be rectified by the supplier - the factory can only action this by refusing to accept goods delivered in an unacceptable condition.

8.1.2 Processing Wastes

To reduce the amount of wastage generated during processing, the following actions should be taken:

- Transfer of raw fruit and vegetables should be carried out carefully to reduce spillage across the site and reduce bruising and damage. Careless handling of incoming materials was a common problem noted during the SEAM audit process, resulting in raw material loss and possible adverse effect on final product quality.
- Reduce water contact as organics can leach out of the product into the water stream, increasing effluent BOD and reducing product quality.
- Reduce water volumes to minimise discharge. Wherever water is being used in the plant, as makeup, process, cleaning etc. the use should be monitored and reduced as much as possible to save money, to reduce discharges and to stop unnecessary loss of product..
- Reduce holding times to minimise amount of losses into water streams.

- Dry and recycle wastes if possible. Wastes may need drying to allow them to be stored and stockpiled, and there are many ways of doing this.
- Use best available technology for slicing, cutting, peeling, evaporating and sterilising etc. There may be opportunities to upgrade older equipment that is no longer as efficient as new, modern equipment and methods.

Consideration should be given to examining the following waste generation steps and finding out the cause of waste generation:

- Raw material washing, grading, trimming - minimise, regrade, specify better quality raw materials and avoid trimming. Every contact with water introduces possibilities for microbial contamination and spoilage and trimming etc. produces wastes which need to be avoided.

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  upstream, peeling avoided and size reduction avoided. Water contact will leach out raw materials into water stream and every time peeling is carried out; size reduction produces wastes.

- Blanching and fluming - can the blanchwater be used elsewhere, is blanch time/temperature correct and optimal, can dry conveying be used instead of fluming? Wet conveying may leach materials out of product increasing BOD and maybe decreasing quality.

- Filling - are settings correct, is the equipment automated or semi-automated, is over or under filling a problem, is staff trained and motivated to detect this? The filling section can produce a lot of high value waste material and containers should be correctly positioned and the equipment correctly set up and maintained for ‚perfect' operation.

- Sanitation/plant cleanup - are the correct chemicals being used at the right concentration and with the correct sanitation regime. This operation is a major source of wastes and can result in high pH material being generated and high volumes of water. Water volumes should be minimised by dry cleanup first and squeegeeing and mopping before any hosing, which should be kept to a minimum. Hoses should have controlling nozzles at the end.

- Processed product cooling - use appropriate cooling process for the product without wasting water. Cooling waters should be reused and recycled as much as possible as they are often good quality. Ascertain the causes of any breaks, leakages etc. causing product to contaminate the cooling waters and fix the problem.

Technology issues that should be considered include use of upstream technologies, such as:

- Use mechanical equipment in field when possible to minimise problems caused by manual harvesting and transport.
- Use appropriate and good quality transport equipment - e.g. suitable protective containers. Many containers are not suitable for transport of goods such as tomatoes and bottom layers and many other layers are crushed both by the weight of containers above them and by the roping process. Use bulk bins or other protective devices to minimise harm to produce.
- Cool and keep chilled during harvesting, transport and reception. For some crops this is a great help in minimising harvest, transport and processing losses and produces much better quality product after processing.

8.1.3 Reception and Processing

During the SEAM Project audits, a number of recommendations were made to reduce losses and improve the ways in which processing was carried out. These included:

- Chilling the incoming products and keeping them cool until they are ready for processing.

- Avoid causing damage during handling. This can occur if the incoming products are tipped from heights; stored carelessly prior to processing, such that they are crushed and bruised; or transferred using inappropriate loading equipment.
- Install process control systems and repair/check/calibrate measuring equipment. In many cases there was no functioning process control equipment, even temperature gauges were missing from evaporators resulting in scorched and caramelised product with poor flavour characteristics. Taking these remedial actions will ensure that energy and water are not wasted, and product quality is optimised.
- Use countercurrent washing operations where possible. The counter current principle has long been known however it is often not practised despite being the most efficient way of washing.
- Reuse clean water streams for preliminary washing operations. Many operations have multiple sources of used water which are relatively clean and can be used for incoming product wash as well as many other non-critical operations around the plant.

Other general recommendations include:

- Use commercially available, proven suppliers of equipment.
- Ensure process controllers are optimised.
- Use minimum process conditions for sterility, safety, quality and product specifications.
- Reuse fluming water after settling, sedimentation or other appropriate treatment.
- Constantly check on technology options available as suppliers improve equipment regularly.

8.1.4 Packing and Storage

- Reduce the quantity of water used for washing and can cooling. In one of the factories audited, it was calculated that 50-70% of this water could be reused in earlier stages of the process.
- Ensure equipment is up-to-date and functional. Many old pieces of equipment were noted which would have poor operational and environmental characteristics. When capital and labour permits the equipment should be updated and optimised.
- Install semiautomated or automatic equipment. Although this may reduce the amount of labour required, the effects on product, process and profitability are expected to be positive.
- Ensure packaging is appropriate for task - strong, durable and suitable. There were many observations made that poor quality packaging was used resulting in carton losses, product breakages and spills, and poor appearance and lower prices for the final product.
- Ensure filling equipment is calibrated and checked. Many instances were seen of underfilling resulting in manual topping off and overfilling resulting in gross spillage. This should be easily avoided.
- Ensure storage areas are at correct temperature and are easily accessed. All storage areas should have appropriate security in place for quarantine goods and other protection measures and safety considerations should govern temperature and access. Access should be arranged so it is safe and mechanical equipment can enter and leave easily and visibly.
- Use mechanical equipment for loading and unloading. Careless unloading and loading were seen to cause many breakages and much damage.

8.1.5 Reuse of Wastes

- All solids should be removed from the process wastewater using screens. These can either be disposed or used as animal feed. In one factory, for an initial investment of around LE 2,000, it was estimated that payback could occur in 1 year. As well as being a valuable source of nutrients, this action will also reduce the strength of the final effluent and reduce the frequency of drain blockages.

- Pectin (used as a thickener in the production of jam) and essential oils (used as food flavourings) can be recovered from citrus fruit skins. Although this is a potentially valuable market, significant investment and careful identification of potential markets will be required.
- Edible wastes should be recovered as animal feed with appropriate care being taken in the identification and removal of glass and other packaging materials.
- There may be opportunities for composting, ensilaging or other added value activities for the wastes.

8.1.6 Wastewater Issues

Throughout the factories audited, high volumes of wastewater containing high concentrations of BOD and suspended solids were common. Based on these observations, a number of recommendations were made which would help minimise both the volume and strength of the effluent:

- Repair all water leaks. At one factory, using average monthly water consumption values, an initial investment of LE6,000 in automatic shut-offs for hoses resulted in annual savings of LE16,000.
- Install steam traps - in one factory, an investment of LE14,500 generated annual benefits of LE32,000, giving a payback period of 5.5 months. These savings could be increased to LE106,700 were the factory to be operating at full capacity.
- Install self-closing hose nozzles - at one factory, an initial investment of LE4,900 gave annual savings of LE9,000, giving a payback period of 6.5 months.
- Recover condensate. For an initial investment of LE40,000, annual benefits of LE33,000 were generated, giving a payback period of 15 months. When the factory is working at full capacity, the annual savings would increase to LE66,000.
- Provide hose reels to store hoses and prevent them being left lying around with water streaming out.
- Provide steam at correct quality and rate to prevent overpressuring lines, incorrect steam trap specification and steam wastage.
- Reuse and recycle water when possible.
- Separate and segregate waste streams at source for by-product recovery.
- Separate low and high strength waste streams.
- Minimise all water flows and stop overflows.
- Use low volume, high pressure hoses.
- Reuse washing water.
- Install closed circuit cooling systems.
- Investigate treatment needs for cooling systems and have adequate blowdowns. Blowdown should be just sufficient to maintain the correct concentration of species in the water.

Other actions that can be taken include the:

- Use of steam blanching instead of water to reduce waste volumes.
- Use of air instead of water for cooling and thawing.
- Reuse of fluming water.
- Education and training of staff, to demonstrate the importance of using water carefully, in order to reduce the volume of the final effluent and save money and resources.
- Provision of simple treatment options to allow water to be recycled - sedimentation, coalescing plate filters etc..

8.1.7 Wastewater Treatment

Wastewater treatment is an expensive and highly technical option requiring substantial inputs of skill, time and process chemicals. It also takes up substantial space which is often lacking in closely packed factories. Anything which can be done to reduce the amount of treatment which water requires or to reduce the quantities will imply substantial savings for the company.

Some low technology options to reduce the need for expensive biological treatment, which are applicable across virtually all sub-sectors, are:

- install screens, grates on drains.
- install filters - especially self-cleaning filters - to recover solids.
- install save-alls and settling basins.
- recover oil from skins and seeds and other raw materials, e.g. corn oil.
- recover colouring compounds.
- fermentation to recover alcohol, animal feed material or other by-product - an ongoing search for appropriate cost-effective substrates.
- install DAF unit to recover suspended materials.

Following treatment, it may be possible to use this water for irrigation. This could be used to irrigate green areas within the factory itself, or by farms adjacent to the factory. However, this water should be periodically checked to ensure that it is not contaminated and meets water reuse criteria, especially for health and safety in your area.

8.1.8 Distribution and Consumption

Somewhat generic in this context, there are a number of activities that are being undertaken to reduce waste and increase profitability in the post - process area. Some activities which stand out are the use of packaging companies' advice on designing packaging and products for the market. Such companies have worked with the industry in different sectors and revolutionised the way food is presented. Modern packaging allows food to be prepared in the factory and consumed much later in the home after passing through the distribution chain with minimal disturbance to the quality of the final product. Controlled atmosphere packaging, as well as the packaging materials themselves, are having a positive effect on the availability of food in the shops, improving choice and increasing safety. Appropriate packaging of the right strength is required to ensure protection of the product from factory gate to final consumption. Distribution chains, e.g. inventory management can also be examined for causes of waste.

Distribution chains are becoming more sophisticated, with extreme care taken to manage temperatures and other important variables through the last life cycle stage of the product.

It is difficult to comment on consumption patterns and waste generation except that there are very strong environmental movements in various countries promoting recycling of wastes via composting. Local governments are also actively involved in recovery of green and wet wastes. However it is believed that life cycle assessment may show these activities to be net resource negative. At the same time the rate of growth of the convenience food is showing no signs of abating in either developed or less developed countries.

8.1.9 Future Trends

There is a move towards examining the food processing industry and others from a systems perspective, rather than the unit operation approach as was common in the past. This is allowing great diversity of technical input into the industry and forcing great changes. These modern approaches which aim to reduce wastes can be grouped into two approaches, upstream and downstream.

Upstream approaches use genetic engineering to improve attributes for processing such as:

- harder skinned tomatoes.

- similar sized products.
- seedless fruits and vegetables.
- fungal resistance.
- bacterial resistance.
- ripening control.

However the use of genetically modified organisms is undergoing a backlash at the moment.

In-process and downstream systems and technology approaches are being used such as:

- cool transporting, handling and storage.
- controlled atmosphere packaging and appropriate packaging.
- better process control.
- prevention or avoidance of water contact.
- quality monitoring and documentation using computers and computer control.
- membrane processes for concentration and separation.
- distribution chain management and control.

All these interventions cause a significant decline in wastes and increase in productivity and economic viability.

8.2 Dairy Industry

8.2.1 Farm Waste Reduction Measures

A number of actions can be implemented at the farm, both to reduce wastage directly and to improve quality, thus reducing process wastage.

- Cool product immediately and efficiently, store in refrigerated area and monitor.
- Computerised tracking of production rates.
- Improved herd management and nutrition.
- Chemical free herds and feed.
- Efficient sanitisation of sheds and cows.
- Good farmer training and extension programs.
- Better breeding programs.

8.2.2 Process Waste Reduction Measures

The pace of change in this industrial sub-sector is rapid as it operates on slim margins and hence needs to be continuously updated to be competitive.

A major technology input has been the use of membrane technologies, including reverse osmosis, nanofiltration and ultrafiltration both for recovering product and for producing new types of product e.g. protein fortified milks. This industry was one of the first to accept such technology changes, especially in countries such as Ireland and New Zealand where the dairy industry is of national economic importance.

8.2.3 Reception of Raw Milk

The following actions will help ensure that raw milk quality is maintained upon arrival at the factory:

- Cool handling, processing and storage.
- Appropriate sanitary design of buildings.
- Efficient pasteurisers, homogenisers, centrifuges and other equipment.
- Use equipment designed for milk with milk fittings used.
- Use CIP (Clean in Place) when possible and check for suitability.

- Do not use non-hygienic materials e.g. wood.

8.2.4 Processing

- Recover and use whey. In Egypt this has included using it in the packaging of white cheese, instead of fresh water. This costed nothing to implement and made annual savings of LE2,000. Whey can also be used to generate other products (e.g. ,yoghurt drinks,) or as an animal feed (see section 9.7.3). The strength of the final effluent will also be significantly reduced by removing the whey from the wastewater.
- Undertake good water management techniques as described for fruit/vegetables (section 8.1.6).
- Minimise spillages by ensuring that all milk storage tanks have level controls with automatic shutoffs and ensure that all valves are of ,food quality, and not leaking. Actioning these 2 items in a dairy factory in Egypt has resulted in annual savings of LE126,000, for an initial investment of LE64,250.
- Use modern equipment for concentration.
- Use modern cheese making equipment.
- Recover and recycle fines.
- Allow streams to cool if hot to recover fats.
- Prevent fats entering waste streams by using save-alls, centrifuges and grease traps.

8.2.5 Distribution and Consumption

Milk is a very versatile foodstuff and rapidly deteriorates due to microbial spoilage if not maintained at low (<4°C) temperatures. Uses for spoilt milk are few. Transport and storage considerations dictate the usefulness of the product and its shelf life, thus all activities which tend to lengthen shelf life will reduce losses from spoilt milk products. Spoilage rates of the final product can be minimised by:

- Use of computerised inventory control system and good temperature control.
- Use of appropriate strength and grade of packing.
- Use of modern packaging system - e.g. Tetrapak or polyethylene bottles.
- Use of modern delivery system including refrigerated vehicles.
- Use of efficient cool storage and transport system and track temperatures.
- Use of appropriate labelling.
- Education of customers about product shelf life and refrigeration needs.
- Installation of a preventive quality system to monitor and record activities.

8.2.6 Future Trends

Innovations in membrane technologies continue to be made, a well-known example being the use of specialist membrane methods for product concentration. Ultrafiltration and nanofiltration are now considered the usual technologies in this industry in many countries.

8.2.7 Other Issues

- Genetic engineering to improve fat and protein content.
- Herd control for higher milk production.
- Chemical flocculation of fats and protein precipitation.
- New technologies for protein recovery.
- Better control of residuals.
- HACCP in dairies for risk reduction.
- Better drying control from better spray dryers with computer control.
- Better people control to reduce anthropogenic contamination of the product.

- New products for example UHT (ultra high temperature) pasteurised milk for long ambient temperature shelf life, protein enriched drinks, whey, buttermilk and other dairy drinks.

8.3 Confectionery

8.3.1 Upstream Considerations

Confectionery factories may use high cost input materials such as cacao and sugar, lecithin and edible oils. There appears to be little the factories can do with their input raw materials, except possibly specify higher quality materials, if this was an issue, treat water to a higher standard, or source a different input supplier. However, like any other manufacturer, confectioners should always be examining their input raw materials for effects on product quality and for method of packaging and delivery etc. There are usually opportunities to negotiate different inputs which may have significant effects on production of wastes and lower quality products.

8.3.2 Process Waste Reduction Measures

The confectionery industry uses high value products and are also relatively low volume producers, therefore controlling wastes may be easier than for some other food sectors. To reduce the amount of wastage generated during processing, the following actions could be taken:

- Consider closed circuit cooling water supply wherever possible.
- Install pressure regulators on steam lines, install functioning steam traps which are appropriately sized and insulate and fix all steam leaks.
- Ensure tempering, storage and other vessels and transfer lines are appropriately insulated.
- Raw material handling creates waste through ingredient storage and movement resulting in spills. One option is to make the raw material packaging stronger in order to reduce breakage and to consult with suppliers to provide more sustainable package and to use returnable packaging.
- Ingredients tend to spill or disperse into the air when poured into silos. There may be options to redesign these to prevent wastage and to introduce cyclones or bag filters to recover product.
- General housekeeping and lack of attention to handling raw materials causes unnecessary waste.
- Use a dry scraping method first to remove product from vats and mixers and obviously the dry cleaning of floors and other areas results in less liquid wastes and more opportunities for segregation and recovery..

Other options which could be investigated include the generic options previously mentioned for other subsectors:

- Install water recovery/water reduction options.
- High pressure low volume sprays.
- Air chilling.
- Dry cleaning.
- Install dust recovery systems.

8.3.3 Product Recovery

Two such opportunities which were identified during auditing included (and which are often carried out):

- Recycle biscuit and wafer wastes into product. The broken or spoiled biscuit material can usually be added as an ingredient into some other confectionery product provided it is segregated and kept clean.

- Sell downgraded product at a lower price to staff.

Other options which could be investigated include:

- Recovering foil and selling it for scrap or to the supplier.
- Selling very low grade material for animal feed.
- Scraping all residuals from containers, using air knives where appropriate.

8.3.4 Packaging and Storage

Packaging in this sector can lead to substantial waste generation as it is often quite expensive with multiple packaging being used to tempt the customer. Thus there are often opportunities to recover spoilt packaging materials, e.g. foils and to look for modern attractive and functional wraps that are less resource intensive. Minimising foil thickness, consulting with suppliers and possibly using a paper laminate are also options to reduce cost of waste and resource use. Wraps can also be a significant loss.

Storage is also a significant issue for this subsector. Spoilage by infestation can be a problem as the finished and raw materials are both attractive to pests. Also climate can affect the properties of the product, and it is important to maintain storage conditions to stop melting, or crystallisation of the product and to maintain shelf life.

8.3.5 Future Trends

Actions that are being adopted internationally include:

- HACCP for risk reduction. In all food industries, HACCP can be profitably used to identify process critical points for spoilage or harm. The materials produced are less likely to be microbiologically harmful than many other food products as they are low in water activity and sometimes have been subject to very high temperatures, however there are many other issues for which a HACCP attack would help in reducing risk.
- Improved workplace management will help to reduce the wastage of expensive raw materials and finished goods from a negligent attitude and lack of appropriate training. Many wastes are avoidable if workers are motivated and secure in their jobs.
- Improved process control from automation and better sensors will have significant downstream effects.
- Improved packaging and form-fill-seal machines coupled with robotics and stronger and more durable packaging will lead to lower wastes and higher pack-out rates.
- Improved hygiene and higher standards will lead to lower rejects.
- Using state-of-the-art tempering and conching equipment will also lead to higher quality standards and lower rejects, while for the harder candy markets better process control and better control of process inputs will lead to minimising wastes.

8.4 Fish Processing

8.4.1 Upstream

Although most factories have no direct influence on how fish are either caught or grown, they may be exert some influence by not purchasing from wasteful producers. Wastage can be minimised ,at source, by:

- Targeting appropriate species.
- Using species specific catch methods.
- Finding a use for by-catch.
- Harvesting appropriate sizes.
- Segregating catches.

- Controlling chemical and antibiotic use in marine farming operations - reduce when possible.
- Controlling farm-feeding operations and seek improvements.

8.4.2 Process Waste Reduction Measures

To reduce the amount of wastage generated during processing, the following actions could be taken:

- Recycle cooling water from autoclaves - for an initial investment of around LE8,000, annual savings in water and energy of LE12,000 were calculated, giving a payback period of 8 months.

- Installation of pressure regulators on steam lines. In one factory, for an initial investment of LE7,500, it was calculated that annual savings of LE36,000 could be made, giving a payback period of 3 months.

Other options which could be investigated include:

- Install water recovery/water reduction options.
- High pressure low volume sprays.
- Air thawing.
- Air chilling.
- Vacuum cleanup.
- Dry cleaning.
- Good clean process areas.
- Use mechanical conveying.
- Modern hygienic equipment for defleshing, etc.

8.4.3 Product Recovery

Two such opportunities which were identified during auditing included:

- Recovery of fish oil. Large volumes of fish oil escaping to the effluent steam represents a loss of a valuable product as well as unnecessarily increasing the organic load of the wastewater. In one factory, it was estimated that for an initial investment of LE4,000, annual revenue could total LE200,000, giving a payback period of less than 1 month.

- Recycling of fish oil sludge. Rather than being disposed as a solid waste, this can be used as an animal feed. For an initial investment of LE5,000, an annual revenue of LE3,600 could be generated.

Other options which could be investigated include:

- Chitin and Chitosan recovery. For many years there has been continual interest in recovering these shellfish structural materials for use in products as diverse as immobilising enzymes to ion exchange. Research is underway in many laboratories to find cost-effective and economical applications for these products, however there is still reluctance to invest in large recovery plants without knowledge of secure markets.

- Recovery of fishmeal. Most larger seafood plants would have a drying plant for fishmeal recovery for feed or for fertiliser. There are also numerous derivatives of fermented or otherwise stabilised products for fertiliser application. Drying technologies are well known and the major problems associated with the plants are odour production and control and fines recovery from what can be a difficult product. In some countries fish are caught principally for fishmeal production. Fish oils too comprise a valuable resource which are usually effectively recovered.

8.4.4 Hydrolysates and Sauces

Many countries have their specific native fermented fish sauces. These are methods of invoking the enzymes present in the seafood or encouraging consortia of micro-organisms to grow and break down the proteins and tissues to produce a savoury brew which can be used as a sauce. Technology options are mostly concerned with controlling the organisms present, controlling the salt levels and preventing pathogenic organisms from growing. These hydrolysates can be very useful as they add palatability to food and to animal feed, they can increase digestibility and can add significant levels of nutrients. They are generally liquid and thus can be easily sprayed on to food in low, controlled doses.

8.4.5 Future Trends

Actions which are being adopted internationally include:

- HACCP for risk reduction.
- Improved retort management.
- Improved workplace management.
- Decreased by-catch production.
- Recycling and reusing water on site.
- Fish juice recovery.
- Mechanised flesh recovery.
- Flavour recovery from washwaters.

8.5 Non-Alcoholic Beverages

8.5.1 Upstream

Most juices and beverages are reliant on the type of agricultural feedstock for quality and taste. The same comments applied to farming operations (section 8.1.1) are relevant in this case. There is a constant search for better mashing barley grains and similarly better juicing fruits and vegetables are constantly being sought.

Manufacturers are aware that in this case pollution represents real loss of product and they take steps to avoid it.

8.5.2 Process Waste Reduction Measures

For many years beverage companies have been aware that they need to reduce costs by minimising wastage and significant advances have been made.

- For carbonated drinks, carbon dioxide concentrations should be controlled in order to prevent spillage and bottle bursts.
- Ensure optimal process control systems in place.
- Separate and segregate cooling and other waters.
- Use low diameter hoses with shut-off nozzles.
- Avoid product loss.
- Reuse low load waters.
- Completely empty containers before washing and segregate.
- Recycle cooling waters.
- Train staff.
- Use pulsating jets.
- Use auto shut off devices interlocked.
- Use caustic washes for neutralising streams.
- Use automated CIP.

- Reduce last runnings by good management.
- Clean only when necessary.
- Use wash/rinse water for mashing.
- Attention to over/underfilling in cask and bottle lines.
- Collect spilt juices and concentrates and reuse.
- Segregate pith, peels and use for composting or animal feed.

8.5.3 Distribution and Consumption

As beverage quality has improved over the years, it is becoming increasingly difficult to find rejects. Quality of product has become excellent in most countries and the dominance of larger multinationals employing sophisticated quality procedures has contributed to generating these changes. Companies have good distribution networks and consumers obviously have a preference for not creating waste from these high value added products.

8.5.4 Future Trends

Benchmarking has been applied in this industry to demonstrate best practice and to show how improvements are effective in saving money. Water consumption rates are now well known in the industry and manufacturers seek to reduce water and load of BOD.

- Pasteurisers are becoming more sophisticated, resulting in less shattering.
- Bottle manufacturing is better controlled and less prone to breaking, damage.
- Twist sealing and unsealing reduces breakages from using leverages and consequent loss.
- Flavour recovery from juice making.

8.6 Major Ancillary Support Services for the Sector

8.6.1 Boilers

The SEAM Project identified interventions whose savings averaged LE42,000, for an average capital investment of LE20,700. Actions included:

- Implementation of suitable preventative maintenance programmes.
- Regular boiler tuning.
- Proper insulation of steam pipes.
- Repair of broken and steam pipes and connections.
- Heat recovery from boiler blowdown water.
- Installation of steam flow meters for each processing department.
- Proper storage and transfer of mazot, to avoid wastage through leaks and spills.
- Recovery of steam condensate.
- Installation of pressure regulators on steam lines.

One or more of these interventions were required in every factory participating in the SEAM Project. Other actions, including some equipment modifications are also recommended. Typical modifications for energy conservation include:

- Fluidised bed boilers, three pass package boilers and thermic fluid heaters.
- Water treatment to control the total dissolved solids (TDS).
- Effluent heat recovery from process water (especially hot water washes) through installation of heat exchangers.
- Optimising boiler efficiency by controlling draft (implementation of damper and fuel firing practices).
- Optimisation of the burner.
- Avoidance of space heating.

- The use of mazot generates emissions with high sulphur and particulates. Its use as a fuel in food processing factories in Egypt is no longer permitted.

8.6.2 Refrigeration Units

During the audits, the following recommendations were made to improve refrigeration unit efficiency:

- Ensuring that doors were closed whenever the unit was not being used.
- Install and maintain insulation.
- Improve maintenance of condensers.
- Installation of curtains on freezers to prevent ice build up.
- Ensure freezers are energy efficient.

In one factory, the refrigeration system was upgraded so that temperature could be fully controlled. This resulted in a more efficient refrigeration system and reduced reject rates of the final product. For an investment of LE26,500, annual savings of LE39,600 were made, giving a payback period of 8 months.

Phasing out freon, which is a hazardous material, is also recommended.

8.6.3 Workshops and Garages

In most of the factories audited, mineral oils and grease was allowed to drain immediately to the sewer, increasing the organic load and partially blocking the sewerage system. This was solved at one particular factory by segregating this material at source, collecting it in barrels and selling it to an oil recovery company. For an initial investment of LE500, annual savings of LE2,500 were made, as well as significantly improving the quality and treatability of the wastewater. Reduction of these spillages across the floor has also improved working conditions and improved the appearance of the factory.

9.0 Cleaner Production Demonstration Projects

9.1 The SEAM Project Approach

The approach for the SEAM Project was evolved based on an analysis of the food processing sector in Egypt, which showed that:

- The sector is characterised by absence of modern process technology;
- There is a lack of technical skills in food processing, specific to Cleaner Production;
- There is no local expertise with regards to both the promotion of Cleaner Production and giving independent advice on Cleaner Production solutions;
- Technical support in the form of guidance manuals is not available

9.2 The Aim of implementing Demonstration Projects

The main goal of the SEAM demonstration projects is to show that significant financial savings and environmental improvements can be made by relatively low-cost and straightforward interventions. These consist of pollution prevention through good housekeeping, waste minimisation, process modification and technology changes. This approach has two benefits - valuable materials are recovered rather than being wasted and factories are moved towards legislative compliance.

As these interventions will reduce both the volume and the strength of the final effluent, the size and capacity of a new wastewater treatment plant will be minimised. This will result in reduced capital, operating and maintenance costs.

In the SEAM Project, a structured methodology was adopted which resulted in success both in terms of results as well as cost-effective utilisation of the resources. Common problems in the sector were identified and solutions implemented in 1 or 2 factories as ‚demonstration projects‚. These also helped to provide ideas for further innovations and gave factories the confidence to replicate them by themselves.

9.3 Identification of Demonstration Projects

It was important that the demonstration projects implemented addressed commonly occurring problems in Egyptian factories. This was achieved as follows:

- **Selection of factories** - A sample of 10 factories were identified that represented a range of food processing practices in Egypt.

- **Industrial audits** were carried out in each of these factories (the methodology developed for this is described in Chapter 6.0 ‚Cleaner Production Audits‚) and an industrial audit report produced. This reviewed the manufacturing process with respect to optimal use (and reuse) of resources, improved housekeeping and improving process operations etc.. In some cases, particularly in the old food processing factories in Egypt, even the basic manufacturing process had to be examined in terms of possible substitution of raw materials, equipment redesign or by identifying entirely different new manufacturing processes.

- **Longlisting Potential Demonstration Projects** - Each audit report was reviewed to identify those problems which were common throughout the sector. At this stage, some of the options which were not true Cleaner Production options, were discarded.

- **Shortlisting Potential Demonstration Projects** - The longlist of projects identified through the industrial audited were then short-listed using the criteria shown in Table 9.1. These criteria reviewed each option in more detail, to see which met SEAM Project objectives, particularly with regard to compliance with existing laws, replicability and sustainability. Factory commitment to the Cleaner Production approach was also required and was assessed in terms of how many of the ,no cost, options had been implemented by the factory.

Table 9.1 Criteria used to Shortlist the Demonstration Projects

Criterion	YES	NO
Does the project comply with Egyptian laws (i.e. not in known violation of existing laws)?		
Does the project comply with the DFID (ODA)/SEAM funding policy?		
Does the project result in economic benefits with a relatively short payback period?		
Does the Project demonstrate the benefits of waste minimisation and/or CP principles?		
Have any low cost measures identified in the audit been implemented?		
High Priority		
Financial		
Is internal or external parallel funding (possibly in kind) available?		
Does the Project involve relatively low initial capital expenditure?		
Environmental		
Is the Project consistent with the priorities set by the NEAP/GEAP/NIPPP?		
Does the Project assure/assist in compliance with the Environmental Laws?		
Technical		
Is the technology appropriate to local conditions?		
Does the Company possess appropriate levels of technical skills and resources to implement and maintain improvements?		
Managerial		
Does the management show good awareness of environmental issues and willingness to implement good environmental practices, including pollution control at source?		
Are managerial and structural barriers to change absent or removable?		
Sustainability		
Is management willing to commit staff resources to the on-going process of internal auditing and improvements for pollution control?		
Is environmental management likely to be integrated in the existing structure?		
Replicability		
Are there significant opportunities to replicate the Project?		
Project Design and Implementation		
Can the Project be completed and evaluated in less than 12 months?		
Can any necessary approvals/licenses be obtained within 2 months?		
Medium Priority		
Environmental		
Will organic loads, chemical or toxic components be reduced/ eliminated?		
Technical		
Can the Project be implemented without significant interruption to process schedules?		
Can the Project be implemented without training of operators or maintenance personnel?		
Managerial		
Does the management effectively communicate policy changes within the company?		
Replicability		
Can the equipment be obtained/manufactured locally?		
Social		
Will the health and safety of the workers be improved?		
Does the project avoid negative effects on the community?		
Low Priority		
Environmental		
Will on-site improvements lead to an improvement in the external environment[1]?		
Will the project result in a variety of internal environmental improvements?		

[1] Such as water quality, air quality, health, noise transmission, land contamination, etc.

9.4 Selection of Factories for Demonstration Project Implementation

Demonstration projects had been carefully selected to address problems that were common throughout the Egyptian food processing sector, in the subsectors considered. The selection of factories as demonstration project ,hosts, had to be carried out with equal care, to prove that the projects were widely applicable throughout the sector, regardless of factory age, size or whether they were publicly or privately owned.

9.5 Plants selected for Implementation

The demonstration projects identified and the factories where these were implemented are shown in Table 9.2.

Table 9.2 Summary of Demonstration Project Implementation

No.	Demonstration Project	Location	Remarks
1	Reducing Milk Losses	***Lead Site***: Misr Dairy, Mansoura	A product-based project.
2	Water and Energy Conservation	***Lead Site***: Edfina for Preserved Foods, Edfina ***Shadow Site***: Kaha for Preserved Foods, Kaha	A housekeeping based initiative umbrella project.
3	Use of Whey as Animal Feed	***Lead Site*** : Misr Dairy, Damietta	A product-based project.
4	Reducing Wastage through Process Control	***Lead Site*** : Misr Dairy, Mansoura ***Shadow Site***: Edfina for Preserved Foods, Edfina	A process-based project.

Based on the discussions in the preceding chapters, the main elements of the demonstration projects address the following issues:

- Water reuse through separation of cooling systems and appropriate physical separation.
- Optimisation of energy use through improved maintenance and process control.
- Minimisation of heavy organic loads via recovery of raw materials, products and by-products.
- Improving processing techniques and quality control to reduce wastage.

9.6 Project Concept Notes (PCNs)

Project Concept Notes (PCNs) were developed for each of the demonstration projects, which described:

- The rationale and justification for carrying out the project.
- The purpose, outputs and replicability of each project and the various activities that would be carried out to achieve these. This also incorporated an outline timebound workplan, which described how long each activity should take to complete.
- An assessment of the costs associated with implementation, including consultancy costs, equipment purchase and analytical expenses.

Each PCN was then discussed and finalised with senior management and technical staff. This then formed the basis for a formal Agreement (including a detailed Bill of Quantities) between the SEAM Project and each of the factories, which described the responsibilities and financial contributions of each party.

9.7 Overview of Demonstration Projects

9.7.1 Reduction of Milk Losses and Pollution Prevention

A range of low-cost pollution prevention actions were identified during the audit and have been implemented by the factory management. To date, savings of LE309,250 have been made, for a capital investment of LE113,250. A number of identified options were implemented quickly and efficiently:

Good housekeeping measures:

- Collection and resale of used oil from the garage, to reduce the strength of the wastewater.
- Segregation and sale of solid wastes, to remove unwanted waste from the site and to generate revenue.
- Drainage improved and blockages removed, all roadways paved and signs put on them, external areas greened.

Reduced water and energy consumption:

- Boiler tune-up and upgrade, to reduce fuel and electricity consumption and minimise gas emissions.
- Restoration of the softening unit to improve boiler performance and reduce blowdown.
- Improving the efficiency of milk refrigeration.
- Rationalisation of the milk packaging unit.

Product recovery:

- Permeate from white cheese manufacturing was used to package white cheese instead of fresh water.

Process control:

- Installing level controls on milk storage tanks to prevent overfilling and spillage.
- Replacing existing valves with food quality valves to reduce milk leakage.

This interventions can be easily implemented by many companies as the costs and benefits are available for all to see. The intangible benefits to the factory are also significant. The workforce is working in improved areas, the morale has lifted, the managers are seen to be caring, the profitability has obviously improved and the plant is eager to become involved in other projects to improve profitability and quality - both of product and environment.

The success of this project demonstrates the way barriers can be overcome by having a champion on site, especially when it demonstrates the commitment of management. This project also shows that many aspects of management which are normally taken for granted, such as controlling overflows and spills, are often overlooked until solutions are pointed out. Management are then to eager to adopt necessary improvements.

9.7.2 Water and Energy Conservation

The industrial audits recognised that many firms in Egypt had severe problems with energy usage and lack of systematic policies in place to manage energy utilisation. This project was identified as being directly transferable to many food processing sector firms in Egypt and even outside the food processing sector. This project was created to demonstrate that energy conservation can save substantial sums of money for the firms and at the same time bring about substantial environmental improvements, without large capital investments. Common problems include large volumes of steam being discharged freely into the atmosphere, steam traps which are inactive or not present, lack of insulation, no condensate recovery, poorly tuned boilers, large fuel oil spillages etc. Similarly with water use there are uncontrolled and unmeasured uses of water throughout the plant, large losses, inadequate measuring devices, little condensate or vapour recovery and general unawareness of water as a resource issues.

This project was designed to alleviate these problems and show that effective water and steam use, including low cost and easily implemented measures could bring about large savings to the firm. Several actions were implemented in these projects to try and cover several energy and utility conservation issues. It was implemented in Edfina for Preserved Foods, Alexandria and Kaha for Preserved Foods, Qalubya sites. Both companies are processors of fruit and vegetables.

Actions carried out for Energy Conservation:

Edfina Company

- Insulation of bare steam lines.
- Replacement of leaking steam traps.
- Replacement of leaking steam valves.
- Installation of Pressure Regulators on Sterilisers.
- The power factor of the site was measured and the capacitor bank.
- The fuel oil usage of the factory was measured and compared to steam generation rates.
- Boiler efficiency was measured and improved by optimising the air fuel ratio.
- Condensate recovery system installed.
- Meters for water and oil installed.
- Steam pressure regulators installed.

If the calculated amount of energy savings result, this will mean Mazot (fuel oil) usage is reduced by 1,045t/a, representing an annual cost saving of over LE190,000. Obviously significant savings will pass on to the environment as this represents a significant reduction in fuel usage and consequent air emissions and natural resource use, as well as the cost savings.

Kaha factory

- Insulation of bare steam lines.
- Replacement of leaking steam traps.
- Pressure regulators installed.
- Repair and replacement of leaking steam valves replaced.
- Condensate return system installed.

If the calculated amount of energy savings result, this will mean Solar (diesel) usage is reduced by 788 t/a, corresponding to annual savings of over LE 354,000. Obviously significant savings will pass on to the environment as this represents a large reduction in fuel usage, if all the calculated savings result.

Actions carried out for Water Conservation:

Edfina Company

Water savings were approached in the same way and at the same time as energy saving. Again, the industrial audits picked up on the fact that substantial problems existed in the sector with water use and misuse and there was lots of scope for improvement with minor interventions.

- Automatic shut-off nozzles installed on hoses around the factory.
- Cooling water deficiency in the juice line was noted and a cooling tower installed.
- Rehabilitation of the Dowe Pack water collection system.

Water conservation is expected to save some 119,400 tpa of water with an approximate payback time of less than one year. Loads on treatment systems or sewers will be proportionately lower. This significant saving in water will have been achieved by replacing the once through water cooling system by a recirculating cooling tower. Also condensate recovery is being started. The effect of such intervention on staff is expected to flow through as staff members start to become aware of the savings that can result from conserving water. Such savings will ultimately result in a better company performance and a better employment workplace.

9.7.3 Recovery of Cheese Whey for Use as an Animal Feed

The industrial audits showed that in the dairy factories, whey permeate from cheese processing was frequently being disposed directly to the sewer. As this has a BOD of around 55,000ppm, this was significantly increasing the pollution load of the final effluents. However, it is often possible to recover and use whey, as it is contains high levels of carbohydrates, proteins and minerals. In Misr Company for Dairy and Food, Damietta, 158m^3 of whey per month was produced throughout the year, a sufficiently high volume for it to be viable as an animal feed.

The holding company recognised the importance of a demonstration project which would reduce its environmental risks and exposure by finding an alternative use for the whey. Several meetings were held to establish the methodology, the experimental approach, (as this exercise had not been carried out before in Egypt) and the amount of support needed to develop a full demonstration project, for farmers and other factories.

Initial tests on the whey permeate confirmed its suitability as animal feed and sheep fed on this showed an average increase in weight of 34%. This was comparable to a weight gain of 35% of sheep fed on cane molasses, a commonly used animal feed supplement. The tests also showed that the whey had to be carefully stored and transferred to ensure that it was of a suitable microbial quality. Quality is independently checked by the farm using pH meters provided by the project - if the pH falls to 4.2 the whey would be disposed of.

In parallel with the experimental work, the ,Animal Wealth Society Farm, was identified as being suitable for continuing the feeding trials with cows. This farm runs a sophisticated dairy feedlot operation where all cows are penfed and breeds are carefully evaluated for milk yield and diets adjusted according to yield. The manager was very interested in the trial for the possibility of a high energy, possibly good quality protein, low or no cost supplement.

Training was provided to staff at both the factory and the farm, to ensure that the whey was handled properly, from production through to feeding. A whey segregation system consisting of piping, pumps and a collection tank with a transfer capacity of 10m^3/hour was also installed. This is transferred from the factory to the farm by lorry.

The main capital cost associated with implementing the project was the construction of the storage and transfer system at the factory. No capital expenditure was required at the farm. The financial benefits included:

- reduction in wastewater treatment and disposal costs for the factory.
- generation of revenue for the factory from a product which was previously wasted.
- low-price, high-value foodstuff for the farm. The 3-year target price of the whey was set at LE15/ton, less than 10% of the price of cane molasses.
- the amount of roughage that needs to be fed to the cattle can be reduced by 75%, corresponding to annual savings of LE200/head of cattle.

Note: Sweet whey, which is produced during hard cheese manufacture may also be suitable for use as an animal feed supplement. It has higher carbohydrate and protein concentrations than permeate and correspondingly high body weight gains would be expected. It was not used in this project, as it was only generated from December to May and would have required more complex feeding trials to be developed.

Case Study Conclusions

This project demonstrates how a new ,product, can be derived from what was previously considered a waste stream how it can be utilised by another industry. It also shows how the integrated support of many different disciplines may be required to commercialise the product and overcome the barriers. This project can be easily copied by many other dairies throughout the country.

9.7.4 Environmental Savings from Improved Quality

The case study describes the Project as implemented at Edfina Company for Preserved Foods, Alexandria. Edfina is a large government-owned company which is also in the midst of privatisation and downsizing. It produces a range of products in processed foods lines and many fruit juice types.

The industrial audit carried out as a part of the SEAM Project recognised that some environmental issues could be linked to quality issues. HACCP (Hazard Analysis Critical Control Point) is one programme where carrying out a systematic audit of the site can identify site improvements which are necessary to ensure some improved degree of food safety and also bring about environmental improvements.

A more detailed assessment of the factory was carried out in order to design a HACCP system specifically for it. This included an assessment of potential hazards, identified ,critical control points, and established suitable operating and monitoring procedures. Once completed, actions that were needed to support this system were easily identified. Priority was given to those interventions which would yield significant savings and be carried out at little or no cost to the factory. This work was supported by training of key process personnel, carrying out awareness-raising sessions with the remainder of the staff and upgrading the existing laboratory facilities.

The following measures were implemented at the factory; for a total capital investment of LE140,000, annual benefits of over LE1million were achieved.

- Low cost housekeeping measures, such as improved raw materials handling, recovery and resale of used garage oil and disposal of wastes.
- Upgrading of drainage and sewerage system.
- Implementation of a pest control programme.
- Redesigning the fruit jam packaging process.
- Improving the vegetable washing and cooling in the frozen foods section.
- Upgrade of the existing vegetable paste packaging unit.

9.7.5 Outputs from the Demonstration Projects

For each demonstration project, the following documents were prepared:

- Case studies (reproduced in Appendix 3) outlining the actions taken and describing the associated costs and benefits. These include:
  - ⇒ ,Case Study: Food Sector. Reduction of Milk Losses,. Misr Company for Dairy and Food, Mansoura.
  - ⇒ ,Case Study: Food Sector. Water and Energy Conservation,. Edfina Company for Preserved Foods, Alexandria and Kaha Company for Preserved Foods, Kaha.
  - ⇒ ,Case Study: Food Sector. Recovery of Cheese Whey for use as Animal Feed,. Misr Company for Dairy and Food, Damietta.
  - ⇒ ,Case Study: Food Sector. Integrated Quality Assurance and HACCP Approach to Waste Reduction in Food Processing,. Edfina Company for Preserved Foods, Alexandria.

- Guidance Manuals, which give step-by-step instructions which will allow other factories to implement similar projects. Each Manual also gives a general introduction to the concept being implemented; cost-benefit analyses, to show exactly how the savings were made and some ‚Helpful Hints‚‚ which were developed during Project implementation. Guidance Manuals prepared for the food processing sector include:

  ⇒ ‚Cleaner Production for Food Processing: Water and Energy Conservation‚.

  ⇒ ‚Cleaner Production for Food Processing: Reducing Waste through Improved Quality Control‚.

Dissemination workshops to share the experiences of the demonstration projects were organised at the management and senior management levels.

The actual implementation of the demonstration projects and the lessons learnt from the implementation are presented and discussed in the next part of this report.

Part C

SEAM Project:
Sustaining Cleaner Production

Part C - SEAM Project: Sustaining Cleaner Production

10.0 Overcoming Barriers to Cleaner Production Adoption In Egypt

The majority of barriers to Cleaner Production confronted by industrial establishments can be placed into one of two categories:

- Those that are **internal** to the establishment, including:
  - ⇒ Economic concerns.
  - ⇒ Technology and technical skills.
  - ⇒ Cultural concerns.
  - ⇒ Quality considerations.
  - ⇒ Information dissemination.

Examples of Barriers to CP Adoption in Factories

- ☹ Lets think about this later.
- ☹ Its good to talk about but will not work in practice.
- ☹ It just will not work.
- ☹ We do not have the time for this.
- ☹ Has anyone done this before?
- ☹ What is wrong with the present system?
- ☹ We are already doing this!
- ☹ You do not understand the problem.
- ☹ Talk to someone else. This is not my field.
- ☹ We are too big/too small for this.

- Those that are external to the establishment, including:

⇒ Difficulty in Accessing Cleaner Technology Information.

⇒ Difficulty in Accessing External Sources of Finance.

⇒ Lack of Economic Incentives.

Several factors are involved in the evaluation of the above constraints. A constraint could be significant or trivial depending on:

- The size of the establishment
- The type of ownership (public, private, joint)
- The type and cost of required modification
- The level of available technology
- The level of pollution (environmental status)

In this way, the profitability of a business will increase whilst its adverse impact upon the environment will diminish.

Whilst carrying out the industrial audits and during demonstration project implementation, the following attitudes were frequently encountered in the food processing industry, all of which will act as barriers to Cleaner Production adoption:

Waste and process losses are a fact of business - waste has and always will happen.

Valuable raw materials and recoverable product are normally **dumped, lost or treated as waste**.

Attitudes to waste, pollution and process problems are **reactive** and accepting.

The workforce not interested in issues outside of their **job description, process area, pay**.

Employees ideas are often disregarded by management.

Quality control only meets **minimal standards, customers needs** or expectations - not forward looking.

For every barrier identified there needs to be a strategy developed to overcome or ameliorate it. Otherwise, they will tend to slow down the adoption of Cleaner Production practices and slow down change.

10.1 Internal Barriers

10.1.1 Economic Barriers

Economic barriers can occur when a company believes it does not have the financial ability or sufficient incentive to implement waste minimisation.

Similarly, the low costs associated with the abstraction of water and the disposal of wastes means that there is little incentive for companies to make savings in these areas.

10.1.2 Technical Barriers

Experience in Egypt has shown that many companies are well aware of local pollution problems but have little appreciation of the wider environmental issues. However, the level of knowledge is limited so that there may be a belief that a subject is well understood but in practice is poorly applied. This problem is compounded by a generally poor quality and low availability of up-to-date technical information.

Changes in the way in which a company operates will frequently present technical difficulties such as:

- Lack of suitable information.
- Concern about changes to product quality and customer acceptance.
- Retrofitting of processes causes shutdown of existing operations.
- New operations may not work.
- There is insufficient space to easily accommodate any additional equipment.
- Adverse employee reactions.

Most of the food processing factories in Egypt do not have effluent treatment plants. Water is subsidised and hence there is no pressure on the food factories to practice water conservation. The lack of effluent treatment plants will also result in disposal of effluent to receiving water bodies or on land.

10.1.3 Cultural Barriers

Many companies are over-manned in comparison to international norms. This may lead to a lack of individual responsibility and a perception that no individual can achieve change. In many factories, this is compounded by an "autocratic" management structure with all instructions coming from the top so that workers do not accept personal responsibility for change.

Resistance to change and friction between personnel may introduce barriers and can be caused by:

- Lack of senior management commitment.
- Lack of awareness of corporate goals and objectives.
- Poor internal communication.
- Restrictive employment practices.
- Inflexible organisational structure.
- Bureaucracy inhibiting change.

There can also be a lack of communication between the different departments within the industrial establishment causing the isolation of the department responsible for environmental affairs. This is clearly a top management responsibility to make sure that all departments:

- are aware of environmental issues.
- are willing to cooperate.
- present their feed-back regarding in-process or in-plan modifications.
- are held responsible for clean environment and public health.

There is a prevailing culture throughout the industry that reflects itself in the behaviour of both management and staff. The main features of this is:

- lack of strong discipline.
- lack of tidiness and neatness.
- no concern about details and perfectionism.
- little pursuit of knowledge and information.

As a consequence:

- There is a resistance of the part of engineers who have acquired the skills to manage existing systems, to acquire the new knowledge and skills that new technology often demands.
- Housekeeping measures are not enforced.
- There is abuse of water and energy consumption.

However, the same manpower with the same cultural, background is managing perfectly well in multinational companies.

10.1.4 Quality Considerations

The lack of quality (defined in this context as fitness for the purpose) of many products is low and consistency is poor. Down-graded products are common but still finds market outlets in Egypt. Where companies have export markets, customer demands often ensure that production methods are better controlled.

There is a need to establish a quality culture within companies and whilst ISO 9000 is widely recognised it is poorly understood. Too often it is regarded as a marketing aid and not as a management tool for maintaining quality, improving efficiency and reducing wastage. However, where a company is considering ISO 9000 it can be used as a vehicle to assist in implementing change within an organisation.

10.1.5 Information Dissemination

To date, information concerning Cleaner Production opportunities has not been readily available. There are no independent associations dedicated to providing technical assistance and information to industry, government departments and others involved in the industry. No formal centre exists which could serve as a clearinghouse of information and as a counselling centre for the promotion of Cleaner Production in the country.

In the dissemination of information, language can be a barrier as all documents, manuals etc. have to be translated into Arabic to ensure that the information is available to the widest possible audience.

10.2 External Barriers

In addition to the internal barriers identified, there are a number of external barriers to Cleaner Production over which firms have little or no direct control. These include:

10.2.1 Difficulty in Accessing Cleaner Technology Information

Most of the food processing sector facilities in Egypt are small and medium scale enterprises (SMEs). These are particularly susceptible to a range of complexities that undermine their ability to access new technologies, even when they may benefit financially from them.

In-plant modifications: recycling, recovery water and energy conservation can be easily implemented and understood. However, process modifications could require a level of technology too complex to be adopted by SMEs. It could require a level of personnel training difficult to attain.

10.2.2 Difficulty in Accessing External Sources of Finance

The implementation of Cleaner Production processes and technologies has been hindered by a lack of access to finance. SMEs in particular are frequently unable to make investments in cleaner technologies for a wide variety of financial reasons, the lack of available external capital being of particular importance.

10.3 Overcoming Internal Barriers to Cleaner Production Implementation

10.3.1 Economic Factors

Economic arguments are all too often the only justification given for a change within an organisation. There is little doubt that in a business sense, profitability is the most significant factor but company profits have little short term effect on the way in which individuals respond within a company.

If individuals perceive a threat to their livelihood, and there is a chance that they may lose their jobs, this will be a strong motivator as it has a direct bearing on their ability to satisfy their physiological needs for water, food and shelter. But making more money for their employers and shareholders is rarely a strong motivator and other more intangible factor such as pride, status, achievement etc. are more significant. Once people feel personally secure and safe they become more concerned with the wider environmental issues such as global warming and damage to the ozone layer. The quality of life is as important, if not more so, than the economics alone.

However, any recommendations made have to be financially sound and will include:

- Monitoring to determine the full cost of pollution control, waste management etc..
- Cost/benefit calculations and pay back periods for investments.
- Target setting, based on true data, to achieve reductions in usage of materials.
- Identification of potential liabilities through a failure to control an environmentally damaging activity.
- Details of environmental funds, customs and tax credits, fixed interest loans to encourage cleaner technologies etc. if/when these are available.
- Identification of cost savings.

  Action: Reduce wastage of raw materials.
  Þ **Effect**: Raw materials costs decrease.

  Action: Reduce the volumes of waste generated.
  Þ **Effect:** Waste treatment, transportation and disposal costs decrease.

  Action: Reduce labour time spent monitoring and handling waste.
  Þ **Effect:** Valuable labour time can be channelled elsewhere.

  Action: More efficient use of energy.
  Þ **Effect:** Reduced electricity, oil and/or gas bills.

  Action: More efficient use of water.
  Þ **Effect:** Reduced water bills where relevant and potential knock-on effect regarding effluent volumes and associated costs.

Taking these actions will also reduce long-term environmental liability and insurance costs.

There are other, wider environmental benefits such as less fossil fuel being burnt at power stations, less need for landfill for solid wastes, etc..

10.3.2 Technical Factors

This is the area in which the company personnel will feel most at home since they know their business well. It is also the area in which they can be highly conservative. To overcome initial reservations, personnel will need to be shown that Cleaner Production can be very successful. This can be achieved through:

- Source of up-to-date information from within the company and outside.
- Identification of training opportunities.
- Pilot scale projects prior to major change.
- Reviews of customer requirements.
- Involvement of all relevant departments in the planning process.
- Use of well-tried technology wherever appropriate.
- Examples of successful applications in other businesses.
- Provision of work instructions, safety data sheets, "duty of care" for hazardous wastes.

Environmental management systems (such as ISO 14000 and BS 7750) also have the potential to play a crucial role in the adoption of a "Cleaner Production mindset" within business management structure.

Application of Quality Assurance techniques and methods like HACCP can have more tangible effects on consumers. Export driven industries will be interested in such environmental certificates such as ISO 14000 for competitive reasons especially when European markets are targeted. Even in the field of export aspects other than environmental are given priority Quality Assurance (QA), packaging, market survey etc.

10.3.3 Cultural Factors

A large number of surveys have been conducted in a variety of countries as to the factors which contribute to the quality of life of an individual. Invariably the list includes a number of essential factors which are in order:

- Good education.
- Clean/healthy environment.
- Personal/family health.
- Good social relationships.
- Money.
- Employment.

Individuals will also describe a wide range of other factors including moral and spiritual values, freedom, peace of mind, stable government etc.. The significant factor is that money, in itself, is not a prime motivator and companies can encourage change through a wide variety of techniques.

Recommendations to overcome cultural barriers will include:

- Company policy and management changes.
- Identification of training needs.
- Identification of incentive schemes which can include financial bonuses, recognition of achievements, "employee of the month", issue of certificates.
- Allocation of responsibilities to individuals, goal setting, timescales for change, use of staff suggestion boxes.
- Company news letters, publicity for achievements, involvement of local community.
- Education in wider environmental issues and protection of the global and local environment.
- The use of the company as an environmental "champion" to stimulate other similar companies; the formation of waste minimisation "clubs" within a geographical area or industrial sector to pool ideas and share experiences.
- Religious beliefs of relevance to the protection of the environment.

Change in Egypt, as with anywhere else in the world, will occur slowly and by a multiplicity of influences. Motivation is complex and frequently difficult to predict. It is important that any recommendations made are realistic and also consider how the changes can be achieved.

10.4 Conclusions and Recommendations

The adoption of Cleaner Production is a cost effective means to achieve higher productivity and lower treatment cost. It can be subdivided into two categories.

- Housekeeping measures and low cost modifications requiring low investments.
- Process changes requiring high investments.

Egyptian industry will choose any of these categories depending on their specific priority which will be based on:

- The status of existing technology (old or new).
- The exporting capabilities of the establishment.
- The financial status.
- The investments required for end-of-pipe treatment.

The SEAM Project promotes the implementation of housekeeping and low cost projects. The success of SEAM depended heavily the attitudes of the factories themselves. A lot of time was spent discussing ideas and modifying proposals to ensure that each factory was satisfied with the end product.

With the coming GATT agreement, Egyptian companies will be more reluctant to raise their expenses for the sake of environmental protection through end-of-pipe treatment. However, rehabilitation and replacement of old technologies can be prohibitive. A step by step approach and temporary waivers could be applied.

10.5 Organisations interested in Cleaner Technology in Food Processing

Following are some organisations that could help promote cleaner technology:

- The National Research Centre ,Food technology and Biotechnology labs.
- Agricultural Research Centre , Food Technology Research Institute.
- Chamber of Food Industries, Cairo.

11.0 Promotional Strategies for Adopting Cleaner Production in Egypt

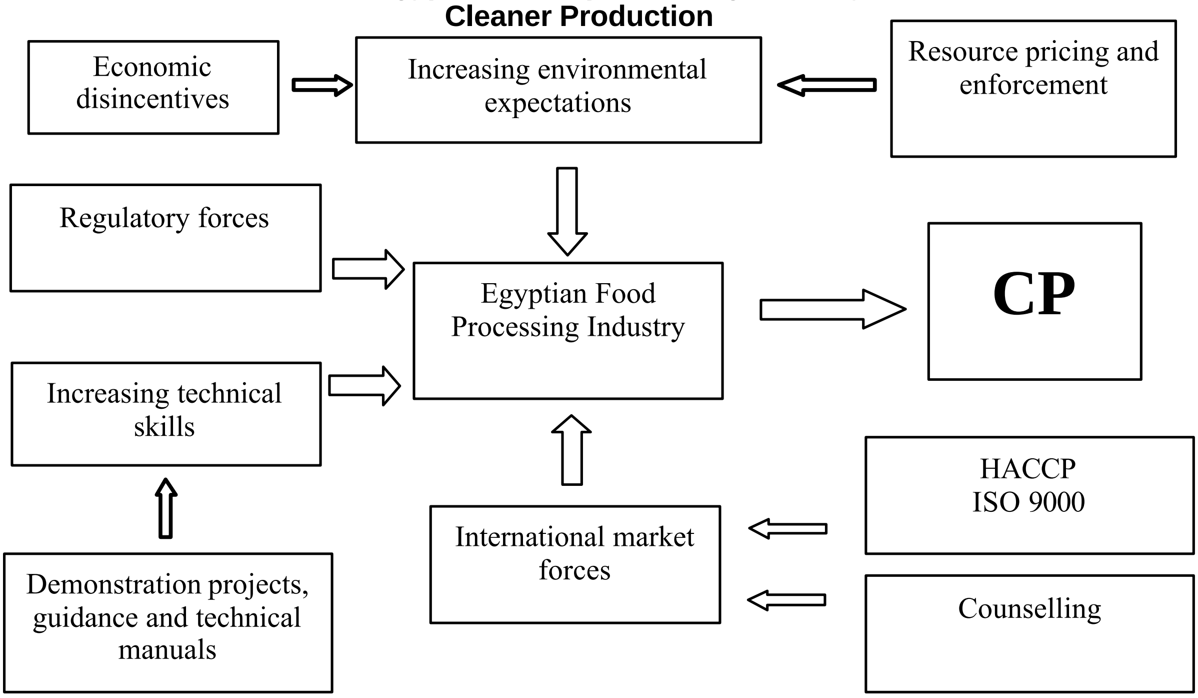
Development of a strategy for cleaner production entails identification of:

1. The "approach" to be adopted (whether product, process, technology or operation related);
2. The "options" available;
3. The "pollution prevention practice" to be adopted (for the sector, specific to Egypt) and finally;
4. The "measures" (i.e., the specific demonstration projects for each factory) that should be taken to implement Cleaner Production.

Given the barriers identified in the previous section, the shift from end of pipe approach to Cleaner Production in the Egyptian food processing industry may take a long time to implement. This delay may adversely affecting company productivity, causing environmental degradation and a threat to self - reliance. However a number of factors as shown in, may help accelerate the "push" of the food processing industry towards adopting Cleaner Production (see Figure 11.1 below).

Figure 11.1

"Push" Factors on the Egyptian Food processing Industry to move towards Cleaner Production



11.1 Policy Options

The policy options need to consider infrastructure issues such as water and energy resources - excessive subsidies on water and energy need to be eliminated and realistic pricing structures developed so that they serve as "push factors" for industry to practice water and energy conservation, thereby facilitating promotion of CP.

In addition to the pricing structure, suitable fiscal incentives also require to be developed by the GOE to promote and encourage adoption of CP methods.

Policy options should target provision of subsidy schemes for SMEs for the implementation of CP options and establish a system for banning of "dirty technologies" and phasing out banned chemicals.

11.2 Company Performance Improvement

It is too early to speak definitively about company environmental performance, however there are some definite pointers of improvements. Misr for Dairy and Food for example opted to take part in a programme to improve the overall quality of its products and at the same time improve its product safety and reliability, as well as seeking a new outlet for a waste. Edfina has instituted substantial changes in the way it manages energy, which have resulted in significant improvements in its energy bills. Kaha has also made large cost savings which will add to its profitability and improve its competitive position. The HACCP project especially, despite its early difficulties, will be a valuable lead project for the rest of the food processing community to follow. Food quality will be improved, food safety will be enhanced and workers will enjoy new levels of protection and safety.

11.3 Capacity Building and Technical Assistance

The experiences from the various SEAM demonstration projects need to be disseminated across the sector. The Guidance Manuals and case studies prepared under the SEAM Project need to be disseminated to enable other factories to implement the Cleaner Production options. This will bring about a "multiplier effect" of the demonstration projects.

Awareness workshops and training programmes need to be organised for industry, government officials, industry associations in the food processing sector. The training programmes should be structured to target the following groups:

- **Senior management** of industry and policy makers and decision makers in government on the economic and environmental benefits of Cleaner Production;
- **Middle level technical and managerial personnel** in industry on production technologies, health and safety aspects;
- **Factory workers** particularly on health and safety aspects.

The GOE also needs to support development of counselling centres for Cleaner Production options targeted primarily at the SMEs.

There is a need to strengthen independent technical skills in the food processing sector, with reference to Cleaner Production. Capacity building to create a middle level of such experts is essential. Senior technical personnel from the sector who have extensive experience in the industry and who have retired from active service should be targeted for development of such a technical corps.

Capacity building for the sector should also commence at the educational institution level where food production and processing technologies, Cleaner Production etc. should be integrated into the curricula to build local technical capacity in the sector.

11.4 Impact of the SEAM Demonstration Projects

The SEAM Project has, through the implementation of the demonstration projects, facilitated the introduction of the technology component of Cleaner Production into the Egyptian food processing industry. This has resulted in demonstrating that the Cleaner Production options are credible, feasible and economical whilst enabling pollution prevention to take place.

Some of the achievements of SEAM have been; implementation of HACCP systems in Misr for Milk and Food, Mansoura and Edfina Company for Preserved Foods, Alexandria; demonstrating in all factories the financial and environmental benefits of simple, low-cost housekeeping interventions and demonstrating how a previously wasted substance - cheese whey - can be recovered and used, rather than being wasted to the effluent.

This however, is the first step in the promotion of Cleaner Production in the Egyptian food processing industry. From this point on the onus is on the Government of Egypt to initiate aggressive promotion of Cleaner Production. The experience from the demonstration projects has to be scaled and multiplied across the sector.

The Government of Egypt therefore needs to play a major role in providing the necessary "push" factors to enable Egypt's food processing sector to compete in the global market. These factors include:

- Developing suitable policy options.
- Strengthening enforcement strategies.
- Providing support for technical assistance in technology transfer, training and awareness, developing innovative Cleaner Production options locally for the sector and disseminating the experiences from the project across the sector.

11.5 Conclusions

The activities described in this document have demonstrated the range of improvements that have happened directly as a result of SEAM working in this sector. SEAM has assisted industry by developing **REAL** interventions which are **SUSTAINABLE** in the long term and can be easily **REPLICATED** in other factories.

Implementation of these demonstration projects has resulted in the following savings:

- 700 tpa of diesel and emissions saved.
- >1000 tpa of fuel oil and emissions saved.
- 120000kl/a of water and wastewater saved.
- Up to 9000 tpa whey and permeate saved and reused.
- Up to 200tpa of milk saved.
- Unknown savings of reject product and other quality issues.
- Many employees and consultants with a larger environmental awareness.

The factories involved have each achieved financial and/or strategic positioning savings from these simple, low cost projects. Significant environmental improvements have also been made.

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Appendix 1

Summary of Relevant Environmental Legislation

Summary of Relevant Environmental Legislation

Introduction

Industrial pollution control has been addressed in many Laws and regulations which has had implications on the level of enforcement scattered between many authorities. Therefore the need arose for a legal set-up that would co-ordinate all these regulations. The most recent of these is Law 4/1994 which designated the Egyptian Environment Affairs Agency (EEAA) as the highest national co-ordinating body for the environment in Egypt. As stated in the Law EEAA main responsibilities include:

- Establishing of norms and conditions to be complied with by owners of projects and establishments before the start of construction and during the operation of these projects.
- Carrying out field inspections of compliance with norms and conditions to be followed by agencies and establishments. Also it shall undertake the procedures stated in the Law against those who violate these norms and conditions.
- Establishing of necessary norms and standards to assure compliance with the permissible limits of pollutants and to ensure that these norms and standards are followed.
- Setting of principles and measures for environment impacts assessment of projects.

Relevant Environmental Laws and Regulations

The following are the laws and regulations concerning environmental protection. These concern the following:

A. Wastewater
B. Air pollution
C. Solid waste
D. Hazardous waste
E. Occupational health and safety
F Licenses

A. Wastewater

1. Law 48/1982 concerning protection of the River Nile and Egypt waterways from pollution:

Regulates the discharge of wastes to the River Nile its branches and the marine environment by a permit from the Ministry if Public Works and Irrigation after fulfilling certain criteria monitored by periodic analysis.

2. Minister of Irrigation Decree 8/1983 implementing Law 48/1982 (the Executive Regulations of Law 48/1982):

Section 6 sets regulations standards and specifications for treating wastewater before discharge to surface waters.

Article 60 indicates the quality of fresh water to which discharge of wastewater is allowed.

Articles 61 and 62 describe criteria of treated industrial wastewater to be discharged to fresh surface water and ground water.

Articles 66, 67, 68 and 69 set criteria for domestic and industrial wastewater before being discharged to non-fresh surface waters and the quality of the receiving water body.

This Decree was amended by the following Decrees:

- **Minister of Irrigation Decree 140/1984:**
  Amending some rules of the Minister Decree 8/1983 implementing Law 48/1982.
- **Minister of Irrigation Decree 225/1984:**
  Amending some rules of the Minister Decree 8/1983 implementing Law 48/1982.
- **Minister of Irrigation Decree 43/1985:**
  Amending some rules of the Minister Decree 8/1983 implementing Law 48/1982.
- **Minister of Housing and Utilities Decree 9/1988:**
  Amending some rules of the Minister Decree 8/1983 implementing Law 48/1982.
- **Minister of Housing and Utilities Decree 106/1991:**
  Amending some rules of the Minister Decree 8/1983 implementing Law 48/1982.

3. Law 93/1962 concerning sewage disposal:

Sewage disposal in public sewers is prohibited except by special permits and on condition of observing the specifications and standards decided by the Minister of Housing. Samples from commercial and industrial facilities are to be analysed in special laboratories designated by the Ministry of Housing to ensure fulfilment of the required criteria.

4. Minister of Housing and Utilities Decree 463/1962 implementing Law 93/1962:

Section 6 sets the specification and standards that must be fulfilled for wastewater discharge into public sewers.

Section 7 describes the methods and frequency of taking samples of wastewater for analysis.

B. Air Pollution

Presidential Decree 864/1969:
Establishes the Supreme Committee to Protect Air from Pollution chaired by the Minister of Health. The committee role include:

a) studying sources of air pollution
b) formulating a general policy for preventing air pollution
c). Setting standards for air quality and
d) Preparing legislation for air quality.

Minister of Health Decree 470/1971:
Sets standards for permissible pollution loads for ambient and workplace air and was later amended by Decree 240 of 1979.

Minister of Housing Decree 380/1975:
Specifies the general conditions for public commercial and industrial buildings and comprises rules for ventilation and avoiding severe heat cold and humidity.

Minister of Housing Decree 600/1982 implementing Law number 3/1982 for Urban Planning:
Sets the specifications for establishing the new industrial areas.

Minister of Industry Decree 380/1982 implemented by Minister of Housing Decree 60 of 1982:
Necessitates the utilisation of air pollution abatement equipment in industry.

Decree 2/1996 which confined the location of heavy industries in specific locations nation-wide.

Law 4/1994 for the environment and its Executive Regulations promulgated by the Prime Minister Decree 338/1995:

Article 34 prerequisites for granting a permit for the establishment of a project that the site chosen should be appropriate for its activity to ensure compliance with the accepted limits of air pollutants.

Article 35 the establishments should ensure that while practising their activities no leaked or emitted air pollutants shall exceed the maximum permissible levels specified in laws and decrees that are in force and stated in the executive regulations of this Law.

Article 36 prohibits the use of machines engines or vehicles that emit exhaust fumes exceeding limits set by the executive regulations of this Law.

Article 40 states that during burning of any fuel the resulting smoke gases and harmful vapours are within permissible levels. The executive regulations of this Law shall define these precautions and permissible limits as well as the specifications of chimneys and other means to control emissions.

Article 42 sets permissible limits of sound intensity and the permissible time limits for exposure to said noise.

Article 43 sets permissible limits of leakage or emission of air pollutants inside the work premises.

C. Solid Waste

Law 38/1967 amended by Law 31/1976:

Concerns public cleanliness regulates collection and disposal of solid waste from houses public places and commercial and industrial establishments.

Minister of Housing Decree 134/1968 implementing Law 38/1967:

Define garbage and solid waste including domestic and industrial waste.

Identifies garbage containers method of transport schedules for solid waste collection.

Sets specifications and locations of dumping places and methods of treatment (sanitary dumps composting incineration).

D. Hazardous Waste

Law 4/1994 for the environment and its Executive Regulations promulgated by the Prime Minister Decree 338/1995:

Articles 25-27 of the executive regulations: outline of regulations permitting authorities and procedures as well as permit cancelling/suspension conditions.

Article 28 sets (regulations/guidelines procedures and policies controlling hazardous waste management ,generation , collection and storage , transportation , treatment and disposal).

Article 29 assigns specific responsibilities relevant to permitting hazardous waste treatment facilities.

Article 30 prohibits hazardous waste import and defines license procedures for trans-boundary movement of hazardous wastes.

Articles 31 and 32 outline general guidelines/precautions for those generating handling producing and importing hazardous materials (gases liquids solids) to ensure that no harm occurs to the environment.

Article 33 requires that owners of establishments whose activities result in the production of dangerous wastes must keep a register for these wastes and the methods of disposal and the quarters receiving these wastes.

E. Occupational Health and Safety

Law 137/1981 (Labour and Workplace Safety)

Requires industries to take special precautions for occupational safety and health in the work place and it deals with physical danger including noise. Section 5 presents the required standards of occupational health and safety.

Minister of Manpower Decree 55/1983

The Decree grants the industrial safety inspectors the right to check the types and composition of the chemicals used.

Article 6 of chapter 3 sets the precaution measures for exposure to chemicals used in the workplace. It also sets the standards for noise in working locations.

Minister of Industry Decree 91/1985 for implementing Law 21/1985

Regulates the production handling and importing of dangerous chemicals. It also regulates the conditions of the production and storage area.

Law 4/1994 for the environment and its Executive Regulations promulgated by the Prime Minister Decree 338/1995:

Article 43 sets permissible limits of leakage or emission of air pollutants inside the work premises.

F. Licenses

Law 453/1954 which gives relevant powers to local administration as the competent enforcement authorities.

Minister of Housing Decrees 380/1975 and 140/1976: implementing Law 453/1954.

Law 21/1956: deals with the industry organisation and the presidential Decree 449/1958 implementing Law 21/1958.

Appendix 2

Industrial Audit Checklist

Industrial Audit Checklist

This Checklist should be used as an aide memoire to assist the gathering of relevant information. Not all sections will be relevant to each site.

		Name	Action
SECTION A - COMPANY DETAILS			
1.0	**Site**		
1.1	Visual impact		
1.2	Previous land use		
1.3	Plans for expansion		
1.4	Geological / hydrogeological information		
1.5	Protection of sensitive environments on-site and adjacent to site		
1.6	Alternative sites considered		
1.7	Site security		
1.8	Location of any sites of special scientific or historical interest		
1.9	Surroundings including habitation, surface waters, neighbouring industries etc.		
1.10	On-site laboratories and capabilities, considering laboratory management and expertise, methods used, standards and calibration techniques, sampling methods.		
2.0	**General**		
2.1	Person(s) responsible for environmental issues		
2.2	Person(s) responsible for health and safety issues		
2.3	Person(s) responsible for product quality		
2.4	Pollution incidents in the last 5 years		
2.5	Major health and safety incidents in the last 5 years		
2.6	Government / local controls and checks - type and frequency		
2.7	Government permits and certificates held		
2.8	Complaints in the last 5 years		
2.9	Written procedures for dealing with incidents		
3.0	**Costs**		
3.1	Cost of water (Piasters [Pt] per cubic metre)		
3.2	Cost of energy: electricity (Pt per kilowatt), oil (Pt per kg), gas (Pt per m^3)		
3.3	Cost of discharge of waste to a public sewer (Pt per cubic metre)		
3.4	Cost of the disposal of other wastes including solids, process materials, etc.		
3.5	Cost of raw materials and process consumables		
3.6	Cost of manpower		

		Name	Action
SECTION B - ENVIRONMENTAL TOPICS - HIGH PRIORITY			
4.0	**Environmental Management and Housekeeping**		
4.1	General tidiness of site		
4.2	Losses through spillage, handling procedures etc.		
4.3	Spill and loss control procedures		
4.4	Presence of documented good housekeeping practices		
4.5	Other areas such as laboratories, maintenance shops, transportation etc.		
5.0	**Resource Usage**		
Resource usage associated with each process unit, factory unit and overall should be investigated.			
5.1	Raw materials:		
	Quantity and quality of raw materials used in process		
	Quantity and quality of cleaning materials		
	Quantity and quality of packaging material		
	Potential for reduction in wastage, reuse, rework or recycling		
5.2	Water:		
	Sources		
	Quantities used		
	Quality of public and private potable water supplies		
	Sufficiency of public and private potable water supplies		
	Results of laboratory analysis		
	Quality of process water		
	Sufficiency of process water		
	Abstraction licences		
	Treatment of water on site		
	Cost of on-site treatment		
	Potential for reuse of water (with or without treatment)		
5.3	Energy:		
	Quantity of oil used		
	Quantity of electricity		
	Quantity of natural gas		
	Potential for reduction		
	Potential for alternative energy sources		
	Checks on boiler efficiency		
	Frequency of power disruptions and effect on production, wastage, etc.		

		Name	Action
6.0	**Wastewaters**		
6.1	Details of effluent discharges (human and process waste)		
6.2	Details of surface water drainage		
6.3	Details of receiving water or sewerage system		
6.4	Typical effluent composition:		
	Volume		
	Analysis		
	Discharge conditions		
6.5	Details of wastewater treatment systems		
6.6	Costs associated with effluent discharge		
6.7	Potential for recycling or reuse of Wastewaters		
6.8	Potential for a reduction in wastewater volumes by:		
	Process changes		
	Segregation of effluent streams		
6.9	Details of any planned changes		
7.0	**Emissions to Air**		
Consideration should be given to point and fugitive (vapours and dusts from low level leakage, evaporation etc.) emissions.			
7.1	Types of gaseous emissions		
7.2	Consent conditions for discharges		
7.3	Sources of dust and whether a nuisance		
7.4	Sources of odour and whether a nuisance		
7.5	Potential for the reduction of emissions to air		
7.6	Details of emission control equipment (if any)		
8.0	**Solid and Hazardous Waste**		
8.1	Handling, storage and treatment of solid waste		
8.2	Details of hazardous and toxic wastes		
8.3	Waste minimisation studies		
8.4	Recycling and reuse of waste		
8.5	Details of landfill sites or other disposal routes		
9.0	**Hazardous Materials on Site**		
9.1	Details of hazardous chemicals used on site		
9.2	Availability of hazardous materials data sheets		
10.0	**Storage Tanks**		
Note should be made of operational and redundant storage tanks.			
10.1	Location and condition of above ground storage tanks and vessels		
10.2	Suitable bunding of storage vessels		
10.3	Location and condition of below ground storage tanks and vessels		
10.4	Frequency and method of checking tank integrity		
10.5	Presence of records of storage inventories		
10.6	Drum storage, condition and spill containment		

		Name	Action
11.0	**Fire Precautions and other Environmental Incident Emergency Procedures**		
11.1	Documented and suitable fire control procedures		
11.2	Availability and suitability of fire fighting equipment		
11.3	Availability and suitability of fire fighting personnel		
11.4	Evacuation procedures and fire drills		
11.5	Containment of water used in fire fighting if contaminated		
11.6	Fire certificates		
11.7	Correct storage of flammable materials		
11.8	Identification of other environmental risks and control procedures		
12.0	**Land Contamination**		
12.1	Evidence of contamination, visible pollution, vegetation die-back etc.		
12.2	Previous site history		
12.3	Presence of dumps, stockpiles, buried wastes etc.		
13.0	**Other Hazardous Materials on Site**		
13.1	PCBs		
13.2	CFCs		
13.3	Asbestos		
13.4	Pesticides		
13.5	Radioactive materials		
13.6	Laboratory wastes - chemical and microbiological		
14.0	**Noise**		
14.1	Assessment of noise levels and details of noise surveys		
14.2	Compliance with noise regulations		
14.3	Noise and vibration control measures		
15.0	**Other Considerations**		
15.1	Aesthetics of the plant, blending with surroundings		
15.2	Damage to the ecology of area		
15.3	Damage to historical sites		
SECTION D - HEALTH, SAFETY AND QUALITY FACTORS			
16.0	**Health and Safety**		
Obvious deviations from good working practices are to be recorded.			
16.1	Documentation of hazards and presence of safety data sheets		
16.2	Compliance with regulations		
16.3	Issue and use of personal protective equipment		
16.4	Safe place of work provisions		
16.5	Safe systems of work including guarding of equipment		
16.7	Ventilation and indoor air quality		
16.8	Exposure to heat		

		Name	Action
16.9	Sickness and accident records		
16.10	Health monitoring of employees		
16.11	Outstanding claims against the company		
16.12	Medical staff, first aid, emergency services		
16.13	Staff training		
16.14	Safety checks on boilers, pressure vessels, lifting equipment, etc.		
17.0	**Quality**		
Factors which affect the quality and safety of products should be noted. Particular care must be taken to ensure that changes to production practices do not compromise the quality and safety of products.			
17.1	Documented good manufacturing practices		
17.2	Quality management systems e.g. ISO 9000		
17.3	Quality assurance system		
17.4	Effects of changing environmental practices on product quality		
SECTION E - OTHER FACTORS			
18.0	**Miscellaneous**		
18.1	Ways in which the facility is enhancing the environment or improving the local infrastructure		
18.2	Future plans		
18.3	Assistance required		
18.4	Information required		

Appendix 3

Case Studies from the SEAM Project

Reduction of Milk Losses

Water and Energy Conservation

Recovery of Cheese Whey for Use as Animal Feed

Integrated Quality Assurance and HACCP Approach to Waste Reduction in Food Processing