6.0 Cleaner Production Audits

6.1 Introduction - What is A Cleaner Production Audit?

A “Cleaner Production Audit” can be defined as:

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

A good Cleaner Production Audit will:

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

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

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

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

Step 1 Management Commitment

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

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

Step 2 Appointing a Cleaner Production Team

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

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

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

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

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

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

**Step 3 Collection of Baseline Information**

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

- Site layout and plans showing buildings and functional units, location of drains and sewers, chimneys, vents and discharge points.
- Listing of all processes carried out and process flow diagrams (if available), including materials storage and handling information, product packaging and dispatch. Cleaning processes, particularly where these involve the use of chemicals, should also be included.
- Operating manuals of machinery, particularly with reference to the design conditions as recommended by the manufacturer.
- Maintenance records.
- Inventories of raw material and product information, including by-products.
Analytical data - product quality and wastewater analyses.
Financial information, including purchase costs of chemicals and utilities, product and by-product selling prices (including downgraded products), operating and maintenance costs. A summary of the cost elements in the total production costs would also be useful.
Environmental information, for example wastewater quality, details of existing wastewater treatment system, air emissions, the production and fate of solid wastes and environmental reports and licenses.
Health and Safety records.

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

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

**Step 4 Understand Factory Operations and Processes**

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

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

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

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

**Examples of Questions for Production Staff:**

- How much time is needed to complete each stage of the process?
- What are water and energy requirements for each step?
- What raw materials are used for each product? How are these weighed and transported to the production area?
- What happens to these rejects?
- How do operating conditions to design conditions?
- Are there any problems with the process/machinery that you are aware of?
### Step 5 Define Inputs

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

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

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

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<table>
<thead>
<tr>
<th>Inputs</th>
<th>Process Steps</th>
<th>Outputs</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasteurised milk</td>
<td>Receiving tank for heating</td>
<td>Condensate</td>
<td>Condensate recycled to boiler</td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
<td>Wastewater (from washing)</td>
<td></td>
</tr>
<tr>
<td>Pasteurised milk</td>
<td></td>
<td>Heat</td>
<td></td>
</tr>
<tr>
<td>Water (washing between deliveries)</td>
<td></td>
<td>Hot water</td>
<td>Hot water recycled within ultrafiltration system.</td>
</tr>
<tr>
<td>Cleaning chemicals (washing between deliveries)</td>
<td></td>
<td>Concentrate</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>Ultrafiltration</td>
<td>Wastewater (from washing)</td>
<td></td>
</tr>
<tr>
<td>Steam (for indirect heating of water)</td>
<td></td>
<td>Condensate</td>
<td></td>
</tr>
<tr>
<td>Heated milk</td>
<td>Homogenisation and pasteurisation</td>
<td>Heat</td>
<td></td>
</tr>
<tr>
<td>Water (washing)</td>
<td></td>
<td>Treated concentrate</td>
<td></td>
</tr>
<tr>
<td>Concentrate</td>
<td>Mixing</td>
<td>Cheese curds</td>
<td></td>
</tr>
<tr>
<td>Electricity</td>
<td>Incubation</td>
<td>Final product</td>
<td>Off-specification products used to produce mish (obtain volume and value of loss and sale price of mish).</td>
</tr>
<tr>
<td>Salt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rennet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated concentrate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheese curds</td>
<td>Packaging</td>
<td>Wasted packaging</td>
<td></td>
</tr>
<tr>
<td>Packaging materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheese</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brine (filling)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The units used for each of these must be clearly identified.

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

Step 6 Define Outputs

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

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

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

Step 7 Prepare Material and Energy Balances

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

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

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

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

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

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.
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 1 ton of product.

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

**Step 8 Benchmarks and Standards**

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

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

**Step 9 Identification of Potential Cleaner Production Options**

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

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

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

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

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

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

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

**Step 10 Assess Costs and Benefits of Cleaner Production Options**

At this stage, a large number of Cleaner Production options will have been identified. The next step is to identify those options which will be of most benefit to the factory, both financially and environmentally. Following is a description of the sort of information that needs to be considered - the amount of detail required will vary on the overall size and complexity of the proposed action.
1. **Technical Feasibility.** The aim of this step is to determine that the intervention will work. It will describes the proposed intervention in detail and evaluates how the proposed measure will affect the process, product, production rate etc.. For each option proposed, the technical benefits that will result should be clearly identified (e.g. improved product quality, reduced energy consumption, improved productivity). These can then be quantified in the assessment of financial viability.

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

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

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

**Step 11 Prioritising Cleaner Production Options**

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

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

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

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

**Step 12 Developing Cleaner Production Action Plans**

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

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

**Step 13 Implementation of Proposed Cleaner Production Options**

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

**Preparation** - This will require:

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

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

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

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

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

### 6.3 Sampling and Analytical Requirements

#### (i) Water and Wastewater Flow Measurements

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

#### (ii) Wastewater Sampling

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

- A series of single “grab” samples can be manually collected. These can either be tested independently or combined to give a composite, time-averaged sample. Automatic time-average samplers for wastewaters are available commercially.
- Flow proportioned samples are desirable but in practice are difficult to take.

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

Certain chemical parameters require the sample to be stabilised, for example, by the addition of acid for heavy metal analyses. In some cases the sample has to be taken into glass containers rather than plastic.
Before any sampling is carried out, it is advisable to discuss and finalise what is required with the laboratory which will be carrying out the analyses.

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

(iv) Wastewater Analyses - Laboratory Analyses
Wastewater may need to be tested for one or more of the following parameters:

- Biological Oxygen Demand (BOD₅), Chemical Oxygen Demand (COD), Suspended Solids and Total Solids.
- Heavy metals. Analyses would only be required for specific metals based on the chemical substances used in the factory.
- Organics such as pesticides, hydrocarbons, oil & grease.

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

(v) Wastewater Analyses - “in situ” Measurements
The following parameters can be measured at the discharge point itself, using portable meters:

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

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

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

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

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

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

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

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

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

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

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

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

7.1 Good Housekeeping

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

Some examples include:

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

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

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

7.3 Water Conservation, Reuse and Recycle

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

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

7.4 Raw Materials and Input Changes

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

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

7.5 Chemical Substitution

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

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

7.6 On site Recycle and Reuse

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

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

7.7 Product Redesign

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

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

7.8 Worker Training Programmes

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

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

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

8.1 Fruit and Vegetables

8.1.1 Cultivation Waste Reduction Measures

(i) Use of Chemicals in Farming

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

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

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

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

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

(iii) Quality of Incoming Raw Materials

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

8.1.2 Processing Wastes

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

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

Use best available technology for slicing, cutting, peeling, evaporating and sterilising etc. There may be opportunities to upgrade older equipment that is no longer as efficient as new, modern equipment and methods.

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

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

- Washing after caustic/steam peeling, size reduction – water should be reused and recycled upstream, peeling avoided and size reduction avoided. Water contact will leach out raw materials into water stream and every time peeling is carried out; size reduction produces wastes.

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

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

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

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

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

- Use mechanical equipment in field when possible to minimise problems caused by manual harvesting and transport.

- Use appropriate and good quality transport equipment - e.g. suitable protective containers. Many containers are not suitable for transport of goods such as tomatoes and bottom layers and many other layers are crushed both by the weight of containers above them and by the roping process. Use bulk bins or other protective devices to minimise harm to produce.

- Cool and keep chilled during harvesting, transport and reception. For some crops this is a great help in minimising harvest, transport and processing losses and produces much better quality product after processing.

### 8.1.3 Reception and Processing

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

- Chilling the incoming products and keeping them cool until they are ready for processing.
Avoid causing damage during handling. This can occur if the incoming products are tipped from heights; stored carelessly prior to processing, such that they are crushed and bruised; or transferred using inappropriate loading equipment.

Install process control systems and repair/check/calibrate measuring equipment. In many cases there was no functioning process control equipment, even temperature gauges were missing from evaporators resulting in scorched and caramelised product with poor flavour characteristics. Taking these remedial actions will ensure that energy and water are not wasted, and product quality is optimised.

Use countercurrent washing operations where possible. The counter current principle has long been known however it is often not practised despite being the most efficient way of washing.

Reuse clean water streams for preliminary washing operations. Many operations have multiple sources of used water which are relatively clean and can be used for incoming product wash as well as many other non-critical operations around the plant.

Other general recommendations include:

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

8.1.4 Packing and Storage

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

8.1.5 Reuse of Wastes

- All solids should be removed from the process wastewater using screens. These can either be disposed or used as animal feed. In one factory, for an initial investment of around LE 2,000, it was estimated that payback could occur in 1 year. As well as being a valuable source of nutrients, this action will also reduce the strength of the final effluent and reduce the frequency of drain blockages.
- Pectin (used as a thickener in the production of jam) and essential oils (used as food flavourings) can be recovered from citrus fruit skins. Although this is a potentially valuable market, significant investment and careful identification of potential markets will be required.
- Edible wastes should be recovered as animal feed with appropriate care being taken in the identification and removal of glass and other packaging materials.
- There may be opportunities for composting, ensiling or other added value activities for the wastes.

8.1.6 Wastewater Issues

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

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

Other actions that can be taken include the:

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

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

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

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

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

8.1.8 Distribution and Consumption

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

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

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

8.1.9 Future Trends

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

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

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

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

In-process and downstream systems and technology approaches are being used such as:
- cool transporting, handling and storage.
- controlled atmosphere packaging and appropriate packaging.
- better process control.
- prevention or avoidance of water contact.
- quality monitoring and documentation using computers and computer control.
- membrane processes for concentration and separation.
- distribution chain management and control.

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

8.2 Dairy Industry

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

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

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

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

8.2.3 Reception of Raw Milk
The following actions will help ensure that raw milk quality is maintained upon arrival at the factory:

- Cool handling, processing and storage.
- Appropriate sanitary design of buildings.
- Efficient pasteurisers, homogenisers, centrifuges and other equipment.
- Use equipment designed for milk with milk fittings used.
- Use CIP (Clean in Place) when possible and check for suitability.
Do not use non-hygienic materials e.g. wood.

8.2.4 Processing

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

8.2.5 Distribution and Consumption

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

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

8.2.6 Future Trends

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

8.2.7 Other Issues

- Genetic engineering to improve fat and protein content.
- Herd control for higher milk production.
- Chemical flocculation of fats and protein precipitation.
- New technologies for protein recovery.
- Better control of residuals.
- HACCP in dairies for risk reduction.
- Better drying control from better spray dryers with computer control.
- Better people control to reduce anthropogenic contamination of the product.
New products for example UHT (ultra high temperature) pasteurised milk for long ambient temperature shelf life, protein enriched drinks, whey, buttermilk and other dairy drinks.

8.3 Confectionery

8.3.1 Upstream Considerations

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

8.3.2 Process Waste Reduction Measures

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

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

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

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

8.3.3 Product Recovery

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

- Recycle biscuit and wafer wastes into product. The broken or spoiled biscuit material can usually be added as an ingredient into some other confectionery product provided it is segregated and kept clean.
Selling downgraded product at a lower price to staff. Other options which could be investigated include:

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

### 8.3.4 Packaging and Storage

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

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

### 8.3.5 Future Trends

Actions that are being adopted internationally include:

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

### 8.4 Fish Processing

#### 8.4.1 Upstream

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

- Targeting appropriate species.
- Using species specific catch methods.
- Finding a use for by-catch.
- Harvesting appropriate sizes.
- Segregating catches.
Controlling chemical and antibiotic use in marine farming operations - reduce when possible.
Controlling farm-feeding operations and seek improvements.

8.4.2 Process Waste Reduction Measures

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

- Recycle cooling water from autoclaves - for an initial investment of around LE8,000, annual savings in water and energy of LE12,000 were calculated, giving a payback period of 8 months.
- Installation of pressure regulators on steam lines. In one factory, for an initial investment of LE7,500, it was calculated that annual savings of LE36,000 could be made, giving a payback period of 3 months.

Other options which could be investigated include:

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

8.4.3 Product Recovery

Two such opportunities which were identified during auditing included:

- Recovery of fish oil. Large volumes of fish oil escaping to the effluent steam represents a loss of a valuable product as well as unnecessarily increasing the organic load of the wastewater. In one factory, it was estimated that for an initial investment of LE4,000, annual revenue could total LE200,000, giving a payback period of less than 1 month.
- Recycling of fish oil sludge. Rather than being disposed as a solid waste, this can be used as an animal feed. For an initial investment of LE5,000, an annual revenue of LE3,600 could be generated.

Other options which could be investigated include:

- Chitin and Chitosan recovery. For many years there has been continual interest in recovering these shellfish structural materials for use in products as diverse as immobilising enzymes to ion exchange. Research is underway in many laboratories to find cost-effective and economical applications for these products, however there is still reluctance to invest in large recovery plants without knowledge of secure markets.
- Recovery of fishmeal. Most larger seafood plants would have a drying plant for fishmeal recovery for feed or for fertiliser. There are also numerous derivatives of fermented or otherwise stabilised products for fertiliser application. Drying technologies are well known and the major problems associated with the plants are odour production and control and fines recovery from what can be a difficult product. In some countries fish are caught principally for fishmeal production. Fish oils too comprise a valuable resource which are usually effectively recovered.
8.4.4 **Hydrolysates and Sauces**

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

8.4.5 **Future Trends**

Actions which are being adopted internationally include:

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

8.5 **Non-Alcoholic Beverages**

8.5.1 **Upstream**

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

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

8.5.2 **Process Waste Reduction Measures**

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

- For carbonated drinks, carbon dioxide concentrations should be controlled in order to prevent spillage and bottle bursts.
- Ensure optimal process control systems in place.
- Separate and segregate cooling and other waters.
- Use low diameter hoses with shut-off nozzles.
- Avoid product loss.
- Reuse low load waters.
- Completely empty containers before washing and segregate.
- Recycle cooling waters.
- Train staff.
- Use pulsating jets.
- Use auto shut off devices interlocked.
- Use caustic washes for neutralising streams.
- Use automated CIP.
- Reduce last runnings by good management.
- Clean only when necessary.
- Use wash/rinse water for mashing.
- Attention to over/underfilling in cask and bottle lines.
- Collect split juices and concentrates and reuse.
- Segregate pith, peels and use for composting or animal feed.

8.5.3 Distribution and Consumption

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

8.5.4 Future Trends

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

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

8.6 Major Ancillary Support Services for the Sector

8.6.1 Boilers

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

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

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

- Fluidised bed boilers, three pass package boilers and thermic fluid heaters.
- Water treatment to control the total dissolved solids (TDS).
- Effluent heat recovery from process water (especially hot water washes) through installation of heat exchangers.
- Optimising boiler efficiency by controlling draft (implementation of damper and fuel firing practices).
- Optimisation of the burner.
- Avoidance of space heating.
The use of mazot generates emissions with high sulphur and particulates. Its use as a fuel in food processing factories in Egypt is no longer permitted.

8.6.2 Refrigeration Units

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

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

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

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

8.6.3 Workshops and Garages

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

9.1 The SEAM Project Approach

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

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

9.2 The Aim of implementing Demonstration Projects

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

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

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

9.3 Identification of Demonstration Projects

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

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

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

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

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

Table 9.1 Criteria used to Shortlist the Demonstration Projects

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

\(^1\) Such as water quality, air quality, health, noise transmission, land contamination, etc.
9.4 Selection of Factories for Demonstration Project Implementation

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

9.5 Plants selected for Implementation

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

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

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

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

9.6 Project Concept Notes (PCNs)

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

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

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

9.7.1 Reduction of Milk Losses and Pollution Prevention

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

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

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

**Product recovery:**
- Permeate from white cheese manufacturing was used to package white cheese instead of fresh water.

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

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

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

9.7.2 Water and Energy Conservation

The industrial audits recognised that many firms in Egypt had severe problems with energy usage and lack of systematic policies in place to manage energy utilisation. This project was identified as being directly transferable to many food processing sector firms in Egypt and even outside the food processing sector. This project was created to demonstrate that energy conservation can save substantial sums of money for the firms and at the same time bring about substantial environmental improvements, without large capital investments. Common problems include large volumes of steam being discharged freely into the atmosphere, steam traps which are inactive or not present, lack of insulation, no condensate recovery, poorly tuned boilers, large fuel oil spillages etc. Similarly with water use there are uncontrolled and unmeasured uses of water throughout the plant, large losses, inadequate measuring devices, little condensate or vapour recovery and general unawareness of water as a resource issues.
This project was designed to alleviate these problems and show that effective water and steam use, including low cost and easily implemented measures could bring about large savings to the firm. Several actions were implemented in these projects to try and cover several energy and utility conservation issues. It was implemented in Edfina for Preserved Foods, Alexandria and Kaha for Preserved Foods, Qalubya sites. Both companies are processors of fruit and vegetables.

Actions carried out for Energy Conservation:

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

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

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

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

Actions carried out for Water Conservation:

Edfina Company
Water savings were approached in the same way and at the same time as energy saving. Again, the industrial audits picked up on the fact that substantial problems existed in the sector with water use and misuse and there was lots of scope for improvement with minor interventions.
- Automatic shut-off nozzles installed on hoses around the factory.
- Cooling water deficiency in the juice line was noted and a cooling tower installed.
- Rehabilitation of the Dowe Pack water collection system.

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

9.7.3 Recovery of Cheese Whey for Use as an Animal Feed

The industrial audits showed that in the dairy factories, whey permeate from cheese
processing was frequently being disposed directly to the sewer. As this has a BOD of around
55,000ppm, this was significantly increasing the pollution load of the final effluents.
However, it is often possible to recover and use whey, as it contains high levels of
carbohydrates, proteins and minerals. In Misr Company for Dairy and Food, Damietta,
158m³ of whey per month was produced throughout the year, a sufficiently high volume for it
to be viable as an animal feed.

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

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

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

Training was provided to staff at both the factory and the farm, to ensure that the whey was
handled properly, from production through to feeding. A whey segregation system consisting
of piping, pumps and a collection tank with a transfer capacity of 10m³/hour was also
installed. This is transferred from the factory to the farm by lorry.

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

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

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

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

9.7.4 Environmental Savings from Improved Quality

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

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

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

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

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

9.7.5 Outputs from the Demonstration Projects

For each demonstration project, the following documents were prepared:

- Case studies (reproduced in Appendix 3) outlining the actions taken and describing the associated costs and benefits. These include:
Guidance Manuals, which give step-by-step instructions which will allow other factories to implement similar projects. Each Manual also gives a general introduction to the concept being implemented; cost-benefit analyses, to show exactly how the savings were made and some “Helpful Hints”, which were developed during Project implementation. Guidance Manuals prepared for the food processing sector include:

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

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

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

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