***SEAM* Project**

Oil and Soap 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
Technical Cooperation Office for the Environment
and
Entec UK Limited

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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 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 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 Report Egypt. Cleaner Production Opportunities.

Food Sector Report Egypt. Cleaner Production Opportunities.

Oil and Soap Sector Report 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.

List of Abbreviations used

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CP	Cleaner Production
DAF	Dissolved Air Flotation
DFID	Department for International Development
EEAA	Egyptian Environmental Affairs Agency
GOE	Government of Egypt
GOS	Gravity Oil Separation
PE	Poly-ethylene (polythene)
RBD oil	Refined bleached and deodorised oil
SMEs	Small and Medium sized Enterprises
TSS	Total Suspended Solids
VFA	Volatile Fatty Acids
WWTP	Wastewater Treatment Plant

1.0 Introduction

1.1 Cleaner Production - Concept and Definition

Traditionally, pollution coming from a factory has been controlled by using end-of-pipe controls, such as wastewater treatment plants. This continues to be the most common method of dealing with water pollution in developing countries even today.

An alternative approach to this is to eliminate the problem at the source, using the Cleaner Production approach. Unlike end-of-pipe solutions alone, Cleaner Production can generate significant financial savings, improve product quality and improve working conditions.

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).

The operational expansion of this definition states that:

- For production processes, CP 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 extraction to the ultimate disposal of the product.
- For services, the strategy incorporates environmental concerns into designing and delivering services.

1.2 The Benefits of Cleaner Production

The CP concept radically differs from the traditional end-of-pipe approach, in that CP 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. In addition, 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 CP 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.

Adoption of the CP approach can result in the following specific benefits being realised:

Improved efficiency: Cleaner Production leads to better efficiency of production, which means more output of product per unit input of raw materials. This helps the financial performance of the factory.

Lower costs: The ultimate goal of Cleaner Production is to minimise the generation of emissions and waste. Thereby the amount of waste and emissions that need to be treated are reduced, as are the associated costs.

Conservation of raw material and energy: Given the increasing cost of raw materials and the growing scarcity of good quality water, industry cannot afford to use these resources inefficiently. Cleaner Production measures help in overcoming constraints posed by scarce or increasingly costly raw material, water and energy.

Market Requirements: Increasing consumer awareness of environmental issues has brought about a need for the companies to demonstrate the environmental friendliness of their products and manufacturing processes, particularly in international markets. The emerging ISO 14000 series further accentuates this need. By adopting the Cleaner Production approach, many of the market requirements are met and a company ability to compete and get access to the green market increases.

Improved Environment: Cleaner Production minimises the volume and toxicity of waste and emissions and renders products more agreeable from an environmental standpoint. The direct effect is that the pollution load on the environment is decreased and environmental quality improved.

Increased compliance with environmental regulations: Minimising or eliminating the causes of wastes and emissions makes it easier to meet existing environmental regulations and standards, and reduces the environmental impact of the factory.

Working environment (Occupational Health and Safety Issues): Cleaner Production not only improves the environment outside the factory but improves working conditions as well. Keeping the factory clean and free of waste, spilled water, oil and chemicals not only reduces the likelihood of accidents but motivates the workforce to control new leaks and material losses.

Public image: As public awareness of the need for environmental protection is growing each day, it becomes more and more important for the industry to respond and react to the questions and demands posed by the public. The environmental profile of a company is an increasingly important part of its overall reputation. Adopting Cleaner Production is a proactive, positive measure and can help the concerned company build confidence with the public regarding its environmental responsibility.

The overall potential of Cleaner Production and subsequent enhancing profit margin in edible oil units is about LE30-100 per ton of final product. The potential of Cleaner Production in monetary terms is given in Table 1.1

Table 1.1: Potential of Cleaner Production

Area	Potential of Cleaner Production	
	Quantity	Value (LE)
Oil recovery from broken seeds	25-30 %	15-20
Final Product	15.30%	0-25*
By-product (lecithin)	4-20 Kg/T	5-25
Steam	200-400 Kg/T	8-15
Electrical Energy	30-60 KW/T	3-6
Neutralising chemicals	10-16 Kg/T	10-16** 20-35
	TOTAL	**61-126**

* Difference in the price of acid oil and hydrogenated oil.

** If using caustic lye.

1.3 Cleaner Production in the Egyptian Oil and Soap Industry

Cleaner Production and pollution prevention concepts started to play considerable role in industrial pollution control activities undertaken by the Egyptian industry. There have been a number of Cleaner Production initiatives, which have made considerable progress in convincing the oil and soap industry management for converting to Cleaner Production. These initiatives comprised awareness programmes developed by the Egyptian government and international development agencies from one side, and research work developed by research centres from the other side. In the following sections these initiatives are presented, along with some implemented measures by the industry as a positive reaction to these initiatives.

Environmental protection initiatives could be traced back in Egypt to the early eighties. In 1982, Law 48 for the protection of fresh water bodies was initiated, to control polluting wastewater discharges. In the same year the Egyptian Environmental Affairs Agency was established.

In the eighties and early nineties, most of environmental protection initiatives for the industry concentrated upon end of pipe approach. Cleaner Production and pollution prevention concepts began to be promoted on a national level in 1994, when the Egyptian Environmental Affairs Agency initiated the National Industrial Pollution Prevention Programme (NIPPP). The programme is being implemented with a sectoral approach to identify different Cleaner Production opportunities that are common in each industrial sector.

In parallel with the NIPPP, several programmes implemented by international donor agencies promoted Cleaner Production. This promotion varied from being the direct objective of some programmes, to an important tool used by some others. The Environmental Pollution Prevention Programme (EP3) is an example of the first type, EP3 has been implemented by the United States Agency for International Development (USAID), adopting the same concepts and methodologies considered by the NIPPP.

Some other programmes, which aimed to help the industry comply with environmental legislation, used Cleaner Production as an important approach in reducing pollution loads of final effluents. Examples of such programmes are the Environmental Pollution Abatement Programme (EPAP) implemented by the World Bank, Environmental Facility for the Public Sector Industry implemented by the German Construction Bank (KfW).

It is worth noting that the Egyptian government has regarded Cleaner Production as a strategic tool in its approach of implementing the environmental Law 4. The previously mentioned programmes are working or have worked under this framework set by the government.

It should also be emphasised that Cleaner Production would also facilitate treatment of wastewater both qualitative and in monetary term.

1.4 SEAM Project in the Oil and Soap Industry

The SEAM Project carried out audits of 11 oil and soap factories. These audits focused on identifying low-cost interventions with fast payback periods - a total of 120 such interventions were identified, with implementation costs ranging from LE0 to LE550,000. Savings from implementing these actions ranged from LE2,400 to LE1,000,000, with average payback periods of less than 2 months A summary of the different types of interventions identified follows:

Type of Intervention	Capital Costs (LE)	Annual Savings (LE)	Average Payback Period (months)
Improved Housekeeping	0 - 200,000	12,960 - 1,000,000	<1
Energy Conservation	0 - 30,000	222,000 - 550,000	<1
Water Conservation, Recycling & Reuse	0 - 40,000	13,000 - 425,000	5
Process Modifications	0 - 127,600	2,400 - 250,000	3
Optimising Use of Process Chemicals and Materials Substitution	0	81,000 - 460,000	<1
Recovery of By-Products	0 - 200,000	1,000 - 630,000	<1

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 CP 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.

1.5 Factories Participating in the SEAM Project

Alexandria Oil and Soap Company, Kafr El-Sheikh is a public sector factory, one of seven owned by the Alexandria Oil and Soap Company. It was built in 1965 and has around 760 employees. It main products include vegetable oil/ghee (700 ton/month), animal fodder (1,500 ton/month), laundry and toilet soap (1,500 ton/month), crude and medical glycerine(175 ton/month).

Alexandria Oil and Soap Company, Kafr El-Zayatt is a public sector factory, one of seven owned by the Alexandria Oil and Soap Company. It was established in 1892 on a 58 feddan site and employs around 2,400 staff. The main products are cotton and sunflower seed oil (1,900 ton/month), laundry soap and soapstock (630 ton/month), glycerine (70 ton/month), sodium and potassium silicates (800 ton/month) and animal fodder.

Cairo Oil and Soap Company, Badrasheen, Cairo was established as a private enterprise n 1950 and nationalised in 1960. It occupies an area of about 28 feddans and employs around 500 staff. The factory produces around 700 ton/month of edible oil (grade 1), 6,500 ton/month of animal fodder, 90 ton/month of soapstock and 20 ton/month of gums.

Misr Company for Oil and Detergents, Zagazig is a public sector company, constructed in 1976 and employing 1,100 staff. The main products are edible oil (2,500 ton/month), shortening (960 ton/month), animal fodder (10,000 ton/month) and soap powder (280 ton/month).

Misr El-Khalig for Oil Manufacture (MIGOP), Suez is a privately owned company, constructed in 1988 and employing around 580 staff. The factory produces a range of edible oils from corn, sunflower seeds and oil palm (1,600 ton/month), shortening (580 ton/month), vegetable ghee (4,080 ton/month), palm stearin (32 ton/month), fatty acids and waxes (14 ton/month).

Misr Oil and Soap Company, Mansoura is a public company, built in 1968 on an area of 30 feddans. It main products are edible oil (2,300 ton/month), toilet and laundry soaps (113,000 ton/month for domestic use) and glycerine (200 ton/month).

Nile Company for Oil and Detergents, Asyut was established in 1928 as a private company and then nationalised in 1960. It is now a public sector company employing around 900 staff. The factory produces around 100 ton/month of edible oil, 90 ton/month of soap stock, 400 ton/month of toilet and laundry soap, 70 ton/month of glycerine and 5,000 ton/month of animal fodder.

Salt and Soda Company, Moharrem Bay, Alexandria was constructed in 1899 and is currently one of 4 factories belonging to the Egyptian Salt and Soda Company. It occupies 12 feddans and employs around 1,300 staff. It produces an average of 5,300 ton/month of edible oil, 115 ton/month of shortening and 19 ton/month of waxes (mainly for forming as candles).

Savola Company, 10 Ramadan is a privately owned company, constructed on a 10 feddan site in 1994 and employing 400 staff. The company produces around 1,030 ton/month of edible oils (mainly palm oil), 300 ton/month of cocoa butter substitute (CBS) and 6,000 ton/month of vegetable ghee.

Sila for Oil Company, Fayoum is a private company which was constructed in 1993, with a workforce of 200 employees. The factory covers an area of 34 feddans. It processes an average of 5,700 tons of seeds per month, mainly sunflower, corn, soybean and cotton, producing up to 2,000 tons of first grade edible oil. The main by-products around 3,300 ton/month of animal feed and approximately 150 ton/month of soapstock and gums.

Tanta Oil and Soap Company, Tanta was established in 1934 as a private sector enterprise and was nationalised in 1962. It is now publicly owned and is one of three that are owned by Tanta Oil and Soap Company. Tanta factory produces an average of 22,000 ton/year of edible oil, 10,850 ton/year of ghee, 2,400 ton/year of soap, 480 ton/year of glycerine, and 54,000 ton/year of animal fodder, using cotton, kettan, and sunflower seeds.

1.6 SEAM Demonstration Projects

The audit findings were assessed to identify common problems facing the Egyptian oil and soap sector. A total of 3 projects were implemented:

Demonstration Project	Factory Name	Location
Waste Minimisation	Sila Edible Oil Company	Fayoum
Oil and Fats Recovery	Tanta Oil and Soap Company	Tanta
Reduced Wastage through Improving Raw Water Quality	Alexandria Oil and Soap Company	Kafr El-Sheikh

Part A

THE OIL & SOAP SECTOR

2.0 The Egyptian Oil and Soap Sector

2.1 Introduction

The oil and soap industry is defined in this report as the industry that extracts vegetable oils from oilseeds, refine extracted oil, manufacture soap, glycerine, fatty acids and animal fodder from by-products of oil processing.

The oil and soap industry is considered one of the oldest and most important industries in Egypt. Its importance emerges from the fact that its major product, edible vegetable oil is an essential ingredient of a balanced human diet. It is generally accepted that vegetable oil is better for human consumption than is animal fat. Animal fat is usually rich in cholesterol and saturated fatty acids, which have their bad effect on the blood circulatory system causing arteriosclerosis. Conversely, vegetable oils are almost free of cholesterol and are rich in the unsaturated fatty acids.

Vegetable oils are produced from oil seeds such as cottonseed, sunflower and soybean or directly from fruits such as palm and olives.

2.2 Ownership and Organisation

Oil and soap production in Egypt is undertaken by both public and private sector companies. Public sector companies are characterised by its large production scale, and its large labour force. There are eight public oil and soap companies working in Egypt, these are owned by the Holding Company of Food Industries, which is one of the major holding companies in the public sector enterprises. These companies include:

- Salt and Soda Company;
- Alexandria Oil and Soap Company;
- Tanta Oil and Soap Company;
- Misr Company for Oil and Detergents;
- Cairo Oil and Soap Company;
- Nile Company for Oil and Detergents;
- El Nil for Cotton Spinning;
- Extracted Oils and Derivatives.

In addition to the public sector, private companies for oil processing now comprise a considerable part of the industry. Individuals, or boards of national and foreign investors, own private sector companies, in other cases shares of such companies are being dealt in the stock market. Private sector companies are smaller in scale than public sector ones, and usually each company owns one factory.

In addition to public and private sector companies, there are also a number of multinational factories that are working in Egypt, mainly in new industrial cities.

Throughout the sector, each factory commonly has several processing plants, such as extraction, refining and deodorisation plants, soap manufacturing plant, glycerol production plant, etc.. In some factories, especially those in public sector companies, all the manufacturing plants for processing oilseed, crude oil and by-products may be present. More commonly though, individual factories will only carry out a part of the process, with by-products being sent to other factories for further processing. For example, a factory may have an oilseed extraction plant, but does not have plant for further processing of its crude oil product. Further processing of the crude oil (refining, bleaching and deodorisation) may be made in another factory, which may be owned by the same company.

2.3 Productivity of the Sector

The amounts of oilseed processed during 1996-1997 were as follows:

- 331,897 ton of cottonseed and sunflower oil;
- 14,568 ton of corn oil, 6,195 ton of soybean oil;
- 26,721 ton of palm oil.

With the exception of soybean, oilseed processing in Egypt depends entirely on local seed production.

Sesame oil is also produced in Egypt, with up to 28,000 tons of seed being processed annually (1995). However, sesame oil is mostly used for preparation of certain food products rather than for direct use as an edible oil.

Public sector companies produce about 85% of the total edible oil production, mainly consisting of cottonseed and sunflower oil. The balance is produced by the private sector, which also produces most of the corn oil and palm oil. Locally produced oilseed only covers 20% of the sectors needs; the deficit is made up by importing crude or semi refined oils. The oils imported are commonly semi-refined cottonseed and palm oils and crude sunflower, soybean and corn oils. Oil and soap production statistics are presented in Appendix 1.

Toilet soap production amounted 66,932 ton in 1996-1997, while laundry soap production was 96,547, public sector is producing about 60% from these figures, and the remaining 40% is produced by the private sector. Local consumption of soap is covered by its production to a great extent, as imported soap was 607 ton in year 1997 of mainly high quality soap. Export market of toilet soap is also growing, as soap exports increased from 4,007 in 1995 to 5,632 ton in 1997.

Public sector companies are currently working to about 64% for oil and 30% for soap of their available production capacity. In contrast, private sector factories are working at around 85% for oil and 87% for soap production.

Although edible oils are the most important product of this industry, other by-products are generated, including glycerine, fatty acids, detergents, animal fodder and cosmetics. Animal fodder is obtained as a by-product from oil seed extraction (seed meal), whereas glycerine is obtained as a by-product from soap manufacture.

2.4 Geographical Distribution

The distribution of oil and soap producing plants throughout Egypt is shown in Table 2.1 and illustrated in the maps of Figure 2.1 and 2.2. It should be noted that certain big factories have separate oil and soap production plants.

Table 2.1 Number of Major Factories producing Oil and Soap in Egypt

Governorate	Number of factories	Oil	Soap	Oil and Soap
Alexandria	24	8	15	1
Asyut	2	-	1	1
Banisuef	1	1	-	-
Behera	6	1	5	-
Cairo	39	9	30	-
Dakahleya	3	1	1	1
Fayoum	3	2	1	-
Gharbeya	25	16	6	3
Giza	24	12	12	-
Ismaileya	1	1	-	-
Kafr El-Shiekh	2	1	1	-
Kalubeya	26	8	18	-
Marsa Matroh	1	-	1	-
Menya	2	1	-	1
Monofeya	3	2	1	-
Sharkeya	26	18	8	-
Sohag	2	-	-	2
Suez	4	2	-	2

Source: General Organisation For Industrialisation (GOFI) 1995, updated from the information centre, Industrial Union, 1998.

Figure 2.1: Map showing the Location of Oil Plants in Egypt

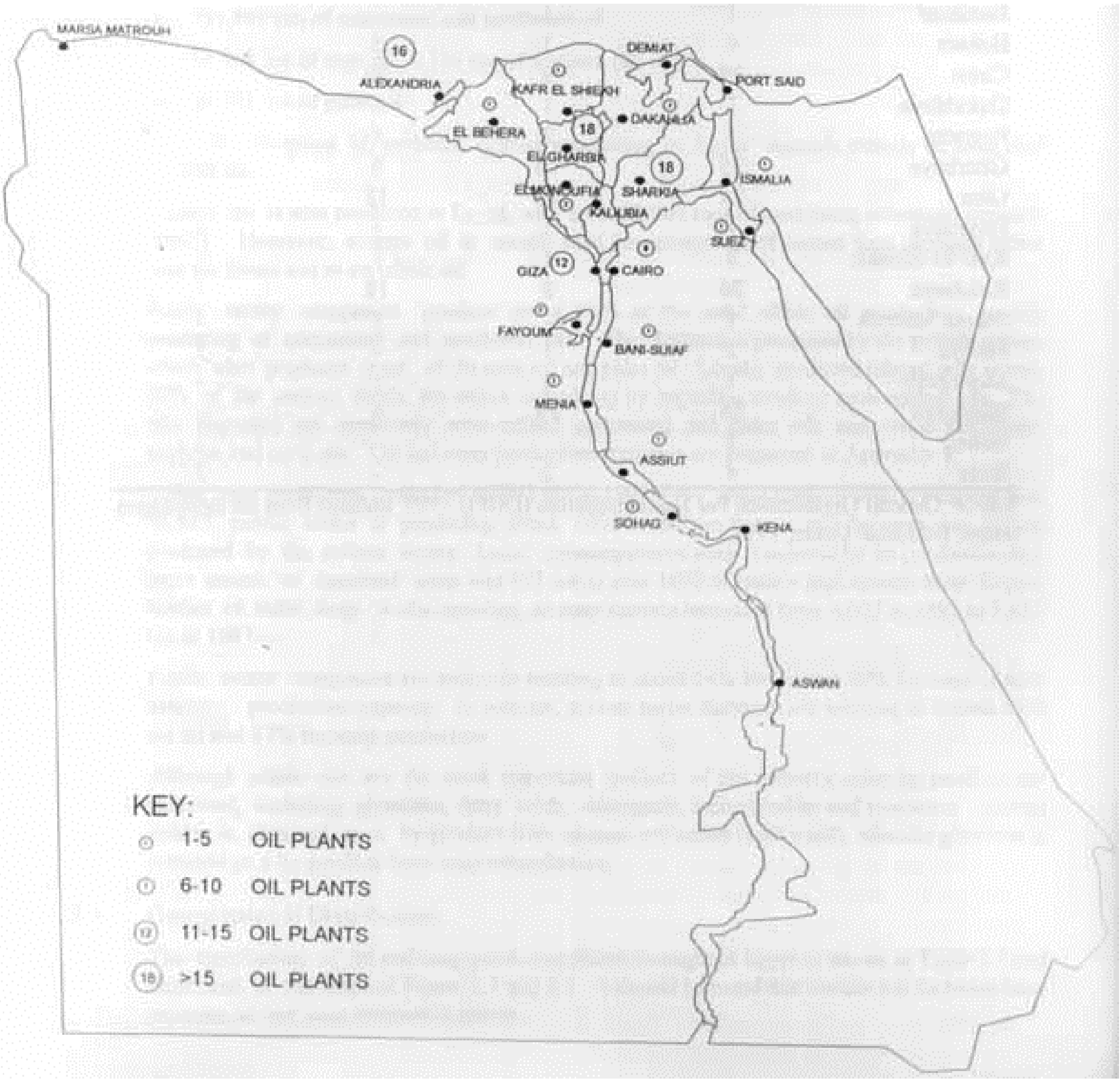
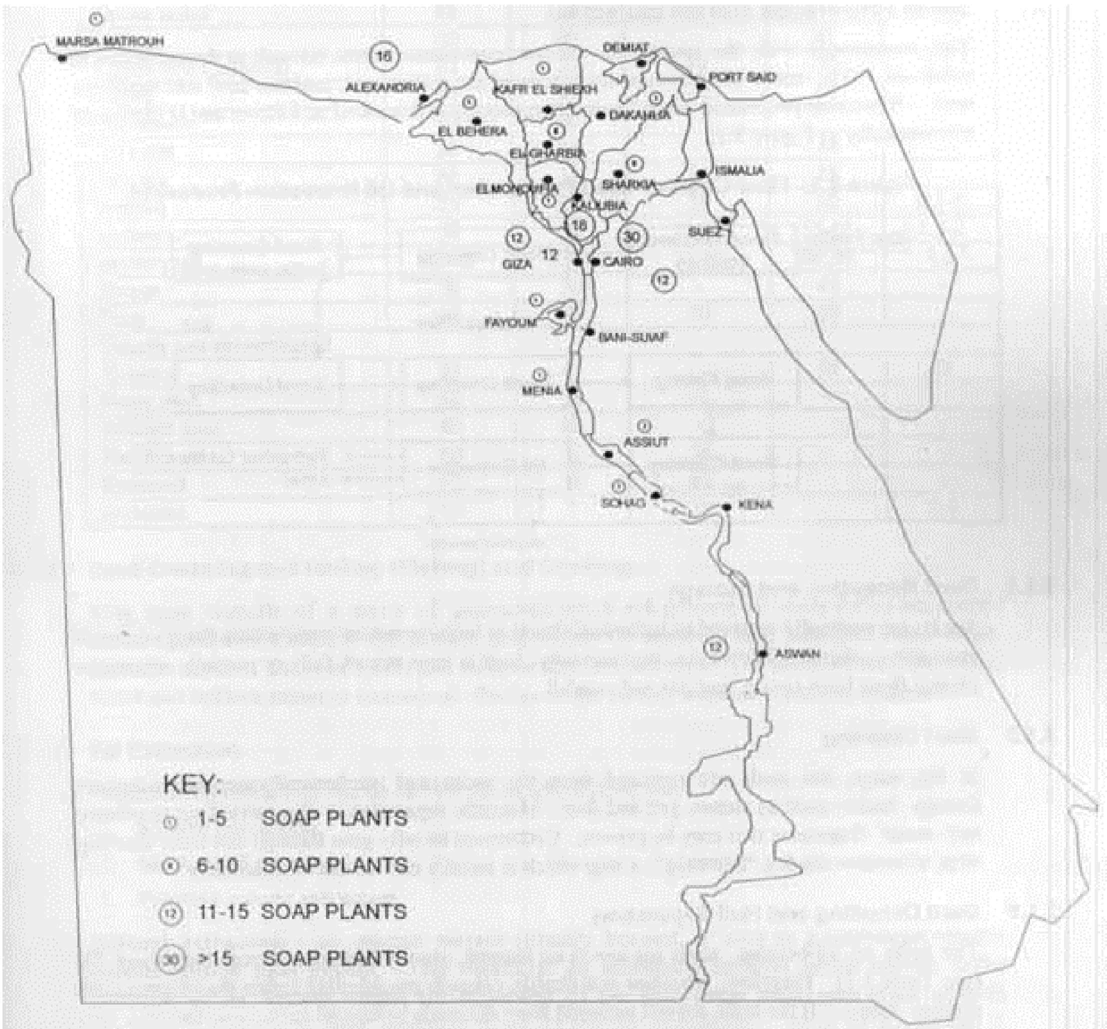


Figure 2.2: Map showing the Location of Soap Plants in Egypt

(to be inserted)



3.0 Oil and Soap Manufacturing Processes

The manufacturing processes described in this section represent the technologies used by the majority of processing plants in Egypt. It should be noted though that alternative processes are occasionally used in a response to specific production needs. These processes have not been considered in this report.

3.1 Seeds Preparation and Oil Extraction

This commences with the receipt of the raw, unprocessed seeds through to the extraction of crude oil. The seeds most commonly processed are cotton seed, soybean seed and sunflower seed. The seeds processing and oil extraction process is described as follows and is illustrated schematically in Figure 3.1).

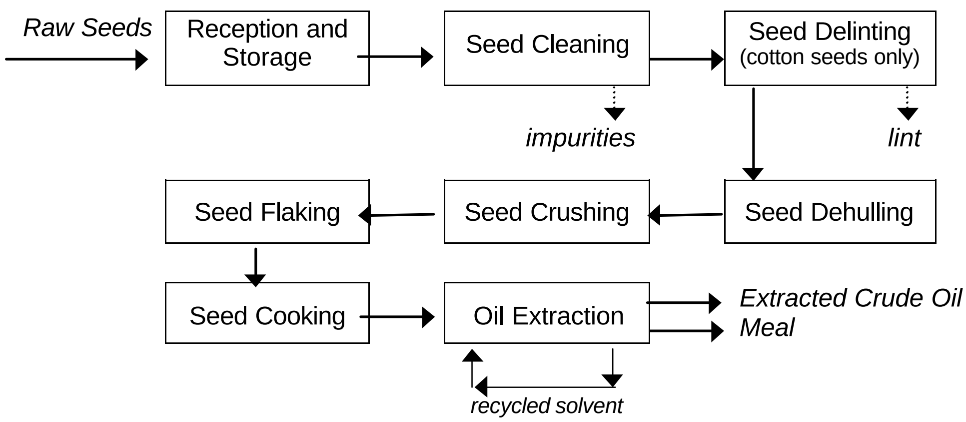


Figure 3.1: Flow Chart of Seed Preparation and Oil Extraction Processes

3.1.1 Seed Reception and Storage

Seeds are normally received in sacks and stored in large reception areas within the premises of processing plants. The sacks are normally kept in open stores, fully or partially covered to protect them from strong sunlight and rainfall.

3.1.2 Seed Cleaning

In this stage, the seeds are removed from the sacks and mechanically screened to remove foreign bodies such as stones, grit and dust. Magnetic separation is also carried out to remove any metal fragments that may be present. Cottonseed usually goes through one more cleaning step, to remove the lint delinting, a step which is usually carried out mechanically.

3.1.3 Seed Dehulling and Hull Separation

The hulls of oil-bearing seeds are low in oil content, usually contain not more than about 1% (see Table 3.1). Therefore, wherever practicable, oilseeds are dehulled before the oil extraction process starts. If the hulls are not removed from the seeds before oil extraction, the total yield of oil will be reduced as they will absorb and retain the oil in the press cake. The capacity of extraction equipment will also be reduced.

Table 3.1: Oil Content of Hulls and Kernels of Various Types of Oil Seeds

Oil seed Type	Seed Composition		Oil Content (%)		
	% Kernel	% Hull	Whole Seed	Kernel	Hull
Usually decorticated					
Babassu	9	91	-	67	-
Castor beans	70-80	20-30	40-50	-	-
Cocoa beans	88	12	50	-	-
Cohune	10	90	-	67	-
Cottonseed (delinted)	62	38	19	30	1-2
Kapok	60	40	20-25	40	-
Murumuru	40	60	-	-	-
Oil palm	25	75	-	48	-
Oiticica	65	35	38	58	-
Peanuts	75	25	38	50	0.5-1
Safflower	50	50	28-33	55-65	1.5-2
Sunflowers	45-60	40-55	22-36	36-55	1-2
Tucum	30	70	-	47	-
Tung	60	40	30	50	-
Usually not decorticated					
Flaxseed	57	43	-	58	22
Hemp seed	62	38	31	-	-
Mustard seed	80	20	-	-	-
Perilla seed	68	32	34	-	-
Rapeseed	82	18	42	-	-
Soybeans	93	7	18	-	0.6

3.1.4 Seed Crushing and Rolling (Flaking) and Cooking

This stage consists of a series of operations which will prepare the seeds for oil extraction. These operations comprise mechanical preparation by crushing and flaking of seeds, which partially rupture the seed cells and increase their surface area. The seeds are then cooked in direct and indirect steam to increase the fluidity of the oil and increase rupturing of the cells.

3.1.5 Oil Extraction

Vegetable oil extraction can be carried out in one of three ways:

1. Solvent Extraction;
2. Mechanical pressing;
3. Prepress solvent extraction.

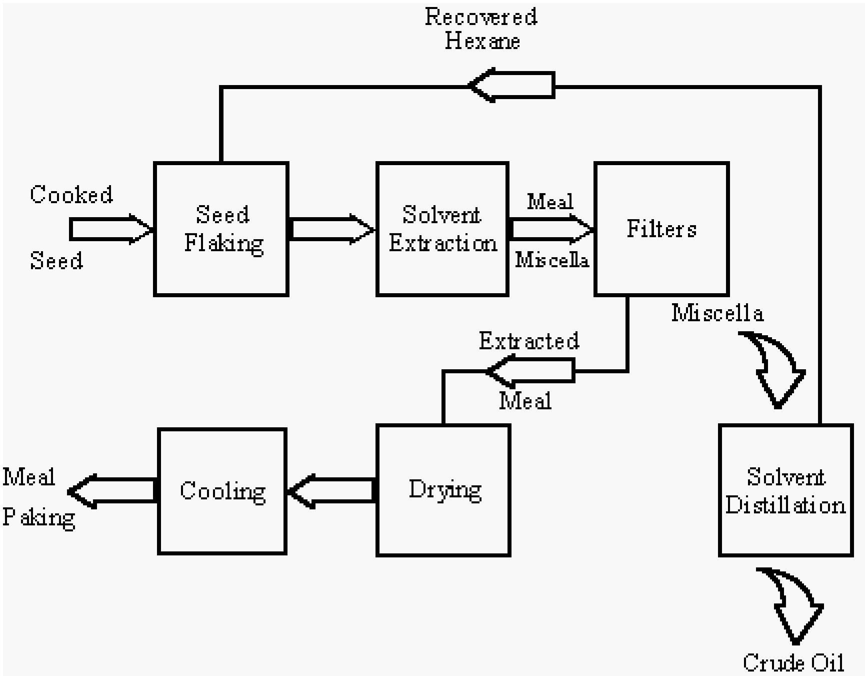
Solvent extraction - an organic solvent (usually hexane) is used in a continuous counter current solvent pass system. This results in an oil-hexane solution which travels in the direction of the hexane, whilst the remainder of the seed (seed meal) goes in the opposite direction. The oil is then separated from solvent by distillation. Most of the solvent is recovered and recycled within the system. A block diagram showing the main processing units in a solvent extraction plant is given as Figure 3.2.

Mechanical pressing - a hydraulic or screw press is used for oil extraction. However, mechanical methods are often criticised for less extraction efficiency - solvent extraction leaves behind less than 0.1% oil in the extracted meal.

Prepress solvent extraction - the oil is first extracted by mechanical pressing and then by solvent extraction.

Of these three methods, solvent extraction is the most commonly used in Egypt.

Figure 3.2: Main Units in a Solvent Extraction Plant

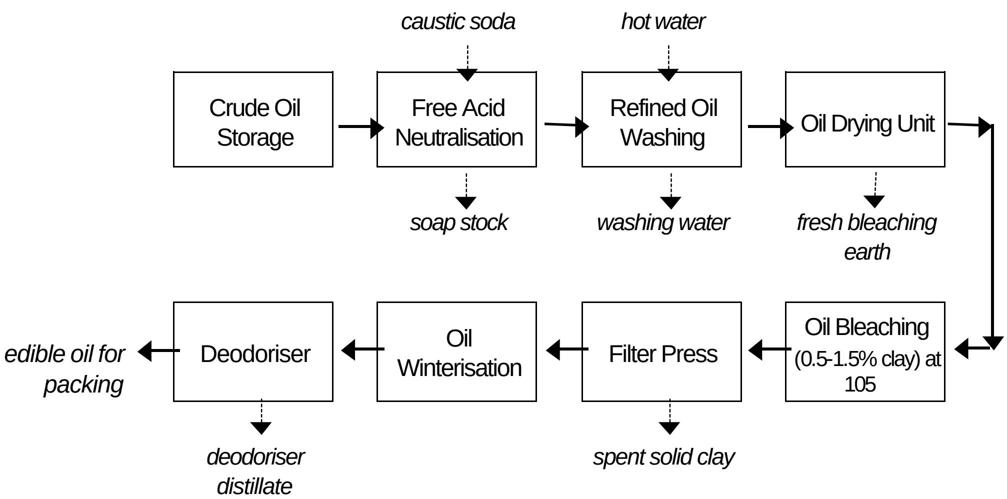


3.2 Oil Refining and Treatment

Crude oils usually contain undesirable constituents which need to be removed to make the oil product suitable for edible purposes. These constituents include free acids, colouring matters (pigments) odoriferous substances, gummy substances and waxes. The first three constituents are the basic impurities in all types of crude oils. The refining process is described in the following sections, the entire process being illustrated in Figure 3.3).

Physical refining suits oils such as palm oil and soybean oil, whereas chemical methods suit oils such as cottonseed oil. If the refining is carried out using chemical methods, the process of oil bleaching using bleaching earth should follow refining whereas in case of physical refining, the oil bleaching should proceed the refining process. The bleaching removes the colouring matters and phospholipid, which can cause problems during the physical refining process.

Figure 3.3: Schematic showing the Refining and Deodorisation Processes



3.2.1 Degumming and Dewaxing

The amount of gums and waxes present in the crude oil depends on the type of oilseed being processed. Soybean oil for example, is richer in gummy substances than cottonseed oil while sunflower oil is also rich in waxes. Thus with soybean oil a step for crude oil degumming prior to refining is essential especially when the oil will be refined physically rather than chemically. Degumming can be carried out by adding a phosphoric acid solution to help precipitate out the gums. The gum separated from crude soybean oil is also a useful by-product from which Lecithin, a natural emulsifier, can be obtained.

With crude cottonseed oil, refining should be carried out using sodium hydroxide in order to remove the free acids and acidic pigments in the oil which impart dark colour to the oil. Chemical refining of crude cottonseed oil is quite sufficient to remove the small amount of gummy substances present.

Sunflower oil contains some waxes and needs to be dewaxed at low temperature prior to processing, whereby the waxes solidify and are filtered off.

These steps can be added or excluded during crude oil processing according to the type of oil to be processed.

3.2.2 Neutralisation

Extracted crude oil is acidic, due to the presence of high levels of free fatty acids. These can be removed either by chemical methods, using caustic soda or by physical methods, where they are distilled out of the crude oil at a high temperature and low pressure. In Egypt, chemical separation is the most commonly used of these two methods and is described in more detail as follows.

The free acids are removed from crude oil using caustic soda solution in batch or continuous process. The concentration of the soda solution used will depend on the oil type and quality. For low grade crude oils, more concentrated solutions are usually used (up to 24 Baume) whereas with high grade oils, less concentrated alkali could be sufficient (12 Baume).

The addition of the alkali solution reacts with the free acids to produce a black semi-solid organic substance called mucilage. This settles out from the neutralised crude oil together with gummy and colouring substances. In some factories separation is achieved by gravity settling alone, where the mixture is allowed to settle for several hours after which the neutralised oil is separated. In more modern units, separation is aided by centrifuging the mixture, which is a more efficient and faster method of separating the two liquid phases. Such efficient separation certainly reduces the amount of neutralised oil lost in the mucilage and the amount of soap traces in the refined oil.

3.2.3 Washing and Drying

The refined oil coming from the neutralisation unit will normally contain traces of entrained soap from the heavier mucilage phase. The oil is washed with hot water in two stages, which is then separated from the oil by centrifuging. The washed oil is then dried under vacuum - this is essential as any traces of water can cause deactivation of the bleaching earth used in the next stage.

3.2.4 Bleaching and Filtration

Bleaching of oils by adsorption involves the removal of pigments which are either dissolved in the oil or present in the form of colloidally dispersed particles. Adsorbents usually employed are bentonitic clays such as fuller earth and Tonsil clays. Activated carbon is less commonly used.

Bleaching can be carried out in a batch or a continuous process. The bleaching earth or a mixture of earth and carbon is usually added to the bleaching kettle in the desired amount (about 1% of oil weight) at a temperature ranging from 100 to 120°C.

After the adsorption step, the oil is passed to filter press to separate it from adhering bleaching clay and returned to the bleaching kettle for clarification. A cake of spent clay is left behind in the filter press, which is blown with air and steam to recover as much as possible of the entrained oil.

3.2.5 Winterisation and Stearine Removal

This step is used only in cottonseed oil refining, as it contains up to 18% stearine fatty acid. The bleached oil is cooled to 4 degree centigrade in special tanks for about 3 days, to allow the partial settlement of stearine. After settlement, the oil is filtered at -3 degree centigrde, leaving the stearine in the filter press. This is removed by separating the press leaves and melting the stearine off with steam.

3.2.6 Deodorisation

The purpose of this process is to remove all substances which cause undesirable flavour or odour from the bleached oil. The oil stock is subjected to the action of superheated steam at 250°C under a very low pressure (absolute press = 6-12 mm Hg). The substances responsible for characteristic odour of the oil stock are volatilised with steam, which are then condensed in a barometric condenser.

Deodorisation is the last step of oil treatment. The oil is now suitable for bottling, which usually carried out automatically, before being packed in boxes for distribution.

3.3 Oil Hydrogenation and Shortening

Hydrogenation is the main process applied in the production of margarine, fats, and oil shortenings. This involves the addition of hydrogen to the unsaturated bonds in the extracted oil to harden the oil and give it some specific edible properties, such as increasing its melting point giving it solid properties at ordinary temperatures. The hydrogenation of oil as carried out in Egypt is described in the following sections.

3.3.1 Hydrogen Injection and Autoclaving:

This is undertaken by heating the oil at a temperature of about 200°C under vacuum in autoclaves. Hydrogen is then injected into the autoclave at a pressure of about 1-2 bar. The reaction between hydrogen and the oil is usually catalysed by appropriate agent, usually nickel.

3.3.2 Cooling and Filtration

After around two hours of autoclaving, the hydrogenated oil is being cooled and filtered to remove the spent nickel catalyst. It is often possible to recycle about half of the recovered nickel catalyst from the filtration process.

3.3.3 Refining of Oil Shortening

After hydrogenation, the oil would have inherited the desired plastic properties, and, hence, is called oil shortening. Oil shortenings pass through the same treatment and refining stages described for regular edible oils (neutralisation, washing, bleaching, deodorisation, etc.). Oil shortenings are then packed in tin cans.

3.4 Soap and Glycerine Production

Production of soap and glycerine usually goes through the following stages:

- saponification;
- laundry and toilet soap production;
- glycerine manufacture.

The raw materials used in producing soaps include:

- tallow - the principal fatty material used in soap making;
- greases - a secondary material used in soap making;
- free fatty acids;
- process chemicals, including caustic soda, sodium chloride, caustic potash, sodium silicate.
- perfumes, silicates, colouring agents, opacifers, antioxidants, emolliants - particularly in toilet soaps;

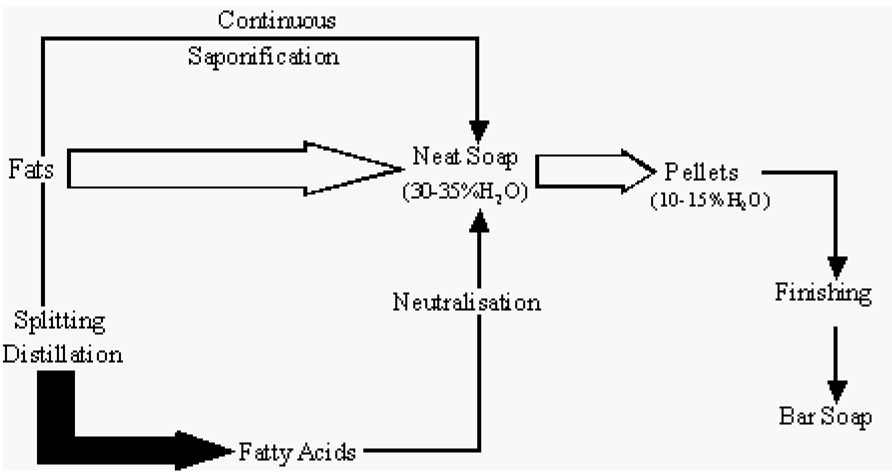
3.4.1 Saponification

In this process, raw fats are thermally treated with steam in the presence of an excess alkali (usually caustic soda), forming soap and glycerine. The complete series of operations in the production of an ordinary fully boiled or settled soap is as follows:

1. Reaction of the fat with alkali until it is largely saponified.
2. Graining out of the soap from the solution with salt in two or more stages for recovery of glycerol produced by the reaction.
3. Boiling of the material with excess alkali to complete saponification, followed by graining out with alkali.
4. Separation of the batch into immiscible phase of neat soap and niger - the so called fitting operation.

The neat soap consists of about 65% real soap with about 35% water and with traces of glycerine, salt, etc. The saponification technique is illustrated in Figure 3.4.

Figure 3.4: The Continuous Saponification Technique



The fresh lye used in the process commonly has a strength of about 30 Be, corresponding to a sodium hydroxide content of 23.5%. The amount of such lye required for complete saponification is in the range of 60-65 lb/100 lb of fat for most stocks.

In Egypt, saponification has traditionally been carried out in soap kettles, where fatty acids are the main raw material. This is now being replaced by continuous alkaline saponification, which is more efficient and can use tallow, greases and free fatty acids to produce soap and glycerine. This represents the most important advance in the production of soap in the last 30 years. The continuous process has two categories:

1. The first group are processes based on the saponification of fats, the most important of these are the De Laval, the Sharples, Mechanica Modern and Mazzoni SCN-LR processes.
2. The second group is based on the continuous splitting of fats into fatty acids, followed by continuous distillation and neutralisation of the fatty acid. The three most important examples in this series are the Mills, the Mazzoni SC, and the Armour processes.

A new approach to soap processing is the High Caustic - High Solids Separation method. The objective is to carry out the neutralisation with minimum amounts of water by using high concentration of caustic soda solution (50%) and finishing with 86% anhydrous soap, thus eliminating the drying step.

3.4.2 Laundry and Toilet Soap Production

Once the saponification process is complete, the end product is neat soap, that is, soap containing about 30-35% H_2O. This neat soap is dried and converted into soap chips with a moisture content of 5-15%. The drying is achieved in a number of ways. Spray drying has replaced the older technique. The so-called Mazzoni, Vacuum spray dryers are available as single vacuum, or as a combination of atmospheric flash plus vacuum multi-stage system.

The dried soap (10% moisture) can then either be sold as is or can be further processed in finishing stage that includes shaping by moulding or milling and then packing. Toilet soap goes through one additional step whereby additives such as colour agents and perfumes are added.

3.4.3 Fatty Acids

Fatty acids are mainly consumed in the manufacture of detergents and soap. Fatty acid, saturated (e.g. stearic acid) and unsaturated (e.g. oleic) have long been employed in many other industries such as cosmetics, water proofing, textiles, etc..

High pressure hydrolysis is the most commonly used process in the fatty acid splitting industry, the three main types being the Twitchell Process, Batch Autoclave Process and the continuous Countercurrent process. Several older and less used separation methods for purifying fatty acids are panning, pressing, fractional distillation, and solvent crystallisation. Appendix 2 compares the three processes used for fat splitting.

Distillation is employed to separate fatty acids of different chain lengths, vacuum distillation being the most widely used. In this, three fractionating towers of the conventional tray type are operated under vacuum. Crude fatty acid (preheated) stock is directed to the top of a stripping tower, whilst it is flowing downwards. Fatty acids with low boiling points are swept out of the top tank, where the condensate remains.

3.4.4 Glycerine Production

The spent lye solution separated in the saponification process usually contains about 10% glycerine in addition to considerable and variable amounts of salt, a small amount of free caustic soda, traces of dissolved soap, and certain organic impurities derived from the fat. Hence, the production of glycerine involves the recovery and purification of glycerine from the lye solution. Glycerine production usually goes through the following steps:

- **Separation of traces of dissolved soap** is usually carried out by dosing with 4 - 14 lb alum/1000 lb of lye. This precipitates out any soap and other organic impurities in the form of soluble aluminium salts, which then reacts with the excess caustic soda to form a flocculent that precipitates out of the solution.
- **Neutralisation of excess caustic soda** in the lye is then achieved by adding a strong acid (usually sulphuric acid);
- **Filtration** of the lye, which is usually undertaken using filter press.
- **Evaporation of the treated lye** is carried out using vertical-tube, double effect evaporators. This concentrates the solution to give 80% crude glycerine and precipitates the bulk of the salts, which then settle to the bottom of the evaporator and into the salt drums. The usual vacuum is 26-28 inches of mercury, where a concentration of 70-80% is reached when the temperature has risen to about 190-200 ; excessive losses of glycerine will occur if further concentration is attempted. Ordinary 80% crude glycerine still contains small amounts of salt and various other impurities, both organic and inorganic.
- **Recovery of the settled salts** - valves in the pipes leading from the evaporators to the salt drums allow them to be periodically cut off from the evaporator and emptied. The recovered salt, after washing and drying, is reused for salting out new batches of soap.
- **Purification and further concentration of glycerine** is carried out to produce the commercial grades of C.P glycerine and U.S.P. glycerine. This process involves fractional distillation of the glycerine from the non-volatile impurities under vacuum, with the aid of superheated steam. The distilled product is then treated with bleaching carbon and various chemicals. Glycerine can also be purified by an ion-exchange method.

3.5 Animal Fodder Production

Animal fodder is an important by-product in the oil and soap plants, the main raw material being the seed meal remaining after oil extraction has been carried out. Production of animal fodder is a simple process, summarised as follows:

- **Mixing meal with additives**: Seed meal is mixed with bran, maize, molasses, lime, and other minor ingredients. Ingredients are usually conveyed to mixing containers and then the mixture is cooked with steam to adjust the moisture content of the product.
- **Shaping and packing**: In this stage, the mixture is pressed into pellets or cubes and left to cool in the air. The product is then packed in sacks for sale and distribution.

3.6 Ancillary Units

There are many ancillary units in oil and soap plants, which may not be directly related to the manufacture of oil and soap products, but which are very important to the process. The most common ancillary units found in most oil and soap plants are listed below:

3.6.1 Boilers - Generation of Steam

Steam is essential for many of the production steps and thus boilers are normally present in all oil and soap processing facilities in Egypt. Steam production is usually undertaken by boiling water in hot vessels through burning of fuel. Many factories, particularly the older ones, use mazot (heavy oil) or solar as burning fuel, while some new factories have converted their burning facilities to natural gas. Recycling of steam condensate is carried out in few factories. The efficiency of this depends on the condition of the steam-piping network.

3.6.2 Cooling Towers

Recently, many factories have started to reuse their cooling water, as it is relatively clean in most cases. Cooling towers work by exposing sufficient surface area of hot water to the atmosphere. Cooled water is then collected and reused in the process.

3.6.3 Feed Water Treatment

Some factories will treat incoming water before it is used in the process. Specifically, almost all steam production facilities have to treat feed water to reduce the high levels of hardness to prevent calcium scaling in boilers that reduce the heating efficiency. Treatment of hardness is usually achieved by compact softening units.

3.6.4 Laboratories

Most oil and soap factories have quality control laboratories, in order to achieve a satisfactory quality of their products. A few factories also have laboratories which are used to carry out other monitoring activities, such as wastewater analysis.

3.6.5 Production of Packaging Containers

Many factories produce their own packaging containers, such as plastic bottles and tin boxes. Cutting, shaping and labelling of plastic or tin are usually the main production activities in oil and soap plants.

3.6.6 Workshops

Most oil and soap factories are equipped with mechanical workshops for maintenance and repair works for different equipment. Most operations done in these workshops are moulding, forging, and other metal shaping operations.

Some factories also provide mechanical maintenance workshops for their vehicles. This may include in some cases gasoline stations and truck garages.

3.7 Utilisation of Resources

Utilisation of resources is an important factor in implementing waste minimisation and cleaner technologies, as over utilisation is an indication of low efficiency of manufacturing processes and high rates of waste production. In this section, the quantification of different resources by the sector has been made. This incorporates a large number of variables that influence resource utilisation in Egypt, such as the types of technologies adopted, type of equipment and maintenance efficiency. The information in this section has been derived from technical studies of various oil and soap industrial facilities in Egypt.

3.7.1 Raw Materials Utilisation

(i) Oil seeds

The amount of oil that can be extracted from the seed depends primarily on the oil content of the seed, which itself varies according to the type of seed being processed. In cottonseed, which is most commonly used for oil extraction in Egypt, oil content is in the range of 17-20%. This means that the ideal capacity of oil extraction is to use 5 parts of oilseeds to produce one part of extracted oil.

Extraction capacities in the Egyptian oil industry vary significantly from one factory to another; usually 4-8 tons of seeds (mainly cotton and soybean seeds) are utilised to produce one ton of crude oil. Extraction efficiency is further affected by the type and quality of seeds.

(ii) Hexane

The seed to solvent ratio should be around 2:1. However, the actual volume of hexane consumed is far less than this, as the hexane is always recovered from miscella and reused. The quantity of hexane to be used to make-up for losses, such evaporation losses, is about 2-30 Kg for each ton of seed.

(iii) Alkali Solution - Caustic Soda

Caustic soda is used in refining plants for neutralising crude oil and in the saponification of fats. The amount of caustic soda consumed by both processes depends upon the acidity content of crude oil, and the type of fat used for soap manufacture. Again, there is a wide range of difference in consumption rates of caustic soda throughout Egyptian oil and soap factories.

Caustic soda used in edible oil refining varies between 1 kg to 600 kg for each ton of refined oil produced. The saponification process consumes between 50-150 kg caustic soda for each ton of soap produced; this variation is highly sensitive to the type of soap required (i.e. toilet or laundry soap) and the fats used.

(iv) Bleaching Clay

Consumption of Fuller Earth, which is the most commonly used bleaching clay, ranges from 3 to 20 kg for each ton of bleached oil. This consumption depends on the desired purity of final products, the content of pigments in the oil and the quality of clay used. For example, darker refined oils are more resistant to bleaching and therefore, the quantity of bleaching earth required to remove the colours increases.

(v) Animal Fats

The amount of fats required for producing one ton of soap ranges between 100 and 1000 ton. This wide range is related to many different variables in the manufacturing process, such as the type of used fats, the type and quality of produced soap, and the efficiency of the operation.

(vi) Salt

The range of salt consumed in soap production is 30-150 kg for each ton of soap produced. The efficiency of the process, along with other quality variables, is the main factor effecting its use.

(vii) Glycerine Water

The glycerine water or the lye solution is separated in the saponification process and then treated to recover glycerine. The average rate of glycerine water production from the saponification process is about 600 kg per each ton of produced soap. This will produce from 60 to 120 kg of final glycerine product (88% pure).

(viii) Coagulant (alum)

Coagulants are used to separate and precipitate the impurities in glycerine manufacture. The range of coagulant consumption is 20-500 kg for each ton of glycerine.

(ix) Animal Fodder

Seed meal, which is a by-product from the oil extraction step, is produced at an average rate of 700 kg per each ton of seeds processed. The amount of seed meal that is used in producing the animal fodder is highly variable, depending on the quality of the final product. The rate of meal consumption ranges from 100-800 kg per ton of produced fodder. Other variables which affect the consumption rates are process efficiency and amount of losses from the system.

Many other materials are used in the production of animal feed, which varies according to the required nutrient content in final products. These materials are mainly bran (200 400 kg / ton fodder), maize (50 150 kg / ton), barley (50 150 kg / ton), molasses (10 30 kg/ton), salt (5 10 kg /ton), and calcium carbonates (10 30 kg / ton).

3.7.2 Water Consumption

Water consumption is very important because it effects the volume of wastewater generation. The consumption of water in oil and soap industries is highly variable throughout Egypt. This variability is not solely related to the size and capacity of the corresponding industrial facility, but it is mainly, and more importantly, dependent upon the source of water supply, and the associated usage costs.

It is very difficult to quantify water use and relate it to different manufacturing processes, because of the absence of water metering facilities inside the factories, and the absence of accurate consumption estimates from water supply authorities.

However, one of the biggest factors influencing consumption rate is cooling water and whether or not it is recirculated. The cooling water represents about 90% of the water used in an oil and soap plant. Therefore, the actual consumption rate of water differs greatly from a factory to another depending on its size, type of plant and cooling water recirculation.

Water consumption can be as much as 15,000 m^3/day for integrated factories, which produce oil, soap, glycerine, and animal fodder in high volumes. In smaller factories, this figure is around 5,000 m^3/day, while it can be as low as 300 m^3/day in relatively small scale privately owned factories. The magnitude of these water consumption figures are strongly related to the source of water, as large consumers of water usually depend on ground water or surface water, which are usually supplied free of charge except for pumping expenses. Smaller consumers are usually factories located in new industrial cities, which are supplied with water from water supply authorities at relatively high rates; LE0.85 in some areas.

3.7.3 Energy Utilisation

The largest consumer of energy in oil and soap factories is the boiler house, the fuels most commonly used being mazot oil, solar oil and less commonly, natural gas. The amount of fuel consumed depends mainly on the scale of the industrial facility, and the rate of consumption within each facility on the efficiency of combustion process.

Most factories use mazot as fuel for running the boilers; consumption can be as high as 70 tons/day or as low as 10 tons/day. Solar is often used to start up the combustion process, therefore the rate of solar consumption is relatively low. Use of natural gas is still relatively limited, depending on the proximity of a natural gas pipeline to the factory. Accurate figures concerning the consumption rate of natural gas are difficult to obtain, however an average consumption of 4,000 m^3/d would be reasonable for medium scale factories.

Electricity is used in many applications of the industrial process, such as lighting, conveyers, control panels and pumps. The range of electricity consumption is between 10,000 to 70,000 Kw.hr/day. Rate of electricity consumption also depends on the scale and efficiency factors discussed earlier.

4.0 The Oil Industry and its Effect on the Environment

A summary of the main sources of pollution generated by each of the processing sequences follows.

A summary of the wastewater volumes, characteristics, pollution loads and solid wastes generated by Indian edible oil factories are given for comparison in Appendix 3.

4.1 Seeds Preparation and Oil Extraction

Poor storage of oilseed prior to processing will result in the production of off-grade crude oils which indirectly increase the pollution level during its processing (refining and bleaching).

Oilseeds are usually stored in most local factories in open areas exposed to rainfall during winter and direct sunlight during summer. Seed packages are also loaded over each other in a very compacted, poorly ventilated areas. Under these conditions, moulds, bacteria and enzymes develop and act on the seeds, causing;

- Seed damage and germination.
- Oil hydrolyses to form free acids and glycerol.
- Development of un-refinable and un-bleachable forms of seed pigments. These fixed forms of seed pigments resist the removal by conventional methods of alkali refining and bleaching. Dark-coloured final oil can thus be produced which does not meet with standard specifications of an edible oil.

Highly acidic crude oils containing fixed pigment forms will require the use of extra amounts of alkali in the neutralisation step and extra amounts of bleaching earth. This in turns increases the quantity of wasted mucilage and the soap concentration in washing water. Also, the use of great amounts of bleaching earth means an extra load on the filtration unit, increased losses of entrained oil and larger amounts of solid wastes (spent earth).

Table 4.1: Wastes Generated during Oilseed Storage

Water Pollution	Air Pollution	Solid Waste Generation
■Filter clothes washing. ■Occasional cleaning of expeller and shop floor.	■Dust arising from decortication (e.g. groundnut). ■Fine dust from the seed cleaning and crushing steps. ■Vibration sieving. ■Feeding and Discharging ends of bucket elevators and along chain conveyors. ■Primary screening. ■Dust from the destoner. ■Cotton lint separation machines in case of Cottonseed.	■Stone, leaves, dust, twigs and nails etc.. ■De-oiled cake. ■Used filter cloth bags and mud.

Table 4.2: Wastes Generated during Oil Extraction

Water Pollution	Air Pollution	Solid Waste Generation
■Hot wastewater discharges from solvent separation. ■Steam condensate discharges (clean, but high volume).	■Feeding and discharge ends of bucket elevators and along chain/screw conveyors. ■Hexane leak from sources like hexane pump, mechanical seals, gland and packing, distillation vent. ■Fugitive emissions from the humidifier in de-oiled cake section. ■Fugitive emission during filling of de-oiled cake. ■Emissions from steam generating boilers.	■Spillages during seed cooking flaking, expanding and other transfer operations.

4.2 Oil Refining and Treatment

A summary of the types of waste generated during the refining process is given in Table 4.3.

Table 4.3: Wastes Generated during the Refining Process

Water Pollution	Air Pollution	Solid Waste Generation
■Refinery wash water from separator having free acids, colouring matter, gum & waxes, mucilage etc. ■Condensate discharges from various heat exchangers etc. ■Filter cloths discharge. ■Aqueous layer discharge from Acid oil section. ■Bleeding of barometer condenser cooling waters.	■No significant air pollution in the refinery section except fugitive emissions, emission during vacuum drying of refined oil, condensed volatile odiferous compound from barometric condenser. ■Thermal fluid heater/boiler stack.	■Gums & waxes (semi solids). ■Spent bleaching earth. ■Spent carbon. ■Spent filter cloth bags.

4.2.1 Degumming and Neutralisation

In some factories, the separation of phases formed in the degumming, refining and washing steps is aided by centrifuging. However, in some other units phase separation is made by gravity settling of the heavier phase for several hours. The separation efficiency by gravity settling is poor and each phase will be partly contaminated by the constituents of other phase. Consequently, oil losses in the mucilage from oil refining and the soap and gum traces in the refined oil will be high. This increases the amount of water needed for oil washing and consequently the organic and hydraulic loads will be increased. In many plants, the wastewater discharged from this process is the strongest in the entire factory, responsible for the majority of the final organic load.

The refining and washing kettles are usually uncovered. This may increase the contaminants and the spillage problem on the floor (in case of foaming).

The soap stock formed as a utilisable waste from the refining unit is stored in most factories in open areas. This constitutes a huge lump of dark solids which, when left for long time, the entrained oil will separate and spread on the ground making sticky and slippery. Some factories process this soapstock to produce the lowest grade of kitchen soap, while others process it to produce fatty acids.

4.2.2 Bleaching

Bleaching is carried out in batches using huge quantities of bleaching earth. The spent bleaching earth usually contains up to 30% entrained oil, generated at a rate of about 5-25 kg per ton of bleached oil, the exact value depending on the quality and efficiency of the process. This clay is discarded, generating large volumes of solid waste which are prone to spontaneous combustion. Recent studies made on oil recovery from this spent clay and regeneration of the clay for reuse proved that this process is not economically feasible.

4.2.3 Deodorisation

Large volumes of water are used in the solvent recovery and the deodorisation units. This constitutes the water needed for cooling and condensing the vapours and used in the water ejectors to produce vacuum in both units. This water is usually almost clean, but in most factories, it is mixed with the process water of the unit, thus increasing the volume of the effluent from the unit.

The deodorisation distillate is usually considered to be a waste. This waste contains odoriferous volatile substances, tocopherol and free acids (it is especially rich in free acids when the deodoriser is used as a physically refining unit beside a deodorisation unit as in the case with palm oil processing).

Process water is always heavily polluted by oil, grease and soap traces and its mixing with large volumes of cooling water markedly increases the load of wastewater treatment facility. It is recommended that process water is completely segregated from cooling water.

4.3 Oil Hydrogenation and Shortening

In the hydrogenation unit, a nickel catalyst is used to enhance the process. Spent nickel catalyst usually contains up to 50% shortening and is generated at a rate of around 2-10kg for each ton of shortening produced. In all local hydrogenation units this spent catalyst is not processed to recover entrained oil or to regenerate it for reuse. The spent quantities cause a solid waste pollution problem.

The production of vegetable shortening by oil hydrogenation has been markedly reduced in recent years in Egypt. Palm oil is now used as a substitute. However, the hydrogenation units still produce saturated fatty acids (stearine) from distilled fatty acids obtained by acidulation of soapstock. Stearine has several uses in food and chemical industries. A summary of the types of waste generated during these processes is given in Table 4.4.

Table 4.4: Wastes Generated during the Oil Hydrogenation and Shortening Processes

Water Pollution	Air Pollution	Solid Waste Generation
■Refinery wash water from separator ■Condensate discharge from heat exchangers etc. ■Filter cloths washing.	■Insignificant.	■Spent bleaching earth. ■Spent carbon. ■Spent catalyst.

4.4 Soap and Glycerine Production

The batch wise saponification process represents one of the biggest sources of pollution in an oil and soap factory. The spent lye drawn from the saponification kettle contains glycerine, salt, free alkali and some soap in solution. Inefficient separation of soap from the spent lye can causes excessive amounts of foams which overflow on the floor. This foam spillage could appear also in the receiving tanks of the glycerine treatment unit. The foam represents a massive pollution load to the final effluent. Wastes associated with soap and glycerine production are shown in Table 4.5.

Table 4.5: Wastes associated with the Soap and Glycerine Processes

Water Pollution	Air Pollution	Solid Waste Generation
■Aqueous discharge from Acid oil section. ■Aqueous layer discharge from soap section. ■Spent lye from the saponification process. ■Floor washing in soap section.	■Water vapours Acidic forms during acid vat spilling.	■Settled gums and waxes. ■Aluminium soap.

4.4.1 Recovery of Soap in the Spent Lye

The residual soap can be recovered from the spent lye by feeding the hot spent lye to any empty available saponification unit. A determined amount of free fatty acids based on residual caustic soda in the spent lye can be added to the saponification unit. The remaining glycerine-water mixture will be almost free from foams. This glycerine-water mixture can then be used without any problem in the glycerine treatment plant.

This solution has many advantages such as:

- ■Relative reduction of pollution load.
- ■Recovery of soap.
- ■Reuse of free alkali in the spent lye.
- ■Relative cooling of spent lye reduces the foaming action.

4.4.2 Recovery of Soap during Shutdown Periods

In the soap processing unit, another major source of pollution comes from the cleaning of pipe lines after each shift, the shut down of electricity, and/or periodical maintenance. These interruptions to the process cause deposits of residual soaps in pipe lines and equipment. This is usually cleaned out of the system by blowing through steam. As a result of this, a residual soap is generated, which is very sticky and has a high viscosity. This is due to the presence of high content of niger produced from the action of steam on the soap. This residual soap is deposited in the storage tank, which if left for too long, hardens to form a substance which is difficult to remove. In one Egyptian factory for example, the volume of soap generated ranges from 0.5-1 ton/day, requiring a basin of $2m^3$ capacity. The available precipitator capacity was far less than this, at $0.4m^3$. To overcome this problem, a steam jacketed tank with adequate capacity is recommended.

4.4.3 Soap Dust

Another common problem is soap dust losses from almost all processing units of laundry and toilet soaps. This could result either from:

- The leakage from powder precipitator which receives the dust from cyclones.
- During discharge of the powder precipitator.

Also, the amount of soap dust losses due to leakage and during discharge ranged between 50-100 kg. This represents about 10% of the whole soap dust quantity.

Soap dust collected in a powder precipitator is frequently thrown to the floor and then packed manually in sacks before being transported to another unit where it is blended with soap powder. This poor material handling practice causes great losses of soap dust and contributes greatly to the pollution load after floor washing.

4.4.4 Polymeric Residue formation in the Glycerine Production Plant

In the glycerine production plant, a polymeric residue may be formed in the glycerine distillation unit due to stock overheating during the process. This polymeric compound is discharged as a shock load to the drainage system. The formation of this residue can be minimised by reducing the distillation temperature and using more efficient vacuum system.

4.4.5 Aluminium Soap formation in the Glycerine Production Plant

Aluminium soap, in form of semi-solid sludge, is generated from glycerine refining processes. Aluminium soap is precipitated from the glycerine solution (the lye solution), by the addition of alum (aluminium sulphate) which reacts with the dissolved soap and precipitates. Generation rate of aluminium soap ranges between 100-200 kg per ton of produced glycerine. Although it could be recovered and used as third grade powdered soap, it is usually disposed as a solid waste.

4.5 Unit Cleaning and Washing

The cleaning of pipelines, production tanks and vessels, drain off appreciable amounts of oils and soaps, especially in the cases of batch processes. This could be a daily activity in some factories, or, more frequently, at times of periodical maintenance of equipment. The amount of oils and soaps etc. entering the wastewater from these activities will depend directly on how little residue is left behind after the units are emptied and how frequently it is carried out.

Floor washing may generate appreciable pollution loads, as it wash off all the leakage, spillage and dirt settling on the floors of the production units. The quantity and strength of washing water depends mainly upon housekeeping efficiency - the better this is, the smaller the amounts of materials on the floor.

4.6 Mixing of Cooling Water with Process Water

In many industrial facilities, cooling water is mixed with process water. This aggravates the pollution problem by unnecessarily increasing the volume of wastewater that needs to be treated.

Of this wastewater, cooling water represents 90% of the total discharge and is relatively clean and can be recycled in the system. Separation of cooling water from process water is therefore a very important approach to reduce the volume of , which will also diminish the size and costs of any treatment plant that is required.

4.7 Utilities

A summary of the main sources of pollution from services and utilities is given in Table 4.6 below.

Table 4.6: Pollution generated by Services and Utilities

Water Pollution	Air Pollution	Solid Waste Generation
■Boiler blow down - pollutants are mainly salts and other dissolved solids. ■Softener regeneration discharges. ■Wastewater discharges from quality control laboratory. ■Cleaning water discharges. ■Workers handwash discharges. ■Canteen and toilets discharges. ■Cooling water discharges.	■The use of mazot as boiler fuel generates thick smoke (particularly at the start-up of the boilers) containing high levels of sulphur and nitrogen oxides.	■Coal ash from boiler house and Secondary sludge from WTP. ■General refuse, including empty barrels, plastic and tin offcuts, scrap metal, paper and packaging.

4.8 Effects of Waste generated by the Sector on the Environment

The most common practices of handling waste in Egypt and the environmental effects of such practices are discussed in the following sections.

4.8.1 Water Pollution

Discharge rate of wastewater can be as high as 14,000 m^3/day in some large factories, but the average rate of wastewater discharge in medium and small-scale facilities is about 500 m^3/day. The wastewater usually contains appreciable amounts of fatty matter that increase the organic strength of wastewater dramatically, raising it above legislative discharge limits. However, it is often that only small portion of wastewater is responsible for high pollution loads, while the rest is mainly relatively clean cooling water. This makes the end of pipe wastewater more dilute than some wastewater streams inside industrial facilities.

Wastewater from oil and soap factories is either discharged to a public sewer network, or directly discharged to water bodies, such as the Nile, irrigation canals, the sea, or ground water. Most industrial facilities discharge untreated wastewater directly to fresh water bodies. Wastewater containing oil, grease, and soap residues exert a strong biochemical load on the receiving water; in some cases the Biological Oxygen Demand (BOD) of such wastewater can reach 50,000 mg/litre. In addition to the high organic load, foaming is a common characteristic of the industrial wastewater.

The discharge of such high pollution loads can cause several environmental effects. In fresh water bodies, strong organic discharges can cause depletion of dissolved oxygen in the water body, which can eventually become severe enough to kill all aquatic organisms. The discharge of oily water with foaming characteristics also limit the efficiency of oxygen transfer to such water bodies, in addition to being extremely unsightly. When such wastewater is discharged to sewer network, it ends up in biological treatment units, where it can cause the treatment process to fail, again damaging the receiving water body.

4.8.2 Contaminated Land

The land is the main receiver of solid wastes and any liquid leakages. Although solid waste may be a less significant problem in quantitative and qualitative aspects, it has considerable environmental risks, because of the lack of standard management procedure of such waste. Solid wastes are initially stored in open areas inside factories before being disposed to a dump. Common problems associated with these practices include:

- **Spontaneous ignition of spent Fullers Earth**. This can occur either in the factory or in the dumpsite and is a severe fire risk. This risk can be increased by the proximity of hazardous or highly flammable materials. Associated with the risk of fire is the generation of dust and ash, the spreading of fire to adjacent areas, damage to property and goods.
- **Ground contamination from oil leakages and spillages**. Oil that is stored or disposed poorly may soak into the ground which can putrefy and make it slippery.
- Transmission of hazardous properties of some waste to the land, as there is no segregation between hazardous and non-hazardous waste
- **Aesthetic appearance of storage or disposal land**. It is common that empty barrels, scrap, and general refuse stays for long times in open storage areas within the industrial facility, which encourages the presence of pests such as rats, mice and cockroaches and also makes the factory appear unsightly and unappealing to visitors.

4.8.3 Air Pollution

Emissions from fuel combustion in boiler houses is the main air pollution problem, as such emissions contain considerable amounts of carbon and sulphur oxides, and suspended particles which has serious effects on the receiving air quality. This problem is most significant in those factories which are located in residential areas, or have low chimney height.

Hexane emissions from the oil extraction process are particularly hazardous due to its highly flammable nature. This will be most problematic in the processing area, where the gas can rapidly accumulate, such as underground voids and small, enclosed rooms.

Other gaseous emissions, mainly fine dusts from delinting of cotton seeds, processing of soap flakes and bars and animal feed manufacture and packaging, will have a lower impact on the surrounding environment. However, within the processing areas, the impacts on the worker health may be significant.

4.8.4 Other Environmental Risks

There are some environmental risks corresponding with the manufacturing process of oil and soap. The main environmental risks are associated with the following activities:

- Storage and utilisation of hexane. In most factories, this is stored and used in adequate and safe conditions. However, the consequences of any accident related to such highly flammable material may not be limited to the factory premises, but cause significant damage in the surrounding environment. This will be of particular concern where the factory is located in residential areas.
- The storage of fuel may also have high risks, mainly in terms of land and water contamination. This is particularly evident in oil and soap factories, as boiler areas are usually heavily contaminated with fuel. Above-ground storage of fuel may also pose risks with regard to leaks on to underlying processes which may act as ignition sources.
- Repairs and mechanical workshop activities inside factories, which may cause oil contamination risks to the land, or in wastewater. In addition, there may be many risks to the workers, including exposure to fumes, injury with sharps, etc..
- General occupational health risks exist throughout the factory from noise, dusty atmosphere, or slippery floors. These are common in oil and soap factories in Egypt.

Part B

CLEANER PRODUCTION AND THE SEAM PROJECT:

Implementation in the Egyptian Oil & Soap Industry

5.0 Cleaner Production Audits

5.1 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:

> The SEAM Project carried out Cleaner Production audits in 11 oil and soap plants. These audits focused on identifying low-cost interventions with fast payback periods - a total of 120 such interventions were identified with implementation costs ranging from zero to LE550000. Savings ranged from LE2400 to LE1000000 with average payback periods of less than 2 months.

- 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 4.).
- 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 basic theory behind a Cleaner Production audit is that whatever goes into a unit operation eventually comes out in one form or another.

5.2 Carrying out an Industrial 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 CP 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 CP 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 CP 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 CP 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 follows:

Audit Team Member	Main Inputs and Duties
■Production Departments: ⇒Seed receipt and storage. ⇒Oil extraction. ⇒Oil Refining. ⇒Hydrogenation and shortening. ⇒Soap production. ⇒Glycerine production. ⇒Animal feed. ⇒Product dispatch.	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 substances purchased storage inventory control main users of each substance.
■The Quality Control Department (including a representative from the laboratory).	Quality control procedures fabric and process chemical 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 (seeds crude oils process chemicals 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.
- Raw material and product information including by-products.
- Financial information including purchase costs of chemicals and utilities product and by-product selling prices (including downgraded goods) 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:

- Construction of a flow diagram for each process (example given as Figure 5.1). 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.
- 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.

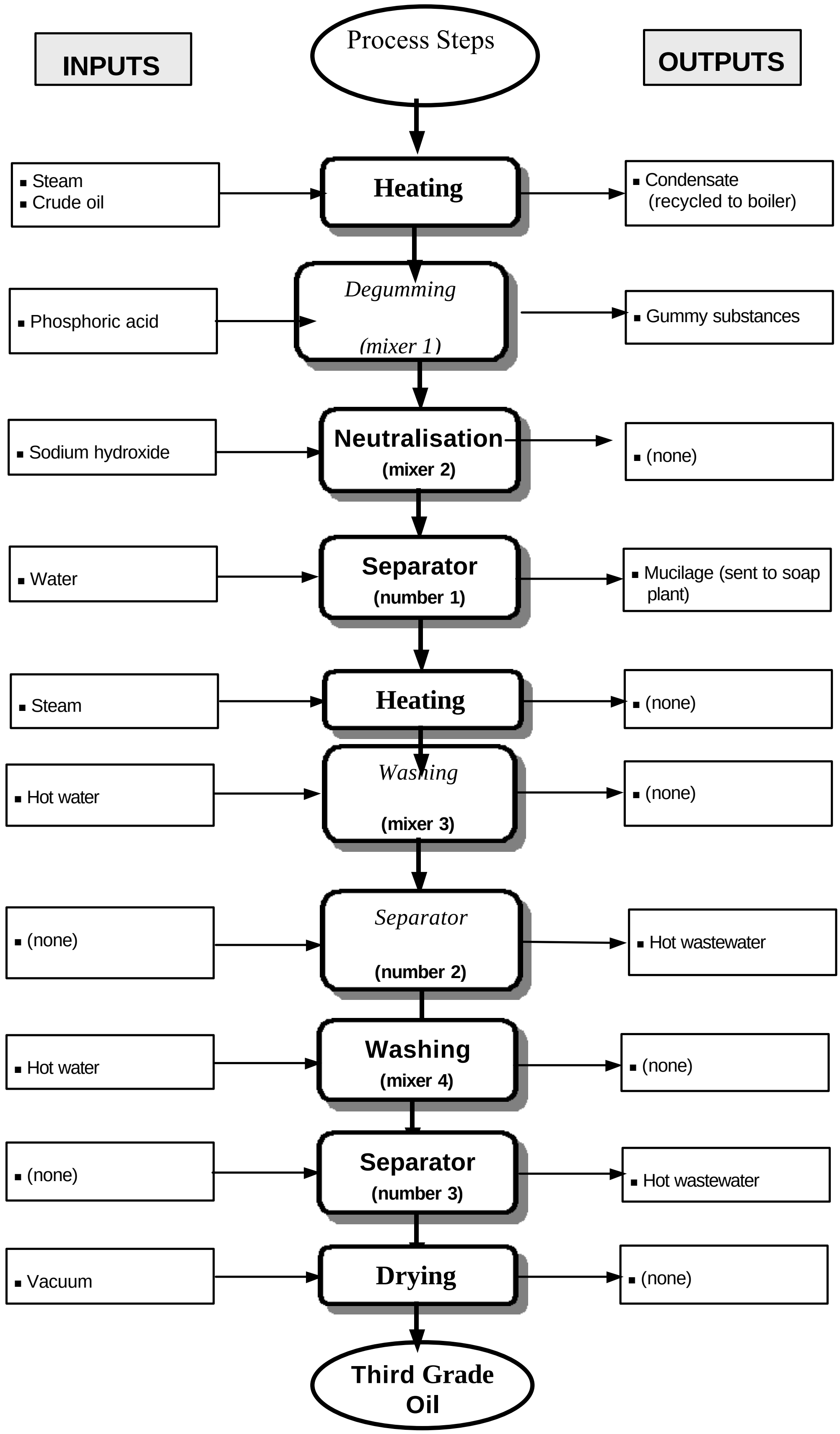
Note: A walk through should be carried out whenever data is missing or there appears to be a conflict between 2 different sources of data.

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 incoming seeds (e.g. acidity) and wastewater quality (e.g. pH BOD COD).

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? 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?

Figure 5.1: Example of a Process Flow Diagram (Alkali Refining of Crude Oil)



Step 5 Define Inputs

Using the process flow diagrams developed in Step 4 the inputs for each department need to be quantified. This may include:

- 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 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. 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 5.

Step 7 Prepare Material and Energy Balances

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

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.

Prepare 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 resources such as hexane.

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. Common causes of discrepancies include inaccurate data different units of measurement being compared missed discharges or waste streams and missed recycling steps.

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 c 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.

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 Section 6.0.

1. ***Identify Obvious Improvement Measures***. Most of these will have been identified during the factory walk through. Examples of such measures include:
   - ⇒ Stopping leakages and spillages.
   - ⇒ Eliminating unnecessary water usage.
   - ⇒ Recycling of slightly contaminated washwaters.
   - ⇒ Improving existing storage facilities to minimise damage to raw materials and final products.
   - ⇒ Segregation of wastes for recovery recycling or sale.

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

3. ***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.

4. 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 and recycling expensive process chemicals (e.g. hexane nickel catalyst).

⇒ Recovering previously wasted by products (e.g. aluminium soap).

⇒ 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***. This 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. 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.

3. ***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 this was presented in the form of Project Concept Notes (see section 7.6).

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 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.

1. ***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.

2. ***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 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.

3. ***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.

5.3 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.

5.4 Sustaining and Developing Cleaner Production

The advantages gained by the implementation of CP 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.

In order to identify new CP 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 CP options.

6.0 Cleaner Production Options identified through SEAM

The hierarchy of CP options ranges from simple housekeeping measures at the first level followed by recycle - reuse of water and recovery of energy and chemicals eventually leading to process modifications entailing chemical substitutions equipment modifications and changes in the technology. Following are some of the recommended CP interventions made for the factories audited during the SEAM Project.

- The existing environmental management practices in several oil and soap factories are given in Appendix 6.

6.1 Good Housekeeping Measures

There are numerous simple internal measures that can be taken in every plant to reduce its wastage. All of these may be described as common sense practices; they are commonly referred to as good housekeeping. Many of them involve the elimination of accidental spills and major losses of costly raw materials. These can cause heavy pollution loads upset in the treatment system and significantly degrade the appearance of the factory. For example batch tanks that are filled manually can be equipped with a high-level alarm or more positive control to prevent over-topping. Material losses resulting from filling mixing boiling or aerating of tanks can be prevented by increasing the free board or adding splash plates at strategic points.

Good housekeeping measures can result in high savings of water energy raw materials and finished products. These measures usually consist of extremely simple actions which can be implemented with little or no capital expenditure. They can be implemented immediately and reviewed as a part of a regular maintenance programme.

In many industries significant in-plant reduction of wastes can be accomplished by improvement of clean-up techniques. The cleaning of equipment and work areas may be carried out in continuous operation or it may be conducted batch wise on non-production shift. Some units require cleaning very frequently or once per year. Whatever the cleaning schedule and frequency the resulting wastes differ from the normal production wastes and place an additional and different load on the discharge facilities.

Proper maintenance and repair of leaks whether occasional or regular (such as a leaking pump gland) are obvious and can be important in combating both material losses and excessive pollution loads. Other simple housekeeping programs can be devised by alert operators. Increasing the drainage time of wet materials before moving the material to the next step will prevent the transfer of liquids and spread of pollution problem.

6.1.1 Storage of Raw Materials

Incoming seeds should be stored out of the sun in a secure clean area preferably off the ground as seeds left in the sun will heat up rapidly increasing the levels of fatty acids which will in turn increase the acidity of the extracted crude oil. The heat will also convert proteins and carbohydrates into fat soluble compounds resulting in a strong colour in the crude oil which is difficult to eliminate. Specific recommendations for seed and raw materials storage include:

- Seeds and other raw materials should be delivered in suitable sacks and stored out of the sun. In several factories seeds were often delivered in plastic bags which weakened and then ruptured when left in direct sunlight for too long. This then resulted in seeds spilling out of the sacks and across the storage area. Windblown materials also increased the dustiness in the immediate area covering buildings clogging machinery and making working conditions uncomfortable. In one factory poor storage of incoming seeds resulted in losses of 3% corresponding to annual seed losses of over LE1000000. In this factory, it was calculated that these losses could be eliminated by an investment of LE200000 in a simple storage shed.

- Seeds should be stored off the ground preferably on palettes. Seeds stored on the ground and in the open are susceptible to physical damage by passing vehicles and personnel. They can become easily contaminated by dirt stones solid and liquid wastes. They are also vulnerable to infestation and consumption by insects rodents and other animals. In one factory physical damage by careless storage and transfer to process units caused annual losses valued at LE250000.

6.1.2 Material Handling and Usage

- Crude oil delivery to the factory should be carefully monitored and controlled to ensure that unloading is complete and spillages kept to a minimum. This would require little or no capital investment. In one of the audited factories annual losses of crude oil during delivery were calculated as being LE300000. These generally occurred once the oil had been delivered; the emptied vehicles would move around the delivery area with their discharge valves open allowing the residual oil to escape.
- Prevent spillage of oils and fats by improving procedural instructions. In one factory oil losses during loading and unloading of batch reactors totalled 1% corresponding to approximately 100 tons per year. The recommendation made was to better control loading and unloading operations by improving operational instructions and by training the operators. This required no capital investment and resulted in annual savings of around LE200000 (assuming 100% efficiency).
- Most of the factories audited had soap processing units. In all of these it is possible to reduce the soap dust losses to a minimum by applying the following actions:
  1. Periodical discharge of the powder precipitator after each shift.
  2. Changing the rubber gasket in the powder precipitator regularly to reduce the leakage.
  3. Recovery of soap dust from the floor using a vacuum cleaner.
  4. Discharge the contents of the powder precipitator directly to the powder soap unit by mechanical rather than manual means.

6.1.3 General Issues

- Avoid wasting packaging materials.
- Recycle or reuse empty containers (to prevent the generation of solid wastes).
- In the majority of the factories audited significant spillages had occurred in the mazot delivery and storage area. Supervision of delivery to reduce these spillages would have little or no capital cost; in one factory annual savings of more than LE23000 could be made.
- Install bunds around all storage tanks. If any leakage occurs the material can be recovered and will be prevented from either entering the sewer which will increase the organic load of the effluent; or fouling the surrounding area.
- Clean the floors regularly especially in areas where slippery surfaces can develop (e.g. soap production unit and oil refining unit). In one of the factories audited this was the cause of the majority of accidents three of which were very serious. In another of the factories non-slip tiles were installed as a part of routine maintenance to further minimise the risk of slips.
- Regularly inspect all storage tan pipes and connections to identify leaks as soon as possible. This can be formally carried out as a part of a routine inspection and maintenance schedule.
- Regular cleaning of grease traps should be carried out to ensure that they are operating efficiently.

- Wherever possible dry cleaning and removal of solids should be carried out before wet cleaning. This will allow spilt products (e.g. soap) to be recovered and will also minimise the strength of the final effluent.

Raw materials can also be conserved by:

- Identifying how they interact with processes substrates and other chemicals.
- Determining their environmental effects proper handling and emergency procedures.
- Adopting a system that allows mislabelled drums to be quickly identified to reduce the likelihood of the wrong chemicals being used.

Staff training concerning the causes and effects of pollution along with how it can be effectively eliminated will increase awareness and help to eliminate a significant number of these problems.

6.2 Energy Conservation Measures

Energy use in the oil and soap industry varies from process to process in both amount and the sources of energy used. Electricity is used for motors and pumps to drive machinery and pump liquids whilst gas and fuel oils are used to generate steam. Actions that can be taken include:

- Implementation of suitable preventative maintenance programmes.
- Regular boiler tuning and maintenance should be carried out to remove scale and any unburned materials. This will improve combustion efficiency and consequently reduce fuel consumption. In one of the audited factories an initial investment of LE20000 gave annual savings of LE225000. FEI data indicates that as scale increases fuel consumption also increases:

Thickness of scale (mm)	Increase in mazot consumption (%)
1.5	15
3.0	20
6.0	39

- Proper insulation of steam pipes.
- Repair of broken and steam pipes and connections. In one factory losses of around 10% were observed. Elimination of these resulted in annual savings of LE222000 for little or no capital investment.
- Heat recovery from boiler blowdown water.
- Installation of steam flow meters for each processing department.

At another factory upgrading of the existing steam network was carried out. This included rehabilitation of steam lines boiler tuning and improved treatment of boiler feedwater recycling of steam condensate replacement of faulty/broken valves replacement or repair of steam traps and pipes and the insulation of hot water and steam pipes. As a result of these actions steam consumption has been reduced by 1800 tons of steam per month and one boiler was taken off line. This resulted in annual savings of over LE550000 for a capital investment of LE30000 (see Waste Minimisation at Sila Edible Oil Co. Fayoum Appendix 7).Other actions including some equipment modifications are also recommended. Typical modifications for energy conservation include:

- Water treatment to control the Total Dissolved Solids (TDS).
- Optimising boiler efficiency by controlling draft (implementation of damper and fuel firing practices).
- Optimisation of the burner.
- Avoidance of space heating.
- Where practicable substitute natural gas for solar and mazot.

6.3 Water Conservation Measures

Water is widely used in the oil and soap industry for processes ranging from generating steam to the washing of oil. The largest sources of wastage are from excess use of water within these processes and disposal of relatively clean water without reuse. This section describes water conservation opportunities that were identified in 11 Egyptian oil and soap factories and suggests where further savings could be made.

6.3.1 Flow Reduction

Consideration should be given to reduce the total flow. This can be accomplished by the use of high-pressure low-volume jet or spray streams for washing. The amount of pollution in the waterborne waste can be reduced by preliminary dry cleaning operations. Moreover the characteristics of the waste can be improved by changing the cleaning agents used.

Flow reduction aims to optimise the volume of water used in production processes to minimise wastewater effluent volume. The industrial audits identified numerous opportunities for flow reduction in all factories:

- Install self-closing taps and water meters to control water consumption. In one of the factories audited this reduced the capacity of the required wastewater treatment plant from $600m^3$/hour to $30m^3$/hour. This was achieved at a cost of LE40000 for 10 water meters (various diameters) and 20 self-closing taps. Other benefits included a reduction in water consumption of $1200m^3$ per day resulting in annual savings of LE36000 (based on the costs of pumping and treating groundwater) and a reduction in the capital costs required for constructing the wastewater treatment plant.
- Unnecessarily high levels of water consumption resulting from leaks broken or missing valves hoses left running.
- Provide water to the equipment only when required (i.e. do not allow water to flow continuously to equipment whether or not it is being used).
- Use automatic shutoffs / flow limits where possible. Highest priority should be given to those units where hot and/or chemically treated water is being lost.

The installation of water flow meters will also allow of departments which have excessively high water consumption levels to be identified. These can then be individually investigated to see what specific actions are required to reduce consumption.

A regular maintenance programme which identifies and actions such losses will ensure that these losses do not develop in the future.

6.3.2 Water Recovery and Reuse

In many factories water is used once and then disposed even when little or no contamination has occurred. Water that is particularly suitable for reuse includes cooling water and condensate.

- Cooling water should be recycled rather than disposed.At one factory four cooling towers were already in place and only needed some new packing materials for them to be operational. For an initial investment of LE1000 in each cooling tower annual savings of

LE13000 in terms of reduced water consumption alone were calculated. In another factory recycling the cooling water from the soap plant to a chiller rather than disposing of it to the sewer would save around 1975m^3 per day. Initial calculations showed that for a capital investment of LE10000 annual savings of around LE135000 could be achieved.

- In the oil refining process washwater from the second stage can be recycled and reused in the first washing step. It can also be used to prepare the caustic soda solution required for neutralisation.
- An evaporative cooling system is preferable to open cooling circuits. This can reduce water consumption by 85% as well as reducing the volume of the final effluent.
- Steam condensate can be recycled to save both energy and minimise the consumption of demineralised water. An assessment of one factory showed that for an initial investment of LE96000 annual savings totalling LE425000 could be realised. Actions required included repairing and upgrading the existing system requiring the insulating of the condensate return pipes as well as installing and insulating components such as steam traps and water buckets.

6.4 Process Specific Options

Process specific CP options can be broadly categorised into in-plant measures and prevention measures. In-plant measures include optimisation of processes to save energy water and chemicals; recovery of chemicals and energy and reuse of water. Prevention measures involve the selection of raw materials and chemicals by considering their utility and environmental impact (quality requirements); limiting the use of a substance when there is no alternative readily available or is economically not feasible and phasing out the use of hazardous or dangerous substances.

- Optimise feeding rate of flaked seeds to the extractor. This will result in an increased extraction efficiency reduce spillages and hexane losses. However this will need a skilled operator to ensure that optimum conditions are maintained.
- Reuse of Fines from Preparation Unit. In one of the factories audited it was noted that the plant was originally designed to recycle sunflower seed fines totalling approximately 40 ton/day back to the expeller (in the seed preparation stage). This step was modified to direct these fines immediately to the extraction plant therefore allowing a higher throughput of fresh seed in the expeller. As a result of applying this modification the crushing capacity was increased by 40 ton of sunflower seeds per day the crush margin considered to be 40LE/ton. Sunflower seeds are available for 3 months of the year and hence the additional yearly income is equivalent to LE120000 with an implementation cost of LE10000.
- Proper maintenance of hexane sensor. This will allow the extraction process to be carefully controlled and to reduce hexane losses through over consumption.
- Modification of solvent spray nozzles (fan flat type). This will improve extraction and optimise hexane consumption. At one factory it was calculated that this would cost LE10000 to implement generating annual savings of LE10000.
- Use of Caustic Soda Solution. In most of the factories audited solid caustic soda was usually used for neutralisation. In one factory this was substituted with a caustic soda solution at a much lower cost: LE2100/ton as against LE1000/ton. As a result daily neutralisation costs dropped by 47% equivalent to savings of 6.5 LE/ton of crude oil. This improvement was achieved at no cost (to the extent that all necessary modifications were made using available equipment) and resulted in annual savings of LE250000. Other benefits of this intervention included reduced losses of caustic soda during transfer to the neutralisation process; reduced levels of corrosion; improved soapstock quality and better working conditions.

- Installation of a mechanical skimmer on hot wells to recover short-chain fatty acids. Demulsifying chemicals may also be added to achieve a pH of 8-9 so that oil droplets will not be deposited in the water nozzles of the cooling towers. The estimated initial cost of skimmer installation is LE2000. Thus the benefits of this action include the recovery of fatty acids and an overall improvement of cooling towers performance and reduced maintenance needs.
- Upgrading oil refining by introducing centrifuges for efficient gum separation. This recommendation is particularly suitable for old factories that suffer from inefficient or non-existent degumming facilities. Poor degumming can increase the amount of oil lost in mucilage which reached about 0.2 % of total produced oil in some cases. The capital cost of implementing this action is relatively low as it only involves installation of a centrifuge pumps and piping network. The financial benefits are usually high and pay back period in the order of a few months.
- A cleaner technology for oil refining by chemical methods is the miscella refining technique. In this technology the crude oil is mixed with hexane (50% concentration) and then the caustic soda is added as usual. The separation of the mucilage from the refined oil in solvent occurs much more efficiently as the viscosity and specific gravity of the mixture is lower than the crude oil and also lower than the mucilage. The oil losses during chemical refining are therefore lower and the power consumed in mixing and pumping the oil-solvent mixture is less. Besides the advantage of lower oil losses during the caustic refining and less power consumed in mixing and pumping the technology of miscella refining has also the advantage of producing an oil of superior bleach colour than that is obtained by conventional refining techniques. However this technology has the following disadvantages:

  ⇒ All equipment has to be tightly closed and explosion proof which adds to the cost.

  ⇒ High maintenance levels of equipment are required to avoid solvent losses.

  ⇒ Refining has to be carried out in the solvent mill.

  ⇒ Miscella has to be concentrated to about 50% oil before being refined which requires a two stage solvent removal process.

- Collection and recycling of oil spilt in the packaging unit. In most of the factories visited spillage and consequent loss of the edible oil was common. In one of these factories a system was installed to recover edible oil from accidental spillages in the bottling department. Originally the oil fell directly to the floor where it was washed to drain. The system was modified so that the oil was immediately collected in troughs and then pumped to a collection tank where the oil was recycled to the refinery for reprocessing. Approximately 1.16 tons of edible oil are recovered on a monthly basis. This was achieved for a capital Cost of LE2500 generating annual savings of LE35000 (recovered oil only).
- Accurate adjustment of temperature and pressure in the glycerine distillation unit to prevent polymer formation. Distillation of crude glycerine should take place under reduced pressure (6-12 mm Hg absolute) in a current of steam at a temperature ranging between 157 to 160 °C. If these conditions are not maintained accurately the temperature of thermal decomposition at this pressure could be less than the boiling of the solution in the distillation unit. The result of such bad operating conditions is production of a polymeric residue that if discharged to wastewater streams represents a shock pollution load. Therefore accurate adjustment of distillation conditions is a very important pollution prevention measure.
- Feeding hot spent lye to a saponification unit (resaponification of hot spent lye). Inefficient separation of soap from the spent lye discharged from saponification kettles (batch

saponification process) results in high soap content in the spent lye. This usually causes over flow of foam to the floor of the unit which is usually washed down causing foaming problems in wastewater. The recommended solution is feeding hot spent lye (at 105°C) to a saponification unit. A determined amount of free fatty acids based on the residual caustic soda in the spent lye can be added. The remaining glycerine water mixture will then be almost free from foams.

- Any wasted soap should be recovered and recirculated to the saponification unit through a closed loop operation system.

- A direct pipeline between a batch saponification unit and glycerine production unit should be installed. This will prevent significant spills and loss of material.

- In the soap production plant pipelines carrying molten soap should be steam jacketed. If pipelines are not adequately protected and a power cut occurs the soap will cool rapidly solidifying and clogging the whole system. The plant will then be unable to operate until the system is cleaned out. In one of the factories audited a capital investment of LE600 was all that was required to insulate the pipeline which would keep the soap hot for long enough to allow it to be completely pumped out . This resulted in annual savings of LE2400 in terms of soap alone - lost revenue due to down time will significantly increase this value. Some manufacturers tackle this problem by blowing steam to soap deposits and collecting these deposits in a simple tank although the soap quality will be poor. To avoid soap deposits building up in this collection tank thus reducing its capacity a steam-jacketed tank should be used.

- High levels of soap dust were commonly observed in soap preparation units. This results in a thick coating of dust on all surfaces clogging of moving parts and unpleasant working conditions. In one factory the soap powder recovered from the cyclone was dumped on the floor and manually transferred back to the main process rather than being recycled in a closed mechanical system.

- Reduction of pollution load discharged from a saponification unit. In an attempt to reduce the organic load discharged from the saponification process wash water discharged after completion of the saponification process was collected in an empty pan. Sufficient fats were added to the pan in order to neutralise the caustic soda The residue was then boiled using steam and allowed to settle. The incompletely saponified product was been returned to the first pan to complete saponification. This allowed recovery of fats and caustic soda and decreased the strength of wastewater significantly.

- Recovery of Fodder Ingredients. Animal fodder production unit tend to be characterised by heavy dust emissions caused during the loading and unloading of the raw materials. This results in the loss of valuable raw materials as well as clogging machinery and generating unpleasant working conditions. In one factory LE127600 was invested in the installation of a cyclone vacuum system which recovered the ingredients and transferred them directly to the raw material intake system. Annual savings of LE107520 were achieved.

- Injection of a neutralising amine at high pressure into the steam pipeline just after the boiler. This avoids pipe corrosion by condensate which may become acidic by absorbing atmospheric carbon dioxide.

- In addition to process optimisation the assessment of the performance of existing equipment and possible modifications to improve efficiency will need to be considered. These following modifications are most likely to be required:

⇒ Installation of varying speed mixer in batch neutraliser to avoid excessive insulation.

⇒ To replace solvent spray shower (perforated) by fishtail fan flat type to get uniform and effective extraction.

6.5 Optimising Process Chemical Use

- By careful control of the use of bleaching earth one factory reduced consumption from 8kg per ton to 5kg per ton. This generated annual savings of over LE81000.
- Refined bleached and deodorised (RBD) palm oil used to produce shortening should be physically rather than chemically refined. In several factories the fatty acids were removed chemically (through alkali neutralisation). As RBD palm oil usually has a very low acidity this step is unnecessary - any excess acidity which develops during storage can be efficiently removed by deodorisation alone. In this way palm oil losses will be minimised the organic load of the final effluent reduced caustic soda and bleaching earth consumption minimised. This action can be implemented at no cost with annual savings at one factory totalling LE460000.
- Hexane consumption can be optimised by ensuring that cotton seeds are properly delinted. In a well-operated unit 8kg hexane can be used to process 1 ton of cotton seeds. The volume of hexane required will increase as the amount of lint present increases. In one factory hexane loss in cotton seed oil extraction was around 16kg per ton of seed. Although the plant was quite old (around 15 years) it was calculated that of this the lack of a delinting stage was accounting for 5kg of the additional hexane requirements. This corresponded to an annual increase in costs of LE76000.
- The optimum amount of sodium hydroxide should be determined in the removal of fatty acids from the crude oil. Too much sodium hydroxide makes the oil start to migrate to the soap fraction giving them an undesirable fatty texture as well as losing the more valuable oil. In a number of the factories audited overdosing with sodium hydroxide was common.

6.6 Materials Substitution

To enable implementation of chemical substitution an inventory and quality control of the chemicals being procured is necessary. The protocol for incoming chemical quality control may consist of the following steps:

- marking the container with the date it was opened;
- comparing data with previous history and vendors standard values;
- entering data on a control chart for display;
- maintaining records;
- reviewing data with the vendor;.
- checking whether the chemicals are listed as priority pollutants;
- designating a materials storage area limiting traffic through the area and giving one person the responsibility to maintain and distribute materials can also reduce materials use and contamination and dispersal of materials.
- purchase raw materials in returnable containers.

6.7 Recovery of By-Products and Wastes

6.7.1 Process Units

- In the seed cleaning unit lint can be collected from the cyclones and sold as a low grade lint for LE200/ton.
- Lint can also be collected from the delinting unit itself pressed packed and sold for LE350/ton. In one of the factories audited this generated an annual income of LE6000.

- Recovery of Broken Seeds. Seeds delivered to oil and soap factories are sieved to remove stones and gravel (which are disposed as waste) and hulls and broken seeds (constituting around 1% by volume and containing 25% oil). In most factories audited these were collected and sold for LE100 as animal feed. Alternatively the process can be modified so that these are collected and transferred to the preparation unit where they are further processed. In one factory all that was required was the installation of a screw conveyor from the sieving and screening area to the seed preparation unit. As a result an extra 78 tons of oil and 595 tons of meal are produced annually valued at LE463250 for a capital investment of LE9000.
- Lecithin can be recovered from gums produced in the degumming unit and sold to the food industry as an emulsifier for LE3800. In one factory 100 tons of gum was produced annually from which about 80 tons of lecithin could be recovered generating a revenue of around LE304000. In a second factory 22.3 tons of lecithin was produced annually generating an annual income of LE84700. In one factory which did not have a lecithin recovery unit gums from soybean processing were sold for lecithin recovery for LE700/ton generating an annual revenue of LE175000.
- Utilisation of spent earth as a fuel (having a calorific value of around 14MJ/kg). In one factory the spent earth is supplied free of charge to nearby homes use in for domestic ovens.
- Utilisation of spent earth as soil conditioner. This use is still being researched the feasibility of utilising spent earth to improve sandy soils for agricultural use will be investigated. Physical and chemical properties of spent earth need to be analysed and its effect on sandy soil will be investigated after biological composting. If proven feasible using spent earth in soil conditioning can significantly reduce solid waste problems in the industry and reduce environmental risks of spent earth storage and disposal.
- Volatile Fatty Acids (VFA) escaping from the deodorisation columns will accumulate on the surface of the hot well. This can be skimmed off manually and used as an animal fodder constituent.
- Deodorisation distillate (fatty acids) can be collected and sold to soap factories for manufacturing third grade soap. In one factory distillate from the oil deodorisation process was sold for LE900/ton giving an annual revenue of LE135000. The same factory also sold deodorisation distillate from the shortening unit for LE1200/ton generating an annual income of LE126000.
- The deodorisation distillate is usually considered to be a waste. It contains odoriferous volatile substances tocopherol and free acids (it is especially rich in free acids when the deodoriser is used as a physical refining unit as well as a deodorisation unit as is the case with palm oil processing). This waste can be utilised to obtain two components which are economically valuable:

⇒ Tocopherol (vitamin E) is used as a natural antioxidant for edible oils and their products and

⇒ Distilled free acids are used in the soap and food industries. Processing of this waste to recover utilisable products also reduces the final pollution load.

- During the hydrogen production process (hydrogen being used in the hydrogenation of oils) oxygen is generated as a by-product. If generated in sufficient quantities this can be recovered and compressed for use in the medical sector where it is valued at LE1.7/m^3.
- The semi-solid waste generated in the distillation tower in the fatty acid splitting unit and in the glycerine concentration plant may be suitable for use as a waterproofing or paving material. At one of the factories audited this pitch-like material is collected from the glycerine concentration plant stored in barrels and sold annually for LE1000 rather than being disposed as a solid waste.

- In the glycerine concentration unit the salt that is generated by the process can be recovered and reused in the soap plant. In one factory 600kg of salt were generated daily - if managed correctly this would fulfil all the salt needs of the soap plant and no additional purchases would be required. This would generate annual savings of LE10000.
- In one of the factories audited glycerine residues from the glycerine concentration plant are recycled to the soap plant rather than being lost to the wastewater during cleaning.
- Solid aluminium soap is formed in the glycerine unit as a result of treating the glycerine water with aluminium sulphate. This is usually treated as a solid waste and disposed off-site. However this can be recovered and sold as a metallic soap. The aluminium soap could also be treated with caustic soda to produce aluminium hydroxide.
- Improving handling of deoiled seeds by minimising losses. Deoiled seed cake has an estimated price of LE250/ton as it is an important ingredient in animal fodder production. Estimated annual seed losses due to bad control of handling and feeding systems have reached 1000 tonnes in some cases. In one factory the provision of forklift truck equipped with suitable platform for proper handling of seed bags was recommended to overcome this. It was estimated that this would cost LE200000 ultimately saving LE250000 L.E per year (assuming 100% efficiency of the system) and reducing many wastage problems.
- Recovery of soap stock from wastewater. Although such wastewater may be low in volume its organic strength is usually significantly high. By segregating this wastewater stream and then filtering it a BOD load of 73000 mg/l can been reduced by 50%. The semi-solid filtrate (fatty matter) is then collected and reused in the process.

6.7.2 Packaging Wastes

- Offcuts and scraps from the manufacture of cans can be pressed and sold to a metal processing factory. Scrap steel is valued at around LE2000 per ton and tin LE400 per ton. At one factory 10 tons of scrap tin was generated and sold for LE4000.
- Damaged plastic bottles and cartons can be collected and sold for recycling. In one factory 1500 tons of polyethylene (PE) are collected and sold for LE400 per ton generating an annual revenue of LE600000.

6.7.3 General

- Construction of oil and grease traps at the outlet of each process unit to recover fats and minimise the strength of the final effluent. This should be collected on a regular basis and either processed on site or sold to soap producing factories. The amount of oil and fatty matter that was wasted in wastewater and which could be recovered by simple gravity means reached 600 tons/year in some cases. The capital cost involved in fitting efficient gravity oil separators is relatively high (about LE100000 per separator) but the benefits are usually high with a pay back period of less than a year.
- Recovery of fatty matter from the refinery effluent. Fat can be manually collected from the refinery effluent by scraper acidulated and then split. The wastewater can then be treated or disposed and the fatty matter transferred to soapstock storage tanks. The benefits of this intervention are the recovery of product and reduced strength of wastewater. In one of the factories where this was implemented an additional 29 tons/year of soapstock was recovered valued at LE500/ton. For a capital investment of LE 5000 annual savings of LE 14500 were achieved.
- Copper welding electrode residues and copper wires can be collected and sold to copper processing factories for LE8000 per ton.
- Wastewater Segregation. Wastewater produced by oil and soap factories includes process effluents domestic sewage boiler blowdown cooling tower blowdown and steam condensate. Of these process effluents have the highest organic loads the effluent coming from the refinery being particularly strong; with typical BOD values exceeding 3000 mg/l.

The blowdown and condensate are usually low in terms of organic pollution but high in volume. In general process effluents blowdown and condensate are combined and disposed generating a high volume organically polluted wastewater. An alternative to combining these wastewater streams is to segregate them. The cooling and condensate water is of a suitably high quality to use for land reclamation activities within the factory such as watering lawns and trees. The heavily contaminated process effluents alone can then be sent straight to the wastewater treatment plant (WWTP) thus reducing the required capacity of the WWTP (see section 6.10).

- In one factory the effluent disposal costs were reduced by LE18000/year for no additional cost (existing structures used). This was also recorded in another factory where the combined effluent was 420-650m^3/hour of which process effluent was only 20-30m^3/hour. Segregation of the heavily polluted wastewater from this reduced the required WWTP capacity resulting in capital expenditure savings of LE680000.

6.8 Technology Change and Modification

Modification of existing processes/equipment or the purchase and installation of new equipment may be considered to reduce the consumption of process chemicals energy and water. As a result of work carried out in the SEAM Project the options outlined in the following sections are particularly suitable for Egyptian oil and soap factories.

6.8.1 Use of Heat Exchangers

Heat exchangers should be used particularly since reduction in water use means an increase in effluent temperature. The oil and soap industry also needs to practice heat recovery to avoid thermal shock to treatment plants caused by hot wastewater effluent.

6.8.2 Solar Energy

Use of solar energy as an alternative for the conventional energy is a promising approach for reducing energy consumption needed for heating process water.

6.9 Adoption of 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 important 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 difficult to sustain in the longer term.

There are many different types of worker training programmes available. These depend heavily on the needs of the organisation its size and management structure. When 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.

6.10 End of Pipe Treatment

This is not a Cleaner Production option but is often required to bring the final effluent up to a standard that complies with wastewater discharge legislation. Ideally this should only be considered once the volume and strength of the final effluent have been reduced as much as possible. In Sila Edible Oil Company in Fayoum a large number of low-cost interventions were implemented (see Appendix 7) which reduced wastewater volume and load such that the capacity of the wastewater treatment plant could be reduced by 66%. This resulted in capital savings of more than LE950200 as well as the annual savings of over LE1million that were made as a result of implementing the low-cost interventions.

Current research and experience suggests that one or more of the following steps will be needed to effectively treat from an oil and soap factory:

- Dissolved air floatation is an efficient method of oil and fat removal.
- Activated sludge process is efficient in reducing the organic load of effluent down to allowed levels.
- Activated sludge should be used after physico-chemical separation.
- Use of coagulants can improve the efficiency of dissolved air floatation process.
- In a study comparing plain floatation dissolved air floatation and dissolved air floatation aided by coagulants oil removal efficiencies was 50% 60% and 94% respectively.

7.0 Cleaner Production Demonstration Projects

7.1 The SEAM Project Approach

The approach for the SEAM Project was evolved based on an analysis of the oil and soap sector in Egypt which showed that:

- The sector is characterised by absence of modern process technology;
- There is a lack of technical skills in processing techniques specific to CP;
- There is limited expertise for CP promotion as well as to provide CP solutions;
- Technical support in the form of guidance manuals is not available.

7.2 The Aim of Implementing Demonstration Projects

The main goal of the Cleaner Production 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 in co-operation with the EEAA. Such a structured approach resulted in a success both in terms of results as well as cost-effective utilisation of the resources. Demonstration projects in many ways help in providing ideas for further innovations confidence to replicate and when promoted can cast a considerable impact in the sector. The demonstration projects completed in the SEAM project are expected to lead to such multiplier factor. In many ways therefore SEAM can become a model for the promotion of the demonstration projects under the National Industrial Pollution Prevention Programme.

7.3 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 11 factories were identified that represented the range of oil and soap factories present in Egypt.

Industrial audits were carried out in each of these factories (the methodology developed for this is described in Chapter 5.0 Identifying Cleaner Production Opportunities) and an industrial audit report produced. This reviewed the manufacturing process with respect to optimal use (and reuse) of resources improved housekeeping more optimal process operation etc. In some cases particularly in the old 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 CP 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 7.1. 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 CP approach was also required and was assessed in terms of how many of the no cost options had been implemented by the factory.

Table 7.1 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* ?		
Will the project result in a variety of internal environmental improvements?		

* Such as water quality air quality health noise transmission land contamination etc.

7.4 Selection of Factories for Demonstration Project Implementation

Demonstration projects had been carefully selected to address problems that were common throughout the Egyptian oil and soap sector. 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.

7.5 Plants selected for Implementation

The demonstration projects identified and the factories where these were implemented are shown in Table 7.2.

Table 7.2 Summary of Demonstration Project Implementation

Demonstration Project	Location
Waste Minimisation	Sila Edible Oil Company Fayoum
Oil and Fats Recovery	Tanta Oil and Soap Company Tanta
Reduced Wastage through Improving Raw Water Quality	Alexandria Oil and Soap Company Kafr El-Sheikh

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

- Reuse and Recycling of in-plant materials.
- 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.

7.6 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.

7.7 Overview of Demonstration Projects

7.7.1 Waste Minimisation Sila Edible Oil Company Fayoum

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 LE1557110 have been made for a capital investment of LE621300. A number of identified options were implemented quickly and efficiently:

Good housekeeping measures:

- ■Steam trap modifications.
- ■Repair of leaking or broken valves.
- ■Repair of damaged water pipes.
- ■Repair of damaged steam pipes.
- ■Collection and recycling of spilt oil from the packaging unit.

Reduced water and energy consumption:

- ■Rehabilitation of steam lines.
- ■Boiler tune-up and improved treatment of boiler feedwater.
- ■Recycling of steam condensate.
- ■Replacement of faulty/broken valves.
- ■Replacement or repair of steam traps or pipes.
- ■Insulation of hot water and steam pipes.
- ■Restoration of the softening unit to improve boiler performance and reduce blowdown.

Product recovery:

- ■Reuse of fines from the Preparation Unit.
- ■Recovery of broken seeds.
- ■Recovery of fatty matter from the final effluent.

Material Substitution:

- ■Use of liquid rather than solid caustic soda.

By introducing these waste minimisation measures water consumption and the organic load of the final wastewater was reduced such that the final wastewater treatment plant was downsized by 66%. This downsizing resulted in capital savings of over LE950000; additional savings will also result from reduced operating and maintenance costs.

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.

7.7.2 Oil and Fats Recovery Tanta Oil and Soap Company Tanta

An industrial audit of the factory indicated that there were a number of low cost measures that could be implemented to reduce pollution and minimise losses. A number of these have been implemented by the factory - to date this has involved a total investment of LE621247 resulting in annual savings of LE637020. By implementing these actions the hydraulic load and organic load of the wastewater was reduced such that the required capital investment was reduced by LE500000.

The actions carried out included:

- ■**Upgrading of loading and unloading procedures**. During the transfer of oil ghee and fatty matter to and from the batch reactors and separators spillages often occurred. These losses were eliminated by improving the existing procedural instructions and by improving their supervision.

- **Recovery of oil ghee and fatty matter**. Three gravity oil separators (GOS) units were installed in the continuous refining unit the fatty acids splitting unit and the deodorisation unit. This has resulted in the recovery of large volumes of oil and ghee.
- **Recovery of animal fodder ingredients**. The animal fodder unit used to generate large volumes of dust particularly during the loading and unloading of the ingredients. This was recovered by installing a cyclone vacuum system with the recovered material being transferred directly to the intake system. As well as recovering valuable raw materials working conditions were also improved.
- **Water conservation**. Large volumes of water were being wasted as cooling water was being sent directly to the drain with the process effluents rather than being recycled and reused in a closed circuit system. This was addressed by segregating these from one another and sending the cooling water to the rehabilitated cooling towers. This also had the effect of reducing the hydraulic load of the final effluent.

Introduction of these waste minimisation measures significantly reduced both the water consumption and the organic load of the final wastewater. As a result the capital investment required for the final wastewater treatment plant was reduced by LE500000. Additional savings will also result from reduced operating and maintenance costs.

7.7.3 Reduced Wastage through Improving Raw Water Quality Alexandria Oil and Soap Company Kafr El-Sheikh

Increasing salinity of the water abstracted from underground wells for use in processing and

was identified from the Meet Yazid canal.

An inlet chamber water pumps before and after the treatment unit sand filters water pipes and fittings were installed at a cost of LE275000. Benefits that have resulted from the interventions include:

- Improved water quality for processing.
- Reduced boiler blowdown volumes.
- Reduced water treatment costs.
- Reduced maintenance costs for plant equipment.
- Reduced operating costs that had escalated to maintain water wells.

7.8 Outputs from the Demonstration Projects

Case studies were prepared for the for the following demonstration projects (reproduced in Appendix 7):

- Waste Minimisation at Sila Edible Oil Co. Fayoum.
- Oil and Fats Recovery Tanta Oil and Soap Co. Tanta.
- 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

SUSTAINING CLEANER PRODUCTION

8.0 Cleaner Production Issues in Egypt

8.1 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 oil and soap 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 minimum 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.

8.2 Internal Barriers

8.2.1 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.

8.2.2 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 oil and soap factories in Egypt do not have effluent treatment plants. Water is subsidised and hence there is no pressure on the 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.

8.2.3 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 co-operate.

- 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.

8.2.4 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.

8.2.5 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.

8.3 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.

8.3.1 Difficulty in Accessing Cleaner Technology Information

Most of the oil and soap 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.

8.3.2 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.

8.4 Overcoming Internal Barriers to Cleaner Production Implementation

8.4.1 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.

How, 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.
Effect: Raw materials costs decrease.

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

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

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

⇒ **Action**: More efficient use of water.
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..

8.4.2 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 QA, packaging, market survey etc.

8.4.3 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.***

8.5 Promotional Strategies for Adopting CP in Egypt

Development of a strategy for Cleaner Production entails identification of the approach to be adopted (whether product, process, technology or operation related), the options available, the pollution prevention practice to be adopted (for the sector, specific to Egypt) and finally the measures (i.e., the specific demonstration projects for each factory) that should be taken to implement CP.

Given the barriers identified in the previous section, the shift from end of pipe approach to CP in the Egyptian oil and soap industry will take a long time to implement, adversely affecting company productivity, causing environmental degradation and a threat to self -reliance.

8.5.1 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.

8.5.2 Capacity Building and Technical Assistance

The experiences from the various SEAM demonstration projects need to be disseminated across the sector. The Guidance Manuals and technical reports and resource materials prepared under the project need to be disseminated to enable other factories to implement the CP 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 oil and soap 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 CP;
- **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 CP options targeted primarily at the SMEs.

Capacity building for the sector should also commence at the educational institution level where process engineering, Cleaner Production etc. should be integrated into the curricula so as to build local technical capacity in the sector.

8.5.3 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 CP into the Egyptian oil and soap industry. This has resulted in demonstrating that the CP options are credible, feasible, economical while enabling pollution abatement.

This however, is the first step in the promotion of CP in the Egyptian oil and soap industry. From this point on the onus is on the Government of Egypt to initiate aggressive promotion of CP. 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 oil and soap 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 CP options locally for the sector and disseminating the experiences from the project across the sector.

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Appendix 1

Oil and Soap Production Statistics

EDIBLE OIL AND SOAP PRODUCTION STATISTICS[1]

A1: EDIBLE OIL PRODUCTION STATISTICS

Table A1.1: Annual Available Production Capacity for Edible Oil

Product	Year	Public sector Production		Private Sector Production		Total Production	
		Rate (ton/year)	Value (10^6 L.E)	Rate (ton/year)	Value (10^6 L.E)	Rate (ton/year)	Value (10^6 L.E)
Cotton and sunflower	1994 - 1995	477,902	1,590.97	29,060	73.72	506,962	1,664.69
	1995 - 1996	479,600	1,577.78	36,660	105.78	516,260	1,683.57
	1996 - 1997	483,100	1,546.27	37,720	107.67	520,820	1,653.94
Corn	1994 - 1995	7,101	22.25	10,000	29.8	17,101	52.05
	1995 - 1996	5,311	15.55	13,450	48.2	18,761	63.75
	1996 - 1997	5,311	15.55	14,222	49.85	19,533	65.4
Soybean	1994 - 1995	13,497	43.53	1,200	3.19	14,697	46.72
	1995 - 1996	6,300	19.68	3,360	8.85	9,660	28.53
	1996 - 1997	6,300	20.04	1,920	5.2	8,220	25.24
Palm	1994 - 1995	0	0	29,559	78.56	29,559	78.56
	1995 - 1996	0	0	25,606	74.92	25,606	74.92
	1996 - 1997	0	0	26,721	80.55	26,721	80.55
Total	1994 - 1995	498,500	1,656.76	69,819	185.26	568,319	1,842.03
	1995 - 1996	491,211	1,613.02	79,076	237.74	570,287	1,850.76
	1996 - 1997	494,711	1,081.87	80,583	243.27	575,294	1,825.14

Table A1.2: Annual Actual Production Capacity for Edible Oil

Product	Year	Public Sector Production		Private Sector Production		Total Production	
		Rate (ton/year)	Value (10^6 L.E)	Rate (ton/year)	Value (10^6 L.E)	Rate (ton/year)	Value (10^6 L.E)
Cotton and sunflower	1994 - 1995	315,020	1,039.8	19,357	57.1	334,377	1,096.9
	1995 - 1996	299,945	977.41	25,055	73.59	325,000	1,050.99
	1996 - 1997	303,077	962.5	28,820	82.41	331,897	1,044.91
Corn	1994 - 1995	1,229	5.83	7,638	20.73	9,567	26.67
	1995 - 1996	3,702	10.1	9,985	36.48	13,687	46.58
	1996 - 1997	3,346	8.65	11,222	39.85	14,568	48.5
Soybean	1994 - 1995	7,858	24.02	480	1.37	8,338	25.39
	1995 - 1996	5,248	16.39	3,060	7.1	8,308	23.49
	1996 - 1997	4,795	15.26	1,400	3.82	6,195	19.08
Palm	1994 - 1995	0	0	28,994	77.15	28,994	77.15
	1995 - 1996	0	0	25,409	74.36	25,409	74.36
	1996 - 1997	0	0	26,721	80.55	26,721	80.55
Total	1994 - 1995	324,807	1,069.65	56,469	156.35	381,276	1,226
	1995 - 1996	308,895	1,003.9	63,509	191.53	372,404	1,195.43
	1996 - 1997	311,218	986.4	68,163	206.64	379,381	1,193.04

[1] Source of all statistics is the Central Agency for Population Mobilisation And Statistics (annual report issued in October 1998)

Table A1.3: Profile of Edible Oil - Foreign Trade

Product	Year	Production: Export		Production: Import	
		Rate (ton/year)	Value (10^3 L.E)	Rate (ton/year)	Value (10^3 L.E)
Cotton and sunflower	1994 - 1995	500	1,687	27,000	680,017
	1995 - 1996	757	1,756	23,298	52,878
	1996 - 1997	1,577	4,088	26,573	68,017
Corn	1994 - 1995	499	1,468	1,174	2,249
	1995 - 1996	198	637	1,213	3,249
	1996 - 1997	414	1,931	2,708	7,800
Soybean	1994 - 1995	136	344	10,428	18,585
	1995 - 1996	364	743	278	769
	1996 - 1997	175	239	6,819	13,080
Palm	1994 - 1995	90	214	26,000	35,831
	1995 - 1996	28	110	40,861	89,453
	1996 - 1997	294	1,783	27,351	51,728
Total	1994 - 1995	1,225	3,713	64,603	124,682
	1995 - 1996	1,347	3,246	65,650	146,349
	1996 - 1997	2,460	8,042	63,451	140,625

A2 RESOURCES AND USAGE FOR EDIBLE OIL PRODUCTS

Table A2.1: Cottonseed Oil and Sunflower Oil (1996 1997)

Resources			Usage		
Itemised resources	**Quantity (ton)**	**% from total**	**Itemised usage**	**Quantity (ton)**	**% from total**
Production	331,897	89	Available for consumption	359,407	96.4
Import	26,573	7.1	Export	1,577	0.4
Stock from last year	14,336	3.9	Stock for next year	11,822	3.2
Total	**372,806**	**100**	**Total**	**372,806**	**100**

Table A2.2: Corn Oil (1996-1997)

Resources			Usage		
Itemised resources	**Quantity (ton)**	**% from total**	**Itemised usage**	**Quantity (ton)**	**% from total**
Production	14,568	80.9	Available for consumption	16,877	93.7
Import	2,708	15	Export	414	2.3
Stock from last year	728	4.1	Stock for next year	713	4
Total	**18,004**	**100**	**Total**	**18,004**	**100**

Table A2.3: Soybean Oil (1996-1997)

Resources			Usage		
Itemised resources	**Quantity (ton)**	**% from total**	**Itemised usage**	**Quantity (ton)**	**% from total**
Production	6,195	47.6	Available for consumption	12,625	97.1
Import	6,819	52.3	Export	175	1.4
Stock from last year	13	0.1	Stock for next year	200	1.5
Total	**13,027**	**100**	Total	**13,027**	**100**

Table A2.4: Palm Oil (1996-1997)

Resources			Usage		
Itemised resources	**Quantity (ton)**	**% from total**	**Itemised usage**	**Quantity (ton)**	**% from total**
Production	26,721	49.3	Available for consumption	53,834	99.4
Import	27,351	50.5	Export	294	0.5
Stock from last year	106	0.2	Stock for next year	50	0.1
Total	**54,178**	**100**	**Total**	**54,178**	**100**

A3 SOAP PRODUCTION STATISTICS

Table A3.1: Annual Available Production Capacity for Soap

Product	Year	Production: Public Sector		Production: Private Sector		Production: Total	
		Rate (ton/year)	Value (10^6 L.E)	Rate (ton/year)	Value (10^6 L.E)	Rate (ton/year)	Value (10^6 L.E)
Laundry soap	1994 - 1995	326,450	401.49	57,400	83.23	383,850	484.72
	1995 - 1996	318,096	491.98	29,721	213.99	347,817	513.38
	1996 - 1997	300,400	448.63	43,950	22.0	344,350	470.63
Toilet soap	1994 - 1995	94,802	285.52	12,503	48.64	107,305	334.16
	1995 - 1996	125,146	407.98	20,239	102.39	145,385	510.37
	1996 - 1997	98,150	319.54	25,523	138.73	123,673	458.27
Total	1994 - 1995	421,252	687.01	69,903	131.87	491,155	818.88
	1995 - 1996	443,242	899.96	49,960	123.79	493,202	1,023.75
	1996 - 1997	398,550	768.17	69,473	160.73	468,023	928.9

Table A3.2: Annual Actual Production of Soap

Product	Year	Production: Public sector		Production: Private sector		Production: Total	
		Rate (ton/year)	Value (10^6 L.E)	Rate (ton/year)	Value (10^6 L.E)	Rate (ton/year)	Value (10^6 L.E)
Laundry soap	1994 - 1995	110,081	171.45	43,250	62.71	153,339	234.16
	1995 - 1996	74,110	151.82	26,836	20.29	100,946	172.11
	1996 - 1997	55,816	84.07	40,731	20.84	96,547	104.91
Toilet soap	1994 - 1995	44,171	130.78	12,178	49.93	56,349	180.71
	1995 - 1996	47,563	150.11	18,162	93.88	65,725	243.99
	1996 - 1997	47,213	154.8	19,719	115.47	66,932	270.27
Total	1994 - 1995	154,260	302.22	55,428	112.64	209,688	414.86
	1995 - 1996	121,673	265.69	44,998	114.17	166,671	379.86
	1996 - 1997	103,029	238.87	60,450	136.31	163,479	375.18

Table A3.3: Profile of Soap Foreign Trade

Product	Year	Production: Export		Production: Import	
		Rate (ton/year)	Value (10^3 L.E)	Rate (ton/year)	Value (10^3 L.E)
Laundry soap	1994 - 1995	-	-	-	-
	1995 - 1996	-	-	-	-
	1996 - 1997	-	-	-	-
Toilet soap	1994 - 1995	4,007	15,226	52	416
	1995 - 1996	4,640	13,660	424	2,193
	1996 - 1997	5,63	18,090	607	1,883
Total	1994 - 1995	4,007	15,226	52	416
	1995 - 1996	4,640	13,660	424	2,193
	1996 - 1997	5,632	18,090	607	1,883

A4 RESOURCES AND USAGE FOR SOAP PRODUCTS

Table A4.1: Laundry Soap (1996 1997)

Resources			Usage		
Itemised resources	**Quantity (ton)**	**% from total**	**Itemised usage**	**Quantity (ton)**	**% from total**
Production	96,547	90	Available for consumption	101,301	95
Import	-	-	Export	-	
Stock from last year	10,558	10	Stock for next year	5,804	5
Total	107,105	100	Total	107,105	100

Table A4.2: Toilet Soap (1996-1997)

Resources			Usage		
Itemised resources	**Quantity (ton)**	**% from total**	**Itemised usage**	**Quantity (ton)**	**% from total**
Production	66,932	94	Available for consumption	60,862	86
Import	607	1	**Export**	5,632	8
Stock from last year	3,314	5	**Stock for next year**	4,359	6
Total	70,853	100	**Total**	70,853	100

Appendix 2

Three Processes used for Fat Splitting

Three Processes used for Fat Splitting

	TYPE OF FAT SPLITTING PROCESS			
Characteristics	**Twitchell**	**Batch autoclave**		**Continuous countercurrent***
	212-220	300-350	450	485 approx.
Pressure (psig)	0	75-150	425-450.	600-700
Catalyst	Alkyl-aryl sulphonic acids or cycloaliphatic sulphonic acids, both used with sulphuric acid 0.75-1.25% of the charge.	Zinc, calcium or magnesium oxides 1-2%.	No catalyst.	Optional.
Time (hr)	12-48	5-10		2-3
Operation	Batch.	Batch.		Continuous.
Equipment	Lead-lined, copper-lined, Monel-lined, or wooden tanks.	Copper or stainless-steel autoclave.		Type 316 stainless tower.
Hydrolysed	85-98% hydrolysed. 5-15% glycerol solution obtained, depending on number of stages and type of fat.	85-89% hydrolysed. 10-15% glycerol, depending on number of stages and type of fat.		97-99%. 10-25% glycerol, dependent on type of fat.
Advantages	Low temperature and pressure; adaptable to small scale; low first cost because of relatively simple and inexpensive equipment.	Adaptable to small scale; lower first cost, for small scale than continuous process; faster than Twitchell.		Small floor space, uniform product quality; high yield of acids; high glycerine concentration; low labour cost; more accurate and automatic control; lower annual costs.
Disadvantages	Catalyst handling; long reaction time; fat stocks of poor quality must often be acid-refined to avoid catalyst poisoning; high steam consumption; tendency to form dark-coloured acids; need more than one stage for good yield and high concentration; not adaptable to automatic control; high labour cost.	High first cost; catalyst handling; longer reaction time than continuous processes; not so adaptable to automatic control as continuous; high labour cost; need more than one stage for good yield and high glycerine concentration.		High first cost; high temperature and pressure; greater operating skill.

Appendix 3

Summary of Wastes generated by Indian Edible Oil Factories

SUMMARY OF WASTES GENERATED BY INDIAN EDIBLE OIL FACTORIES

A3.1 Wastewater Volumes

A survey of 39 edible oil processing units in India indicated that shortening units generated the largest volumes of wastewater. Of these, the smaller units were the highest producers of wastewater. The units generating the least wastewater were the seed preparation units (where the incoming seeds are cleaned, dehulled, crushed and rolled), an essentially dry process. This is illustrated in more detail in Table A3.1.

Table A3.1: Wastewater Volumes generated by Different Process Units

Unit Name	Category	Wastewater volumes generated (litres / ton)
Seed Preparation	Large	60 - 180
	Medium	30 - 60
	Small	--
Solvent Extraction	Large	223 - 229
	Medium	200 - 214
	Small	280 - 400
Refinery	Large	900 - 2500
	Medium	600 - 800
	Small	800 - 900
Shortening (hydrogenated oil)	Large	1900 - 2700
	Medium	2100 - 2600
	Small	1500 - 1800

Where:
Large units are those which process >100 T/day of oil and/or 7250T/day of oil seeds;
Medium units are those which process >50-100 T/day of oil and/or >100 T/day-250 T/day oil seeds.
Small units are those which process <50 T/day of oil and/or <100 T/day of oil seeds.

Key issues identified by these figures are as follows:

1. Variation in wastewater generation is due to:

- The different operational procedures used in each of the mills and
- In large oil factories, filter clothes from refinery section are also washed along with filter clothes, therefore resulting in a relatively higher specific wastewater generation.

2. In solvent extraction plants, the high range of values of specific wastewater generation in the small-scale plants is due to variations in:

- operational procedures;
- the raw material being processed and
- the volumes recovered and methods used in steam condensate recovery/recycling.

3. The high variation in wastewater generation in large-scale refinery units is probably due to:

- the variation in the types of process used (eg batch refining/continuous refining) and
- discharge of uncontaminated cooling water. The lower range value of 900 litre/ton closely matches the specific values of medium and small-scale categories.

A3.2 Wastewater Characteristics

An analysis of flow proportionate composite samples from the same 39 units incorporated in Table A3.1 is presented in Table A3.2.

Table A3.2: Wastewater Characteristics generated by Different Process Units

Unit Name	Category	Wastewater Characteristics				
		pH	BOD (mg/l)	COD (mg/l)	TSS (mg/l)	Oil & Grease (mg/l)
Seed Preparation	Large	8.5-9.5	6,350-14,000	22,500-40,000	17,650-33,500	5,750-7,800
	Medium	8.5-9.0	14,200-27,000	42,500-72,000	28,600-52,200	5,500-9,500
	Small	--	--	--	--	--
Solvent Extraction	Large	7.5-8.2	180-238	485-525	140-161	21-29
	Medium	6.8-7.2	364-495	678-835	79-90	5-30
	Small	5.4-6.6	239-1,083	489-2,740	104-1,352	9-12
Refining	Large	2.5-4.5	1,375-2,250	2,500-4,250	325-675	200-500
	Medium	1.3-7.0	2,500-6,500	4,000-10,500	100-5,800	150-1,900
	Small	1.0-2.0	3,000-3,500	5,500-6,500	800-1,250	400-750
Shortening (hydrogenated oil)	Large	4.5-5.0	1,200-1,700	2,700-3,500	350-425	410-490
	Medium	3.0-3.5	1,500-2,000	3,300-4,200	850-1,100	950-1,200
	Small	1.0-3.5	2,100-3,800	4,500-8,800	550-1,325	600-1,300

Key issues identified by these figures are as follows:

1. The higher BOD, COD, TSS and Oil & Grease concentrations recorded in the medium scale oil units as compared to large units are due to lower water usage resulting in more concentrated effluents.

2. The wastewater characteristics from the solvent extraction unit depend largely upon the type of process employed and maintenance and operational practices adopted. The higher range of values in the small-scale industries may be due to variation in the types of oil seed processed. The higher BOD and COD is due to discharge of total suspended solids (TSS) along with the wastewater.

3. The variation of wastewater characteristics from refinery units is due to:

- variations in operational practices;
- dilution factor variations depending upon the extent of water usage;
- the types of process employed - batch or continuous;
- in medium-scale industries, a neutral pH value coupled with a high oil & grease concentration is due to improper splitting of the soap stock, resulting from inadequate acid dosage;
- less retention time for splitting and
- inadequate heating of the batch.

4. Oil & grease concentrations are the most significant parameter for wastewater characterisation in refining units and hydrogenated oil units. Other wastewater parameters such as BOD and COD are mainly dependant on the oil concentration. Wide variations in the wastewater characteristics as a result of the types of operational practices adopted and the quantity of water usage and therefore the magnitude of the dilution factor.

5. The higher concentration of BOD and COD in small-scale units as compared to other units is because these units tend to employ obsolete technology and do not have proper oil seed/raw oil

storage facilities, which can lead to increasing levels of free acids.

6. Cottonseed oil processing units often develop problems related to the presence of excess gums. The gums, which do not get dissolved in the aqueous layer, settle at the bottom. These sediments are then discharged along with the aqueous layer as wastewater.

A3.3 Pollution Loads

The calculated specific pollution loads in terms of kg of pollutant per ton of seed/product processed are shown in Table A3.3.

Table A3.3: Specific Pollution Loads for each Process Unit (Kg/Ton of Seed or Product)

Unit	Category	Wastewater Characteristics			
		BOD	**COD**	**TSS**	**Oil & Grease**
Seed Preparation	Large	0.38-2.52	1.35-7.2	1.1-6.03	0.345-1.4
	Medium	0.43-1.62	1.27-4.32	0.86-3.13	0.16-0.57
	Small	--	--	--	--
Solvent Extraction	Large	0.04-0.05	0.11-0.12	0.03-0.04	0.004-0.007
	Medium	0.02-0.07	0.13-0.17	0.016-0.019	0.001-0.006
	Small	0.067-0.433	0.137-1.096	0.029-0.541	0.002-0.005
Refinery	Large	1.237-5.625	2.25-10.625	0.292-1.687	0.18-1.25
	Medium	1.5-5.2	2.4-8.4	0.06-4.66	0.09-1.52
	Small	2.4-3.15	4.4-5.85	0.64-1.125	0.32-0.675
Shortening (hydrogenated oil)	Large	2.28-4.59	5.13-9.45	0.665-1..147	0.779-1.323
	Medium	3.15-5.2	6.93-10.92	1.78-2.86	1.995-3.12
	Small	3.15-6.84	6.75-15.85	0.825-2.385	0.9-2.34

The wide variation in the specific pollution load is due to:

- Variation in type of seed/product to be processed;
- Variation in maintenance level of plant and machinery and
- Poor designs of free floating oil and suspended solids trapping system.

In the large scale industries, the lower pollution load (in terms of BOD and COD) is due to continuous solvent extraction process with scheduled maintenance and better housekeeping practices.

In the medium scale refineries, the higher range values of BOD, TSS and Oil & Grease is usually caused by the improper splitting of soap stock batch.

A3.4 Solid Wastes

The quantities of solid wastes and the calculated specific solid waste generation from large, medium and small scale oil mills are as shown in Table A3.4.

Table A3.4: Volumes of Solid Waste generated by each Unit

Unit	Category	Sources	Solid Waste (ton/day)	Specific Solid Waste (Kg/T) of Raw Material Processed
Seed Preparation	Large	**	3.3-6.5	32.5-33.0
	Medium	**	1.7-3.3	33.0-34.0
	Small	**	1.0-1.7	34.0-40.0
Solvent Extraction	Large	**	14.0-16.5	70.0-85.0
	Medium	**	8.2-14.0	82.0-94.0
	Small	**	6.0-8.2	80.0-82.0
Refinery	Large	Spent earth	720-1000	122-127
		Activated carbon	1500-2300	--
	Medium	Spent earth	525-720	127-129
		Activated carbon	450-1500	--
	Small	Spent earth	350-525	126-128
		Activated carbon	280-450	
Shortening (hydrogenated oil)	Large	Spent earth	1000-1500	--
		Activated carbon	2380-3600	--
		Spent catalyst	50-65	--
	Medium	Spent earth	800-1100	--
		Activated carbon	710-3600	--
		Spent catalyst	35-50	--
	Small	Spent earth	550-800	--
		Activated carbon	440-710	--
		Spent catalyst	25-40	--

Note: ** Combined Solid Waste.

Specific solid waste values in the small-scale units are relatively high due to the disposal of used filter cloths. Based on above values, the average specific solid waste generation for oil producing factories is calculated as being 34 Kg.

From refinery and hydrogenated oil, bleaching earth containing 15 - 20 % oil is either sold to soap manufacturers or disposed. The average specific waste generation in terms of Kg/Ton of raw material processed is calculated as 126.5 and 152.5 for refinery and hydrogenated oil respectively.

Appendix 4

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

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 nationwide.

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 5

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 6

Environmental Practices of Selected Factories

ENVIRONMENTAL PRACTICES OF SELECTED FACTORIES

Table A6: Wastewater Control Systems - Existing and Planned

Factory Name	Location	Sector	Discharge Volume (m^3)	Discharge Point	Existing Wastewater Treatment	Planned Wastewater Treatment
Alexandria Co. for Oil & Soap	Alexandria	Public		Sewer	• Oil and grease traps. • Primary treatment (oil separation and sedimentation).	--
Alexandria Oil & Soap Co.	Kafr El-Sheikh	Public		Agri. drain	•	--
Alexandria Oil & Soap Co.	Kafr El-Zayatt	Public			•	
Arma for Food Industries Co.	10 Ramadan City	Private		Sewer	• Oil and grease traps. • Sedimentation tanks. • Neutralisation.	--
Chief Co.	10 Ramadan City	Private		Sewer	• Oil traps. • Air flotation. • Chemical aided gravity sedimentation.	--
Cairo Oil & Soap	Badrasheen	Public			•	
Edible Oil and Detergent Co.	Sohag	Public		Sewer	• Primary treatment (oil separation, sedimentation).	--
MIGOP	Attaka, Suez	Private		Sea	• Oil Gravity separation. • Oil separation by air flotation. • Sedimentation.	--
Misr Oil & Soap Co.	Mansoura	Public		Agri. drain	• Screening, settling, neutralisation.	• Chemical-aided flotation treatment. • Biological treatment (Activated Sludge).
Misr Co. for Oil & Detergents,	Zagazig	Public		Agri. drain	• Oil traps.	--
Nile Co. for Oil & Detergents	Asyut	Public	700 (1997)	Agri. drain	• Gravity oil separation.	• Oil separation. • Coagulation, flocculation, sedimentation. • Biological treatment (Activated Sludge).
Salt and Soda Co.	Alexandria	Public		Sewer	• Sedimentation.	• Gravity separation. • Chemically aided gravity sedimentation. • DAF unit.

Factory Name	Location	Sector	Discharge Volume (m^3)	Discharge Point	Existing Wastewater Treatment	Planned Wastewater Treatment
Savola Egypt Co.	10 Ramadan City	Private		Sewer	• Oil and grease traps. • Sedimentation tanks. • Filtration.	--
Sila Edible Oil Co.	Fayoum	Private		Sewer	• Oil and grease traps. • Equalisation, coagulation, flocculation. • DAF unit. • Biological treatment processes - activated sludge. • Drying beds.	--
Tanta Oil & Soap Co.	Tanta	Public		Agri. drain	• Gravity oil and grease traps. • DAF unit. • (Wastewater treatment plant to be installed).	

Appendix 7

Case Studies from the SEAM Project

Waste Minimisation at Sila Edible Oil Co., Fayoum

Oil and Fats Recovery, Tanta Oil and Soap Co., Tanta