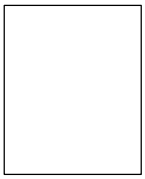
SEAM Project

Guidance Manual

Cleaner Production for Food Waste Reduction by Improved Quality Control and HACCP Implementation

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

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



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Cleaner Production for Food
Waste Reduction by Improved Quality Control and HACCP Implementation

SEAM Project
Implemented by:

Egyptian Environmental Affairs Agency
Technical Cooperation Office for the Environment
and
Entec UK Limited

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The SEAM Project - An Introduction

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

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

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

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

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

Textile Sector

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

Food Sector

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

Oil and Soap Sector

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

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

Executive Summary

This project evolves with traditional waste reduction techniques and applies a total quality approach by setting guidelines to address safety, quality and waste controls within a food processing establishment. It is designed to encourage the adoption of a Quality Assurance System and HACCP principles and should be applied as appropriate to facilitate development and implementation in food safety, quality and waste reduction programmes across the different segments of food industries.

This demonstration project was successfully implemented in two sectors within the food processing industry: the dairy and preserved foods industries. However, this guidance manual applies to all food industries, processors and their operators, engineering personnel and management. It is a guide for any individual responsible for auditing food safety and quality, including government regulatory and inspection agencies, food and nutrition specialists, and health safety and environmental professionals.

Factories Participating in the SEAM Waste Reduction Demonstration Project

Edfina Company for Preserved Food, Alexandria, Egypt

The factory is one of the oldest and largest producers of preserved foods in Egypt. It was built in 1958 on 56,000 square meter of agricultural land in Ras El-Souda district in Eastern Alexandria. Today it has 600 employees working in 10 departments 6 days a week in 2 to 3 shifts per day.

The production is seasonal and market-driven, to include a wide variety of products. During 1997/98, the factory processed 8,400 tons of raw vegetables and fruits to produce juice and syrup (5,110 ton/year), jam (1,180 ton/year), tomato paste (1,020 ton/year), cooked beans (900 ton/year), frozen vegetables and fruits (1560 ton/year), sugar (85 ton/year), and various other products (230 ton/year).

Misr Company for Milk and Food, Mansoura, Egypt

The factory is one of several owned by the public sector holding company and is one the largest producers of dairy products in Egypt. It was built in 1965 in Mansoura, Dakahleya and currently has a workforce of 420 employees.

During 1997/8, the factory processed 7,200 tons of milk to produce pasteurised milk (1800 ton), sterilised milk (600 ton), white cheese (1200 ton), yoghurt (1080 ton), and ghee (350 ton). Blue cheese (50 ton), mish (200 ton), and sour cream (10 ton) are also produced.

Part A

Introduction

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1. What is Waste Reduction?

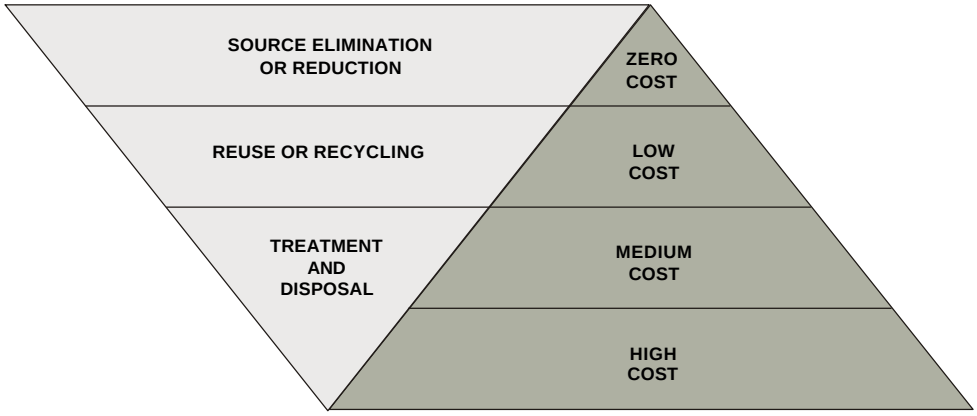
Pollution prevention, also referred to as source reduction, is the elimination or proportional reduction in the generation of non-product outputs, wastes, or pollutants at the point of generation. Waste minimisation has a narrower scope than pollution prevention as it focuses on reducing the entire spectrum of pollution and waste released to the environment. Unlike strictly oriented pollution prevention concepts, waste minimisation often includes treatment methods that reduce the volume and/or toxicity of the existing waste.

Waste reduction has a broader focus than waste minimisation and is defined as the act of reducing or eliminating the use, release or generation of a pollutant or waste, requiring treatment or disposal. This definition includes source reduction, recycling, reuse, reclamation or modification of existing practices. Waste reduction is an activity that falls somewhere between pollution prevention and waste minimisation.

Priorities of waste prevention are summarised in the pollution prevention hierarchy represented in Figure 1:

Figure 1

Pollution Prevention Hierarchy



- the **first priority** is to prevent or reduce waste at the source, meaning that less material enters the waste stream and more financial benefits are achieved because of direct savings on raw material costs;
- the **second priority** is to reuse or recycle wastes that can not be prevented or reduced, and in this case the factory will incur costs of lost raw materials, handling and treating recycled waste streams;
- the **third priority** is to treat final waste stream;
- the **fourth priority** is disposal of the final waste stream without treatment.

This project has been developed to emphasise the first and second priorities as they entail the most significant financial and environmental benefits and require low or no investment costs.

2. Waste Profile of the Egyptian Food Industry

The food processing industry is wide and diversified, it encompasses the various types of foods such as meats, grains, vegetables, fruits, beverages and dairy products. The diversity of the industry is not only apparent by its vast array of products but also by the waste it generates.

In food processing, wastes can be broken down to:

- *Direct waste* - all waste that can be accounted for in dumpsters or bins and are comprised of lost raw ingredients and semi-processed or fully processed product. Direct wastes can be further broken down to:
- *Intentional waste* - any waste expected as part of the process, such as peelings and pits from vegetable processing, whey from white cheese making, blood and bones from meat processing, and wash water from different processes.
- *Unintentional waste* - waste resulting from poor operation, improper maintenance and cleanup practices.
- *Indirect waste* - waste created as a result of direct wastes discharged to the drain. Indirect waste is comprised of sludge which is the solid waste produced from the treatment of effluent wastewater. Sludge generation will depend on the type of food processed, the amount lost into the drain and the type of wastewater treatment.

2.1. Direct Waste

When the input resources of a process do not interact together as designed and the result varies from a target performance, the primary loss will be comprised of direct waste which may be in the form of material losses, spoilage, rework or scrap. Direct material wastes generated in food factories differ between the processed products. However, experience at Edfina Company for Preserved Foods and Misr Company for Milk and Food has shown that the common types of waste are generally intentional, such as:

- damaged raw materials;
- unused raw materials;
- in-process wastes;
- cleaning wastes;
- spills and leaks;
- packaging wastes;
- poor quality or downgraded products;
- product recalls;
- spoiled products;
- excess wash and rinse water;
- low power factor in energy use;
- excess steam; and
- excess heat.

From a business management standpoint, waste can occur not only to materials but to all process inputs, including human resources, equipment and methods. While material wastes (direct or indirect) are the most visible, they result in one or more additional waste elements, for example:

- use of labour, equipment and materials associated with product rework;
- reduced efficiency if time is spent handling reworked product;
- handling and disposal of spoiled products;
- clean-up of spills, including clean-up materials, labour, and disposal;
- storage of excess stock; and
- additional treatment of wastewater.

The prevailing reasons for waste occurrence in the Egyptian food industry are attributed to:

- Lack of a clear policy towards quality and waste;
- Unsuitable, or out of specifications, raw materials;
- Spoilage of ingredients or finished products in storage or transit;
- Inaccurate quantification of ingredients or formulation of products;
- Poor housekeeping and handling practices;
- Poor or inappropriate packaging;
- Shortage of skilled labour and poor training;
- Poor resource management, including people management;
- Inadequately designed or outdated equipment;
- Poor equipment maintenance;
- Poorly designed manufacturing processes;
- Lack of proper process control;
- Insufficient quality control procedures;
- Lack of quality monitoring equipment and measurement tools; and
- Inaccurate record-keeping and documentation.

Other hidden wastes can be found or concealed in lost sales, production variances, loss of market share and poor staff morale.

2.2. Indirect Waste

The traditional approach to managing indirect waste in food processing has been:

- end-of-pipe treatment; or
- land disposal.

Land application has difficulties associated with disposal problems, land incapacity, soil absorption and conversion inefficiencies and requires extensive research on different crops.

Common treatment processes include anaerobic pounds or lagoons, aerobic pounds, activated sludge, clarifiers, trickling filters and rotating biological contractors.

Although the majority of the pollutants of concern in food wastewaters are organic and compatible with most biological treatment methods (i.e. public or domestic treatment works), the following difficulties exist:

- The volume and characteristics of food processing effluents exhibit extreme variability. The biological oxygen demand (BOD) and total suspended solids (TSS) of food factory wastewaters are directly related to the food products in the wastewater. BOD and COD may be found in concentrations as high as 200,000 ppm and 120,000 ppm, respectively. A factory may have a BOD load equal to a town or small city. The pH values are very variable, and in some wastewaters may be highly alkaline (pH 11.0) or highly acidic (pH 3.5).
- High strength wastewater and highly variable seasonal loading make treatment schemes ineffective and not cost efficient. The strength of food factory wastewaters is typically 10 to 100 times greater than domestic sewerage.
- The construction of wastewater treatment plants can be costly. Costs for treatment vary depending on size and types of operations. Capital and operational costs of a treatment facility may present a financial burden on a food processing factory.

- Discharge limits are mandated by regulations depending on the receiving body. Location and proximity of the wastewater treatment plants to surface waters (i.e. the Nile River and branches) may increase design requirements and thus make the factory more complex and costly. See Appendix A for Egyptian industrial discharge regulations.
- The use of chemicals (e.g. in peeling vegetables, pickling operations, sanitation and cleaning solutions) may create wastewaters of unique treatment requirements (e.g. alkaline, acidic or highly chlorinated) and thus result in extra costs.

3. What Can You Do to Reduce Waste in Your Factory?

With more regulatory pressures, greater number of food processing plants are taking steps to reduce waste and particularly save on water consumption because of rising treatment costs and environmental standards.

It is apparent that the best way to reduce waste is not to generate it in the first place, which is synonymous with waste prevention. Rather than control waste once it is generated, the quick and inexpensive way is to stop making waste. In the absence of feasible prevention opportunities, waste should be recycled or reused.

To start identifying options for waste reduction, attention should be given to measures that will have an obvious positive impact. A criteria for identifying opportunities was developed to meet one or more of the following:

- Easy to identify and implement.
- Requires low capital investment.
- Requires affordable or available technology.
- Can be carried by the factory with minimum outside consultancy input.
- Results in attractive savings.
- Provides an good return on investment with a short payback period.
- Reduces the quantity and/or toxicity of the factory's waste.
- Moves factory towards compliance to regulatory pollution discharge laws.
- Improves safety and working conditions for employees.
- Improves the factory's public image.

Waste reduction can be applied to all waste generating activities, such as:

- manufacturing and production operations;
- facility operations, facilities and equipment;
- maintenance, storage and transportation; and
- personnel.

Using the above approaches, Part B of this manual provides information on how to identify and prioritise waste reduction opportunities through a quality assurance approach.

Table 1 summarises the general approaches that may be adopted to reduce waste.

Table 1
General Approaches to Waste Reduction in Food Processing

Approach	Method	Application
Source Reduction	Product Redesign or Modification	1. Design product to produce less environmental impact. 2. Product reformulation. 3. Increase product shelf-life.
	Process Change or Modification	1. Input material changes: ▪ Improve raw material specification; ▪ Material substitution. 2. Improved good manufacturing practices: ▪ Layout changes; ▪ Improved operating practices; ▪ Improved material handling and storage; ▪ Improved management practices; ▪ Production scheduling; ▪ Improved sanitation and cleaning. 3. Technology changes: ▪ Increased automation. ▪ Improved equipment. ▪ New technology. 4. Process or equipment modification: ▪ Increased automation. ▪ Improved equipment.
	Improved Housekeeping	1. General tidiness and organisation. 2. Spill and leakage control.. 3. Waste stream segregation. 4. Solid Waste segregation.
	Improved Process Control	1. On-line process controls. 2. Efficient measurement tools.
	Purchasing, Inventory and Recall	1. Optimise and rationalise purchasing. 2. Inventory control. 3. Supplier inspection procedures. 4. Recall system.
	Maintenance	1. Preventative maintenance. 2. Equipment calibration..
	Staff Training	1. Personal and hygienic practices. 2. Manufacturing control. 3. Refresh training.
	Conservation	1. Water conservation. 2. Energy conservation. 3. Efficiency improvement.
Recycling	Recycling	1. Product recovery. 2. In-process recycling 3. Out-of-process recycling.
	Reuse	1. Composting. 2. Reuse as animal feed.

4. Making Your Waste an Asset

Most factories are unaware of the real total costs of their wastes. The major cost that is undefined is the value of raw materials, labour and other process costs which are embodied in each waste material.

The Egyptian food industry wastes an estimated LE3 billion in direct costs associated with raw material losses, 15% to 40% in raw materials and 15% in final product losses. The primary cost tracked by most companies is market recalls.

Waste prevention provides **upstream benefits** because it reduces consumption and lessens the depletion of valuable resources. It also provides **downstream benefits** because it helps to lower the environmental impacts of manufacturing, distribution, recycling, and disposal as well as increasing business efficiency. These benefits can be briefly summarised as follows:

Financial savings - through reduced operating and production costs, by consuming fewer resources, increasing operation efficiency (i.e. more finished product for less raw materials), reducing waste management and disposal costs. Cost savings may be immediate when directly connected to the product or anticipated when realised over time, as in overhead costs.

Improved corporate and public Image - improving the positive image of the factory will enhance the business image among the public, including clients, and will give a competitive edge in the marketplace. Waste reduction can serve as an effective public relations tool.

Improved environmental performance - through less on-site waste storage, less pre-treatment and packaging prior to disposal, smaller quantities to be treated with a possible shift from a treatment, storage and disposal (TSD) facility to a zero pollution status. Reducing production wastes reduces the factory regulatory exposure by moving towards environmental compliance.

Step toward ISO 14000 - including waste reduction programme to form an integral part of developing sound environmental management systems.

5. Quality Approach to Waste Reduction

Experience gained from the SEAM demonstration projects has shown that there is prevailing belief among the different industry sectors that: (1) quality is motivated mainly by customer satisfaction, and (2) better environmental performance is driven by increased industrial waste disposal regulations.

The approach of the SEAM Project and of this guidance manual emphasises that pollution prevention, or waste reduction strategies, parallel quality management strategies and other related quality assurance systems. Viewing quality and environmental impacts separately opposes the rationale behind preventing waste, which goes far beyond the immediate benefits of lightening the waste management load and avoiding treatment or disposal. When waste is generated from a process, it indicates that the process may be inefficient, and that several cost dimensions are being impaired.

Waste reduction is driven by more than environmental performance or standards. For example, the reject rate at Misr Company for Milk and Food for packaged pasteurised milk is 3%. Although the quality of the product itself is satisfactory, the reject rate is due to packaging problems, rather than a sub-standard food product. The packaging line produces about 15,000 units a day. Based on continuous monitoring of losses and other factors, the factory determined the reject rate acceptable and did not consider the quality of the packaging process to be an issue. However, the factory dedicated a full-time worker and operator to examine the packaging, remove reject pouches, open them, and recover the milk for re-

pasteurisation and re-packaging. This resulted in extra costs in labour, time, energy (in re-pasteurisation) and additional packaging, in addition to the cost of disposing the waste packaging.

From the factory strict final product quality standpoint, modification or change to a process or product (i.e. packaging) could be unnecessary, but from a process efficiency point of view, a financial analysis for improving the packaging line quality is essential. The management approach to productivity and quality can also produce an opportunity to alleviate waste and environmental impacts of disposing tens of thousands of waste pouches per year.

The key issue is that similar practices and procedures are used for quality improvement and waste reduction, and that quality management practised through a factory quality assurance system is actually incomplete if it is not quality environmental management.

6. Outline of Food Quality Assurance (QA) Systems

At the heart of a quality assurance strategy in a food factory is its due diligence defence. This is defined by law within Europe but the concept is universal. Basically, a company due diligence is that it took all practicable precautions and exercised all due diligence to prevent a problem occurring.

All practicable precautions means that if a factory or company can do something to prevent a problem then it must do so. What is practicable is open to interpretation, but obviously activities that have an unreasonably high cost would not be expected. However, it is usually accepted that the bigger a factory is the more is expected of it. In essence, this means that a company has to set up a system to ensure the safety and quality of its products. All due diligence means that a company has to be able to demonstrate that the system is operating correctly and, if challenged, to have the necessary records to verify this in a court of law, for example.

The system developed to establish due diligence is made up of a number of components. As discussed below, two key activities are at the centre of the system, namely Good Manufacturing Practices (GMPs) and Hazard Analysis and Critical Control Point (HACCP).

6.1 Good Manufacturing Practices (GMPs)

Good manufacturing practices are universal steps or procedures recognised within the food industry that are necessary to control the operational conditions within a food establishment, thus allowing for favourable conditions in the production of safe and good quality food. In order to develop comprehensive quality or safety systems within a food establishment, prerequisite programmes have to be developed, documented, implemented and monitored in order to control factors that may not be directly related to manufacturing controls but support effective quality management. Several international standards are available for the requirements of good manufacturing practices, which are usually based on legal requirements, customer specifications and the establishment own standards. Common programmes include, but are not limited to:

- **Facilities** - property and facilities layout; building; and sanitary facilities.
- **Specifications** - specification for all ingredients, products, packaging materials as well as water/steam/ice quality.
- **Receiving, Transportation and Storage** - food carriers; temperature control; storage of incoming material, ingredients, non food materials and finished products.
- **Process Control** - specifications of manufacturing processes; recall and traceability procedures; and documentation and records.

- **Equipment** - general equipment design; equipment installation, equipment maintenance and calibration.
- **Personnel** - hygiene practices; health requirements and training.
- **Sanitation and Pest Control** - includes relevant cleaning; sanitation and pest control programmes.

The importance of constructing adequate and effective programmes can not be overstated. They form the foundation of quality and safety plans, and using them as a basis would simplify and guarantee the integrity of the Quality Assurance System. The requirements for these prerequisite programmes are discussed in more detail in Part B of this manual.

6.2. Supplier Quality Assurance (SQA)

Supplier Quality Assurance (SQA) refers to a programme of actions that ensures the safety and quality of the raw materials (i.e. also equipment) supply. This generally consists of procedures to assess supplier competency and can be achieved through:

- Contracts.
- Supplier Analysis Certificates.
- Written material specifications.
- Inspection, sampling and testing.
- Supplier compliance to international standards (i.e. ISO 9000, HACCP).
- Questionnaires.

6.3 Statistical Process Control (SPC)

Statistical Process Control (SPC) refers to statistical techniques achieved through sampling and analysis to detect defects in the manufacturing process. SPC is effectively used in monitoring activities in food processing through the following activities:

- **Sampling/reading** - taken randomly from the process, according to a pre-set frequency, to verify the capability of the process of achieving the control criteria established. This is achieved in food processing by (1) taking readings from equipment instrumentation, and (2) final product testing.
- **Process Control Charts (PCCs)** - represented in the form of data from sampling/reading records with graphical plotting. PCCs provide historical knowledge on acceptable variations in the process and can verify its stability.

SPC techniques are of most benefit when they allow process operators to quickly stop a problem occurring in the process, thus avoiding the output of a substantial amount of defective products. Part B of this manual emphasises the use of SPC as an on-line process control tool for quick monitoring activities, comparing it with using it for acceptance purposes in final product testing.

6.4 Standard Operating Procedures (SOPs)

It is important to translate the requirements of GMPs, SQA and SPC applications to a working document that can be easily used by the factory employees. The main purpose of SOPs is to standardise procedures in order to:

- **Harmonise the factory procedures** in the miscellaneous parts of the manufacturing operations.

- Ascertain that all workers have a **unified way of doing things** and there is no possibility for personal interpretation.
- Provide a **working document accessible at all times** for employees to refer to at times of operation or doubt.
- Assist in **auditing activities**.
- Facilitate **training of employees**.
- Assist in any **upgrading or integration** with other quality management aspects.

6.5. Hazard Analysis and Critical Control Point (HACCP)

HACCP, or the Hazard Analysis and Critical Control Point System has been recognised as an effective and rational means of assuring food safety from primary production through to final consumption, using a farm to table methodology. The application of this preventive oriented approach would give the food producer better control over operations, better manufacturing practices and greater efficiencies, including reduced wastes.

The technique was developed in the 1960 as part of the US space programme, mainly by the US based Pillsbury Company together with the US National Aeronautics and Space Administration (NASA). The system is based on a zero defects philosophy for food products for astronauts using the engineering concept of Failure Mode Analysis Scheme. In short, it assumes that if something can go wrong it will and that the only way safe food can be produced is if control is achieved over: (1) the raw materials; (2) the process; (3) the environment; (4) the people; and (5) beginning as early in the system as possible.

Under this system, if a deviation occurs in a certain food product processing operation, indicating that control has been lost and causing the product to be unsafe to consumers, the deviation is located and control is restored by applying quick effective corrections. The principles of HACCP mainly include:

- hazard analysis;
- the identification of critical control points where a failure could cause the hazard to occur;
- establishing critical limits or operating parameters and procedures for monitoring; and
- establishing corrective actions, verification, and record keeping and documentation for the critical points.

The HACCP programme is at the core of the recognition and control of problems. As part of this programme the regime for the taking of samples and other quality control activities would be defined. Most companies will find that many of the requirements of HACCP are already in place and operable in their establishments. The HACCP approach isolates quality control procedures at various points in the process and incorporates it into a system. Relating these points and interlocking them into a HACCP system prevents the process from deviating from specifications and causing a hazard without the information being picked up through the monitoring procedures.

It should be noted that HACCP must be product specific and specifies an acceptance criteria associated with regulated food health and safety conditions necessary to ensure food suitability for human consumption.

Before implementing HACCP for a product line the first step is to review existing overall manufacturing practices in the establishment. GMPs and SQA, are prerequisites for HACCP implementation.

Food standards in the world are focusing on HACCP as a tool to meet the demands for a hygienic and high quality food product. It is becoming essential for food producers and processors to be proactive in developing and expanding their quality systems to maintain marketplace or expand to international markets where HACCP is being recognised as imperative for international food trade:

- In 1993, European standards governing the hygiene of foodstuffs mandated by Council Directive 89/397/EEC effected a requirement to use HACCP.
- In 1997, the US Food and Drug Administration issued a final rule establishing HACCP for the seafood processing industry.
- In 1998, the US Department of Agriculture requires large meat and poultry factories to establish HACCP system by year 2000.

Within a few years it is anticipated that HACCP will become mandatory in the United States and European Community for all food products, and Egyptian food establishments that are not working towards HACCP may have trouble sustaining their current export markets. To date, HACCP is mainly practised voluntarily in Egypt. However, the Ministry of Health, which is the main government body that regulates and controls food safety, is taking active steps to promote HACCP adoption and establish an auditing and accreditation scheme.

Part B of this manual provides a step by-step guide on how to develop and implement a HACCP plan.

6.6. ISO 9000

ISO 9000 refers to the internationally accepted series of quality management standards, issued and maintained by the International Organisation for Standardisation (ISO). ISO 9000 focuses on the systems, practices and processes by which a company assures that its food products meet or exceed customer expectations. The standards do not specify quality or performance criteria for any particular product but rather it requires the organisation to determine, document and explain how it assures quality with respect to common processing functions. An ISO 9000 compliant company must implement policies and procedures for most of the following 20 elements:

- Management commitment.
- Quality system.
- Contract review.
- Design control.
- Document and data control.
- Purchasing.
- Control of customer supplied products.
- Product identification and traceability.
- Process control.
- Inspection and testing.
- Control of inspection; measurement; and testing equipment.
- Inspection and test status.
- Control of non-conforming product.
- Corrective and preventive action.
- Handling; storage; packaging and delivery.
- Control of quality records.

- Internal quality audits.
- Training.
- Servicing.
- Statistical techniques.

There are different levels of certification that a company may attain:

- **ISO 9001** - covers all 20 elements of the standard.
- **ISO 9002** - covers 18 elements of the standard, excluding the procurement, production and installation elements.
- **ISO 9003** - covers 16 elements of the standard, excluding the production process and has lower conformance requirements.

ISO 9001/2 certifications among Egyptian industries have grown exponentially during the past few years to meet global competition, particularly for exports. While not mandated, Edfina Company for Preserved Foods, for example, needs to ensure an accredited ISO system to sustain its considerable export market, particularly to the European Community which has pushed strongly for ISO accreditation of food producers within member countries, thus raising pressure on countries exporting to the EC.

In industries where quality is looked upon as critical such as the food industries, ISO 9001/2 has almost been realised regulated and a necessity for market survival.

It is very important to ensure that GMPs and the HACCP system are fully developed before embarking on accreditation under the ISO 9001/2 international standard. ISO 9002 is the common standard applied in Egyptian food industries. Several guides are available to help a factory develop and choose the most suitable ISO standard[4].

Unlike HACCP, ISO 9000 is predominately concerned with the management of the process and is less concerned with the technical decisions on which the system has been designed. This is the role of GMPs and HACCP. Another conceptual difference from HACCP is that ISO 9000 is a factory quality management system and covers not only a certain product as with HACCP, but covers all production lines within a food factory.

6.7 ISO 14000

ISO 14000 refers to a family of environmental standards for Environmental Management System (EMS), and Eco Management and Audit Scheme (EMAS), which primarily consists of:

- Specification and guidelines of environmental management system.
- Environmental auditing.
- Environmental performance evaluation.

ISO 14000 focuses on providing a structure for conducting environmental audits to guarantee current or continuous improvements of environmental compliance to relevant regulations and laws (see SEAM Guidelines for Industrial Auditing). However, a key similarity with ISO 9000 is that under ISO 14000 the establishment is free to shape its management system and set the level of environmental compliance.

ISO 14000 will involve:

- Identification of current issues.
- Developing an environmental policy and plan.

- Modifying and integrating the current factory procedures and operations into an environmental management system.
- Continuously monitor the system.

The idea of ISO 14000 is to promote continuous environmental improvements in the quality management system and the environmental friendliness of the factory operations.

It should be noted that maintaining ISO 14000 against established targets or levels of pollution is the essence of waste reduction. The tools used to achieve, implement and control ISO 14000 are the same techniques used under ISO 9000, GMPs, and HACCP.

6.8. Total Quality Management (TQM)

Total quality management (TQM) is a broad management concept and long-term business philosophy that stresses meeting a right first time, zero defect, in which staff at all levels are fully involved at all times in a process of continuous improvement to meet process consistency and prevention of defects.

If a food establishment decides to take a TQM approach to the way it operates, this invariably means that a number of broad workplace programmes must be in place. Both ISO 9000 quality standards and HACCP system embody a great part of the TQM philosophy and having attained ISO 9000/HACCP, compliance is a strong step in the TQM direction.

7. Integrated Quality Assurance Instruments for Waste Reduction

Taking a sound quality assurance approach to waste reduction simply means that all activities of the factory must meet the quality or waste reduction objectives. In this respect a Total Quality Management System should be targeted using various instruments of quality assurance (see Figure 2).

Figure 2
Quality Assurance Instruments for Waste Reduction

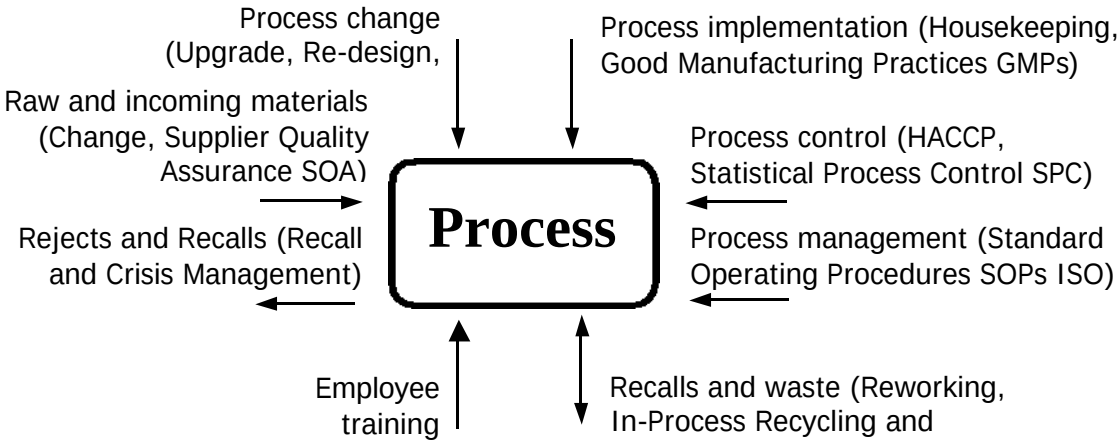


Figure 2 illustrates the different quality assurance measures adopted in this project, using the following instruments:

Instrument 1. Establishing a Supplier Quality Assurance (SQA) System
- Supplier specifications
- Material specifications

Instrument 2. Working to Good Manufacturing Practices (GMPs)
- Process specifications
- Operating procedures
- Monitoring procedures
- Employee practices
- Audit procedures

Instrument 3. Using Statistical Process Control (SPC)
- Sampling/Reading/Testing (process, intermediate and final product)
- Control methods (control limits and charts)

Instrument 4. Use the **Hazard Analysis and Critical Control Point (HACCP)** system to pull all the above actions together into a HACCP plan
- Hazards and control points

Instrument 5. Establish a Product Recall and Crisis Management Plan

Instrument 6. Maintain Training Programmes built into all other instruments.

Instrument 7. Manage the QA programme under ISO standards
- Once the technical contents of the above has been designed, the management of the activities has to be defined to ensure that the integrated system is maintained 100% of the time by using the **ISO 9000** approach.
- This quality management system can be subjected to external accreditation under the ISO 9001/2 international standard.

In the development of the QA Programme, the systematic use of these seven instruments is complemented by several problem solving tools such as brainstorming, process flow diagrams, cause-effect diagrams, control charts, etc.

Once a QA Programme has been agreed it can be further reviewed and adjusted with reference to ISO 14000.

Part B

How to Prevent Waste Through Integrated Quality Assurance - A Step by Step Guide

Step 1: **Management Commitment**

Step 2: **Formation and Responsibilities of the Factory Team**

Step 3: **Employee Education and Training**

Step 4: **Conduct the Detailed Assessment**

Step 5: **Identification of Improvement Opportunities**

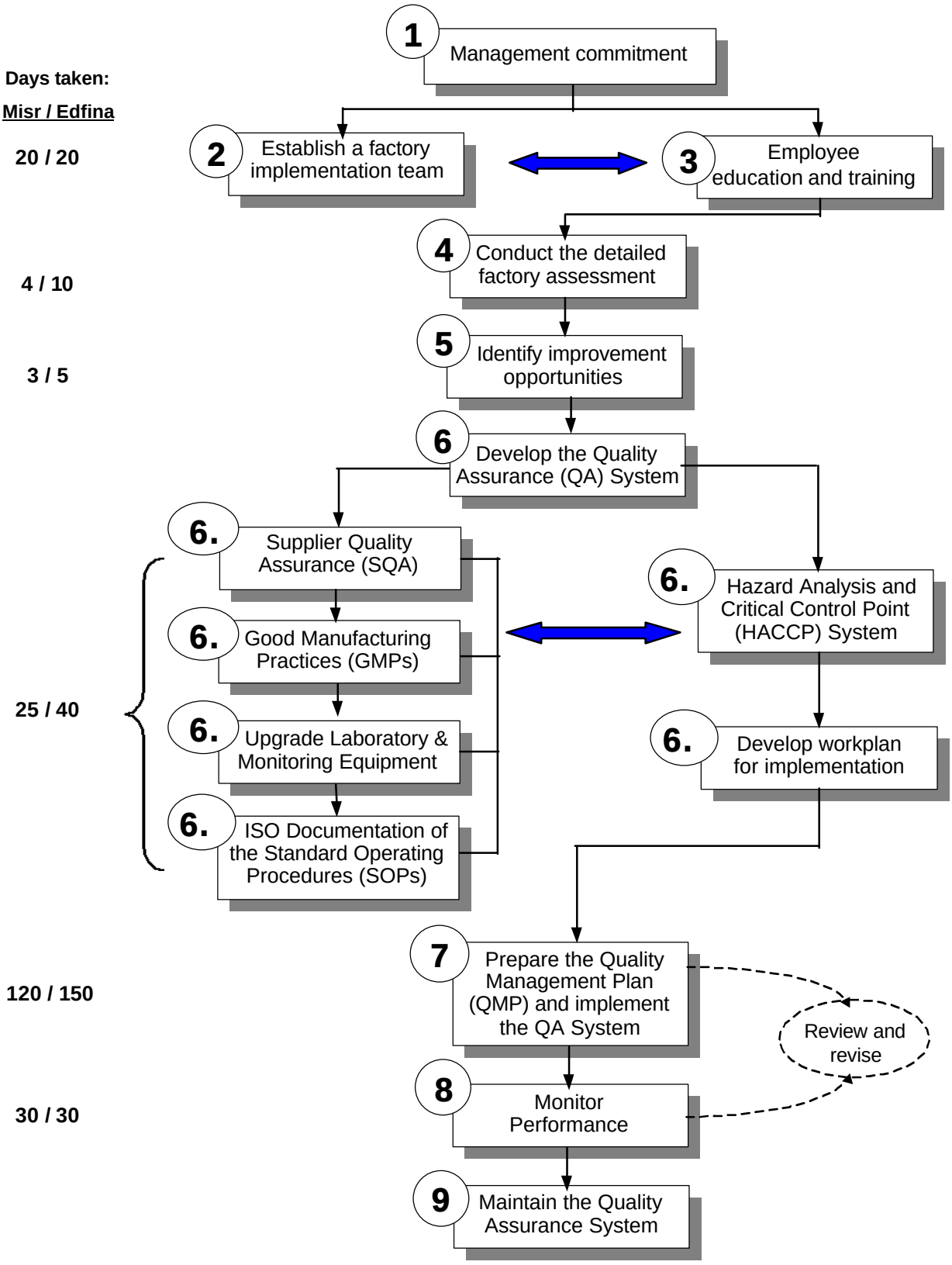
Step 6: **Develop the Quality Assurance System (GMPs, HACCP and ISO 9000)**

Step 7: **Implement the Quality Assurance System**

Step 8: **Monitor Performance**

Step 9: **Maintain the Quality Assurance System**

Figure 3
Step-by-Step Flow Diagram for Achieving Waste Reduction Through Integrated Quality Assurance QA and HACCP for Food Industries



How to Prevent Waste Through Integrated Quality Assurance - A Step by Step Description

This section gives a step-by-step description of how to achieve efficient waste reduction through out the different factory processes by improving Quality Assurance (QA) and establishing a Quality Management Plan (QMP).

STEP 1 - Management Commitment

Once the management has decided to establish a quality assurance and waste reduction plan, it should establish a framework for its commitment which could be expressed in several forms. For example:

- Executive management level decision.
- Policy statement to state: (1) the reasons for considering improvements to the quality assurance system and reducing waste; (2) the goals the management hopes to achieve, and (3) the employees expected responsibilities.
- Consensus building - to present the policy to employees in order to gain their support and commitment.
- Encourage employee participation - to provide a positive atmosphere to achieve best results (see Part D of this manual).

STEP 2 - Formation and Responsibilities of the Factory Team

A multi-disciplinary QA Team should be made up of representatives from key factory departments and operations, centred around a Team Leader or co-ordinator. The factory team should be selected carefully according to their capabilities and performance, which will determine the success of implementation.

All key members named to this task force should have a thorough knowledge of the company operations and have considerable technical, business and communications skills. As a rule, the team should include managers, engineers and senior operators from the following departments:

- Quality Control.
- Environment.
- Engineering.
- Production.
- Maintenance.
- Inventory.
- Purchasing.
- Finance.

Depending on the size of the factory, several of these positions may be filled by the same individual or they do not exist. The task of the Team Leader is crucial in overcoming possible resistance to proposed changes in operations and should posses the authority and the influence to direct the development and implementation of the waste reduction measures.

Once the task force has been established, specific roles and responsibilities should be assigned. The services of an external consultant with experience in quality management or pollution prevention/waste reduction in food industries may be retained to work with the in-house team.

Box 1 is an example of the team composition at Edfina Company for Preserved Foods.

Box 1
Factory Team Composition at Edfina Company for Preserved Foods

Quality Control and Environmental Manager
Production Manager
Maintenance Manager
Engineering Manager
Finance Manager
Purchasing Manager
Inventory Manager
Senior operators from the above departments

STEP 3 - Employee Education and Training

Up-front training is a very important part of a quality system. A very critical step is to educate the factory managers and employees since only few might realise the importance of a reliable quality assurance system and the true benefits of waste reduction.

At both factories participating in the project, employee capacity building needs were examined through the perspectives of the task force and an external consultant. The education and training needs were determined by conducting a survey and through discussions with plant process engineers, production supervisors and line workers. The outcome of the training needs assessment has concentrated training efforts in seven areas:

- Integrated Food Quality Assurance Systems for food industries.
- Good Manufacturing Practices (GMPs) in food processing.
- Hazard Analysis and Critical Control Point (HACCP) Systems.
- Technical and implementation skills for food quality.
- Cleaner Production principles and waste reduction techniques.
- Monitoring techniques including environmental measurements.
- Information technology and computer systems for analysis and monitoring.

From the experience gained during the training activities at Edfina Company for Preserved Foods and Misr Company for Milk and Food, the following elements are suggested for a successful training strategy:

- **Active involvement of senior management** - to provide the incentive for employees to become informed, motivated and to take action. In this project, factory managers opened the first training session by explaining that quality and waste reduction are indispensable tools and necessary financially if the plant is to continue and compete in the marketplace. Employees were asked for positive involvement in every step of the planning and implementation.

- *It is our first and foremost responsibility to improve the quality of our products and aim at reducing our waste* - From opening speech given by Misr Company for Milk and Food factory manager, June 1998.

- **Planning of the training activities** - to be delivered in a cost-efficient manner. Training was delivered on site through a series of 2-hour sessions with minimum disruption to production operations.

- **Training manuals** - should be prepared to achieve industry specific training goals. Two manuals were prepared, one for dairy processing operations and one for preserved and canned foods.
- **Customised learn-on-the-job approach** - whenever possible classroom training was integrated with practical training as well as on-site discussions and problem solving.
- **The use of outside trainers** - should be adopted for group training and skill building. Bringing in external expertise has helped to see management and waste reduction issues from different perspectives and has helped to overcome the limitations of in-house training.

STEP 4 - Conduct a Detailed Assessment

In order to identify improvement opportunities and establish an effective QA system and quantify the savings from waste reduction measures, it is important to establish baseline information for preliminary assessment. This can be achieved through:

1. In-Factory Walk Through

The factory team should go through the various areas of the factory in order to re-familiarise itself and document the different resources and operations. The team should follow the different processes from beginning to end, in order to:

- Provide a descriptive account for the conditions as completely as practical.
- Prevent overlooking factory settings that were not documented before.
- Supplement and verify exiting documentation and data.
- Decide on data sources and information to be collected.
- Identify visible waste sources.
- Locate potential areas for improvements.

2. Data Collection and Documentation

Data collection is important to help quantify the current operations and enable the factory team to establish procedures for a detailed assessment and priorities for an action plan. Most of the required data can be collected as a normal part of the factory operations and will depend on the size of the factory and complexity of its operations. Information to consider during the data collection phase are discussed in the following sections.

2.1 Process Information

- Process design and actual layout.
- Equipment lists.
- Equipment specifications and data sheets.
- Piping and instrumentation diagrams.
- Factory plot and schematic blueprints.
- Equipment layout and logistics.

2.2 Material/Production Information

- Product composition and batch sheets.
- Product quality test results.
- Material specifications and data sheets.

- Product and raw material inventory.
- Production schedules.
- Operating procedures.
- Standard procedures.
- Maintenance procedures.

2.3 Financial Information

- Purchasing records.
- Utility bills.
- Product, energy, and raw material costs.
- Operating and maintenance costs.
- Department cost accounting reports and budget calculations.
- Waste handling, treatment and disposal costs.

2.4 Waste Information

- Scrap reports.
- Records of reworked, returned scrapped goods.
- Waste, wastewater and air emissions flow measurements and analysis.
- Environmental audit reports.

2.5 Other Information

- Organisation charts.
- Inspection and test reports.
- Customer complaints log.
- Regulatory information.
- Industry Publications.

3. Assessment of Practices and Processes

The first step is to examine data and analyse collected information. The data should be divided into process groups and groups split into unit operations. This makes it a simple task to review the factory total operation. The assessment of the factory processes and practices can be achieved through the following steps:

3.1 Develop Process Flow Diagrams

Process Flow diagrams (PFDs) are created to link unit operations and organise the manufacturing steps. PFDs should:

- Be constructed for each production line (i.e. product).
- Start from point of receiving raw materials through collection, processing, transport, manufacturing, etc., reaching final distribution.
- Include a brief title for each process.
- Include a number assigned to each step corresponding to order of occurrence;
- Show direction of flow.
- Comprise all process inputs including raw materials and water.

- Comprise all process outputs including by-products.
- Show any recycling or rework activities.

A description of factory processes identified at Edfina Company for Preserved Foods and at Misr Company for Milk and Food are describe in Box 2.

Box 2

Factory Processes of Edfina Company for Preserved Foods and Misr Company for Milk and Food

Box 2a Processes of Edfina Company for Preserved Foods	Box 2b Processes of Misr Company for Milk and Food
Canned Tomato Paste - raw tomatoes are received from suppliers, weighed, sorted and washed. Clean sorted tomatoes are pressed for juice and screened. Seasoning is added and juice is concentrated under vacuum and heat treated. Paste is automatically canned, sealed, sterilised, cooled and stored. ***Fruit Drink Manufacturing*** - fresh fruits are received, sorted, washed and squeezed. Pulp is heated, screened and mixed with ingredients. The mixture is heated, screened, homogenised, either bottled or canned then pasteurised. The final product is incubated before final packaging and storage. ***Canned Jam Manufacturing*** washed, peeled then cut. It is then mixed with sugar, steam cooked and concentrated under vacuum. Concentrate is packed in tin cans, sterilised and stored. ***Frozen Vegetables Manufacturing*** are received, weighed, sorted, trimmed, peeled and cut manually. Peeled vegetables are sorted, blanched, frozen, sieved, and packed in pouches. ***Canned Cooked Beans Manufacturing*** are received, weighed, sprayed with insecticide, sieved, sorted, dipped and spray washed, and soaked. This is followed by steam cooking, sudden cooling and final sorting. Cooked beans are seasoned, canned and sterilised. ***Canned Fish Manufacturing*** - whole fish is received and freeze stored. Defrosted, cut, cleaned and soaked in brine solution. Fish is then washed and hand-packed in cans. Open cans are cooked by steam and oil/salt solution is added. Lids are double seamed, cans washed, and heat treated. Finally, it is incubated and packaged.	***Milk Receiving, Preparation and Storage*** - raw milk tested and graded. If it is of a suitable quality it is then accepted and refrigerated prior to use. ***Milk Pasteurisation*** - the milk is pasteurised by being rapidly heated and cooled. It is then either sent for packaging or for further processing. ***White Cheese Manufacturing*** produced from the milk concentrate produced by the ultra-filtration of pasteurised milk, which is then curded, packaged and sold. ***Gee Manufacturing*** from the raw milk and blended with artificial ghee and salt and then cooked. This mixture is then incubated for a day, then packed. Morta is generated as a by-product of this process, which is also packed and sold. ***Roquefort Cheese Manufacturing*** milk is placed in basins, where it is curded, incubated, and refrigerated, followed by punching. It is stored for one month to allow the blue colour to develop, then packed and stored for dispatch. Whey is generated as a by-product. ***Yoghurt and Sour Cream Manufacturing*** fixing agents are mixed to produce yoghurt, which is then automatically packed in small cartons, incubated and refrigerated for dispatch. ***Mish Manufacturing*** - this is produced using dairy product rejects. These are mixed, ground and filtered to separate the solids from the whey. Preservatives are added and the product is packaged.

3.2 Prepare Material and Energy Mass Balances

Mass balances are used to identify and quantify the composition of input materials for each process, materials consumed during each process, and waste streams produced from each process. Mass balances should be:

- constructed for each production line (i.e. product), for defined boundaries, or for the system as a whole (i.e. the factory work-site). Mass balances restricted to a production

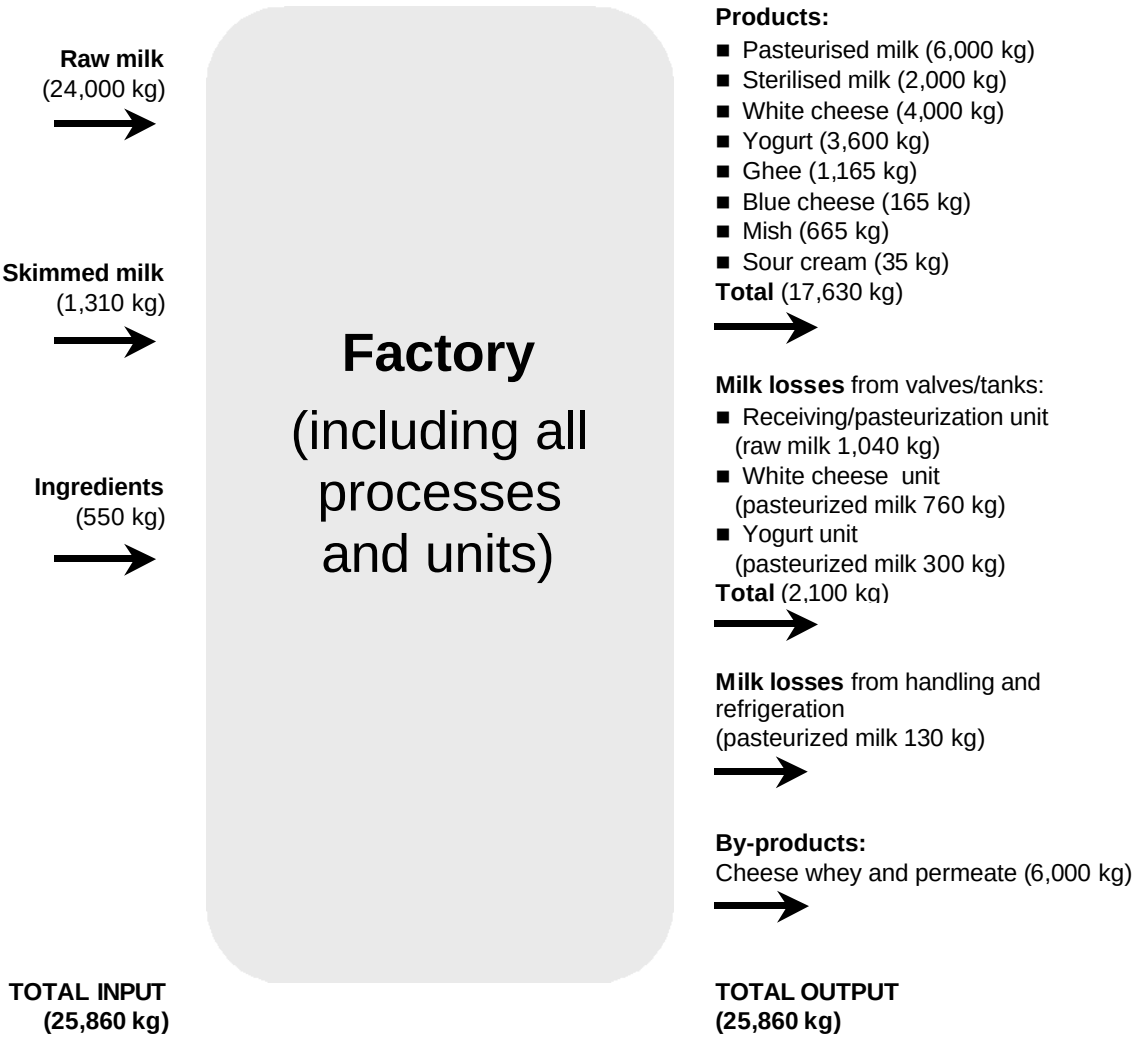
line, consisting of unit operations, are preferred to broader balances as more detail can be determined.

- calculated for each resource component entering and leaving the process (water, steam, fuel, etc.).
- drawn according to the mass conversion principle:
  [Mass in = Mass Out - Generation + Consumption + Accumulation].
- always balanced. Imbalances indicate either that data collected are inaccurate or that wastes are occurring without being accounted for.
- helping to identify gaps and permit calculation of missing information.
- used when it is difficult or uneconomical to quantify, collect or analyse samples of a certain component, particularly waste streams.

Box 3 shows the mass balance analysis prepared for the milk products in Misr Company for Milk and Food.

Box 3

Material Mass Balance for Raw Materials and Milk Products at Misr Company for Milk and Food



3.3 Prepare Product Movement and Traffic Flow Diagram

A product movement and worker traffic flow diagram is a visual means to analyse the flow of components within a product line. The product flow and worker traffic patterns are also elaborated based on the PFD prepared earlier and drawn on simple plant blueprints.

3.4 Measurements and Baseline Monitoring

It is important that measurements are established to complete mass balance calculations and define baseline quality and environmental conditions to enable later quantification of the incremental costs and benefits. The evaluation should cover the following:

1. **Products** - quality parameters should be assessed for the different food products:
   - Important compositional characteristics; such as TSS percentage for fruit drinks and fat percentage for dairy products, etc.).
   - Existence of contaminants, such as pH to indicate chemical contamination and foreign bodies as a physical contaminant.
   - Microbiological loads, such as pathogens; parasites; pests; etc.
2. **Water Supply** - samples of the processing water should be tested for physical, chemical and microbial quality.
3. **Processing Controls** - measurements of environmental controls in processing, transportation and storage equipment should be done to assess that the standard operational conditions are being met. Common controls in food manufacturing are temperature, pressure and holding time.
4. **Sanitation** - swap sanitary tests should be taken from the different factory facilities, equipment, piping, fittings, etc. to verify the effectiveness of the sanitation and cleaning activities.
5. **Waste Streams** - measurements of the quantity, composition and environmental quality of the different waste streams including wastewater, solid waste, and air emissions need to be established for mass balance calculations and to assist in determining the factory waste profile.

   Food products lost to the drains can be directly related to levels of BOD in the effluent. BOD is the most used test for measuring wastewater pollution from food processing factories. A high BOD indicates inefficient processes. Other directly related measurements are TSS and fats, oil and grease (FOG). 1 kg of BOD is equivalent to 0.89 kg of fat, or 1.03 kg of protein or 0.65 kg of carbohydrates.

   For more information on waste measurements, sampling and testing, see SEAM Guidelines for Industrial Audits.
6. **Costs** - the quantification of cost issues must be addressed to include:
   - Production related data (i.e. units produced, weight/volume of products, etc.).
   - Processing time or hours of production.
   - Consumption of raw materials and processing aids.
   - Water consumption.
   - Electricity and fuel consumption.
   - Steam consumption.
   - Labour utilisation.

It is very important to normalise measurements where appropriate to avoid skewing by production levels or other factors. For example:

- Raw material consumed should be expressed as material use per production unit.
- Quantity of waste generated should be expressed as waste per production unit.

3.5 Waste Assessment and Audit

At this stage most of the information needed to establish the waste profile of the factory should have been identified and characterised and it is essential that the following questions are answered:

1. Where are the wastes generated (i.e. process, machine, department)?
2. Why are the wastes generated (i.e. spills or leaks, by-products, inefficiencies)?
3. What is the quantity of the wastes?
4. What is the composition of the wastes generated from the factory?
5. Where does the waste go (treatment, recycling, or disposal)?
6. What process inputs generate these wastes?
7. What quantity of process inputs are found in the wastes?
8. How efficient is the production process and its various steps?
9. What are the costs (i.e. treatment, handling, labour, chemicals, disposal)?

Responses to these questions will serve as the basis for demonstrating progress, accomplishments and the success of future waste reduction activities. The answers need to be measured on a process-by-process basis and then translated into periodical waste inventory lists. Creating a list of the waste streams at the factory will:

- Distinguish between the different wastes (i.e. water pollutants, wastes than can be recycled, wastes that can not be recycled).
- Help track waste generation levels.
- Help control costs associated with meeting waste reduction goals.
- Raise the understanding of waste generation levels and the associated environmental responsibilities and compliance.

Typically, a waste inventory list should include the following:

- Waste type (liquid, solid, air emission).
- Waste generation source (process step).
- Waste quantity and characteristics (i.e. composition, pollution load quality and quantity).

Box 4 presents waste inventory lists prepared for Edfina Company for Preserved Foods and for Misr Company for Milk and Food.

Box 4
Waste Inventory Lists for Edfina Company for Preserved Foods and Misr Company for Milk and Food

Box 4a
Waste Inventory List for Edfina Company for Preserved Foods

Item	Waste Type (Liquid, Solid, Raw, Final, etc.)	Waste Generation Source(s) or Process Step(s)	Waste Quantity and Percentage	Waste Handling Method (Collection, Disposal, etc.)	Environmental Impact/Pollution Load of Waste Stream
1.	Raw vegetables and fruits (raw materials)	Receiving	220 ton/year 2-3%	Collection - disposal outside factory	n/a
2.	Fruit drink (final product)		204 ton/year 4.5%	Collection - disposal outside factory	n/a
3.	Jam (final product)		58 ton/year 15%		n/a
4.	Tomato paste (final product)		57 ton/year 11.5%		n/a
5.	Frozen vegetables (final product)		45 ton/year 4.5%		
6.	Cooked beans (final product)		23 ton/year 1.5%		
7.	Tins (raw materials)				
8.	Glass bottles (raw materials)				
9.	Water	Washing activities, uncirculated cooling water			
10.	Steam	Condensate, bare steam pipes, leaky valves and steam traps			

Box 4b
Waste Inventory List for Misr Company for Milk and Food

Item	Waste Type (Liquid, Solid, Air emission)	Waste Generation Source (Process Step)	Waste Quantity and Percentage	Waste Handling Method (Collection, Disposal, etc.)	Environmental Impact/Pollution Load of Waste Stream
1.	Whey (by-product)	Ultrafiltration		Discharge into sewer	

3.6 On-site Verification

On-site verification must then take place to ensure accuracy and completeness of the information collected and the preliminary assessment results.

Box 5
Good Manufacturing Practices (GMPs) Improvements at *Edfina for Preserved Foods* and *Misr Milk and Food*

Factory	GMPs/ Measures	Improve Facilities and Premises	Improve Material or Product Specifications	Improve Receiving, Transportation and Storage	Improve Process and Control	Improve Equipment Design and Maintenance	Train Personnel and Improve Practices	Improve Sanitation and Pest Control
Misr Company for Milk and Food	Low cost housekeeping	☑					☑	☑
	Solid waste collection	☑		☑				☑
	Whey reuse as white cheese brine	☑	☑		☑			☑
	Oil collection and sale	☑		☑				
	Installation of milk valves/controls			☑	☑	☑	☑	
	Modify white cheese making	☑	☑	☑	☑	☑	☑	
	Modify milk flow/refrigeration	☑		☑	☑	☑	☑	
	Water and energy conservation				☑	☑	☑	
	Use clean-in-place systems		☑		☑	☑	☑	☑
EdfinaCompany for Preserved Foods	Upgrade sewerage/drain network	☑						
	Pest control programme	☑						☑
	Ingredient mixing				☑	☑	☑	
	Jam packaging				☑	☑		
	Modify vegetable washing/cooling				☑	☑		
	Modify vegetable paste packaging				☑	☑		
	Add dry sorting at fruit receipt			☑	☑		☑	
	Add bottle rinsing				☑	☑		☑
	Modify product labeling		☑					
	Water and energy conservation				☑	☑	☑	
	Use clean-in-place systems		☑		☑	☑		

STEP 5 - Identification of Improvement Opportunities

After data from the factory audit has been collected and analysed, the Team should brainstorm to evaluate improvement opportunities extensively. Problem areas should be targeted, based on the following:

1. Operating problems;
2. Product quality;
3. Waste generation; and
4. Cost cutting.

This can be achieved by following the sequence described below:

1. Identify Opportunities

The assessment has highlighted improvements in the following main areas:

1.1 Good Manufacturing Practices (GMPs)

Many GMPs can be implemented at low or no cost. Box 5 on page 25 shows the problems encountered and the improvement measures at Edfina Company for Preserved Foods and Misr Company for Milk and Food.

1.2 Waste Reduction

The waste audit has identified waste reduction opportunities. The next step is to determine the waste reduction method or technique to be used. This can be done by using a decision tree to analyse and screen the possible methods for waste reduction. An example of using the decision tree for improving the vegetable paste packaging operations at Edfina Company for Preserved Foods appears in Appendix B.

1.3 Food Quality and Safety

Challenges related to product quality and safety have emphasised the need for a quality assurance technique for process control. HACCP was identified as the system required to prevent the occurrence of problems by ensuring that controls are applied at any point in the food production chain within the factory where hazardous or critical situations could occur. This has solved problems related to:

- Final product quality and safety.
- Traditional quality control procedures and inherent limitations.
- Delegation of responsibilities within the production and QA departments.
- Product recalls.
- Short product shelf life.
- Pressure from international clients to provide evidence of product safety.

1.4. Monitoring Tools and Laboratory Equipment

Difficulties associated with measurements may be found while carrying the different assessment activities and can hinder evaluation of the effectiveness of quality improvements and waste reduction measures.

Traditional factory performance criteria are based on costs, profitability, sales and production levels. Other performance criteria that are not well defined and not as easily monitored are:

- the quality control levels in the different factory operational activities, which are commonly accounted for by conventional testing of final products, and
- the waste loads and their environmental impacts which are usually not measured nor analysed.

It is difficult to control what is not measured. Using traditional quality concepts which rely mostly on periodic process inspections and testing the finished products, are inefficient and are resource intensive. A shift towards developing routine monitoring using various measurement tools has been stressed during the different stages of the project. This has targeted the following improvements:

- Upgrading laboratory facilities.
- Strengthening traditional quality control procedures.
- Identifying and establishing on-line process controls.
- Creating tools to measure environmental performance and waste loads.

2. Evaluate and Prioritise Options

Options for improvement that have been identified should be examined to determine which improvements are feasible. The feasibility analysis prioritises the possibilities for implementation through the following evaluation procedures:

2.1 Technical evaluation

A technical evaluation is necessary to determine whether the proposed solution is likely to work technically and in the specific application. Options that are technically not feasible should be held for later examination. Typical technical evaluation criteria should include the following evaluation procedures:

- Space and layout limitations.
- Technical capabilities of workers.
- Technology availability.
- Time frame for implementation.
- Effect on production rate and/or product quality.
- Safety and health issues.

Options that affect production conditions need careful studying and in some cases it is important to set up small-scale trial runs to check validity and suitability.

2.2 Environmental evaluation

An environmental evaluation addresses the advantages and disadvantages of each opportunity with regard to their effect on the environment. Several environmental considerations should be examined to prioritise the proposed improvements, such as:

- Creation of new waste streams.
- Increase in quantity or pollution loads of current waste streams.
- Environmental impact on the health and safety of the workers.

2.3 Economic evaluation

To evaluate all costs and returns for each opportunity involves several financial issues:

- Total costs and capital investment.

- The costs and resources required.
- Potential benefits particularly cost savings.
- The anticipated payback period.
- Potential production impacts (e.g.. productivity, production capacity, etc.).

Part C of the manual describes in detail the economic evaluation of the measures proposed or implemented at Edfina Company for Preserved Foods and Misr Company for Milk and Food. In addition, it provides an overview of the types of cost and benefit factors that should be examined.

3. The Action Plan

Once the improvements have been targeted, the assessment results of the different options should be summarised in an action plan. An action plan details the outputs of the feasibility study, the methods that will be used and the final status or decision. This may be in the form of a brief report or summary table, concluding:

- The options identified.
- The solutions proposed.
- Results of the assessment and the evaluation of each opportunity, including technical constraints, the economics, and the environmental pros and cons.
- Estimated time for implementation.
- Possible performance or success indicators to be monitored.

The summary action plan can be used for:

- Building top management support.
- Circulation to managers and concerned factory departments for review and comments.
- Funding decisions.
- Developing the QA implementation work-plan.

The action plan should be simple and quickly readable. Box 6 summarises the action plan for Edfina Company for Preserved Foods, in priority order. For detailed economic assessments and cost benefit analyses for both factories, see Part C.

STEP 6 - Develop the Quality Assurance System (GMPs, HACCP and ISO 9000)

Once the opportunities are identified and evaluated, the following key requirements should be addressed by the factory Team:

- Make the final decision to select the opportunities to be implemented.
- Secure funding.
- Plan and design the QA system incorporating all the proposed improvements.
- Develop a time workplan for implementation.

A condensed description of the QA system and methods implemented at Edfina Company for Preserved Foods and Misr Company for Milk and Food follows.

Box 6

Action Plan for Implementing the Improvement Measures at *Edfina for Preserved Foods*

Improvement Opportunity	Proposed Solution	Implementation Assessment				Performance and Monitoring Indicators
		Technical Constraints	Economic Constraints	Financial Savings	Benefits (Quality, Product, Environment)	
Low Cost Measures	Housekeeping	S	L	M-H	M-H/SW, L/WW	Reduction in SW at raw material receiving areas, garage/workshops WW pollution loads (TSS, OFG)
Fruit Jam Packaging	Process Re-design	F	L	H	H/Q, L-M/SW	Reduction in product waste, rejects, or recalls
Vegetable Washing/Cooling	Process Change	-	L	M-H	H/Q, M/P, L-M/WW, L/SW	Reduction in washwaters, product waste and Labour
Vegetable Paste Packaging	Process Change, Automation	T	L	M-H	H/Q, H/P, L-M/SW	Reduction in washwaters, product waste and Labour
Water Consumption	Water Conservation	T	L-M	H	H/P, H/WW	Water flow, WW loads, water bills
Energy Consumption	Energy Conservation	-	L-H	H	M-H/P, L-M/A	Steam consumption, electricity bills, boiler emissions
Pest Control Programme	Facility Upgrade	-	L-M	L-M	H/Q, L-M/SW	Field survey, reduction in product rejects or recalls
Bottle Rinsing in Fruit Drink	Process Addition	-	L	L	H/Q	Product quality and contamination
Raw Materials Receipt	Supplier Assurance	S, T	L-M	M-H	M-H/Q, L-M/P, L-M/SW	Product quality, reduction in SW loads and Labour
Sorting at Fruit Reception	Process Addition	S	L	L	M/Q, L-M/WW	Reduction in washwater pollution loads (BOD, TSS)
Mixing in Fruit Drink	Process Elimination	-	L	L	L/Q, L/WW	Reduction in washwaters, product contamination
Routine Monitoring and Quality Control Testing	Laboratory and Equipment Upgrade	S, T	L-H	L-H	H/Q	Improved control, improved product quality, reduction in QC Labour
Labeling Instructions	Specifications	-	L	-		Consumer attitude and sales
HACCP for Fruit Drink	Process Control	S, F	L-M	H	H/Q, M-H/P, L-M/SW, WW	SW and WW loads, product quality, export sales
Drainage and Sewers	Facility Upgrade	L, P	M-H	L	M/WW	Reduction in sewer WW loads (BOD, TSS)
Ingredient Mixing/Addition	Process Change	-	L-M	L	L-M/Q	Product quality and contamination
Clean In Place (CIP)	Improve Sanitation (Process Change)	S, T, P	H	H	H/Q, M-H/WW	Improved product quality, reduction in Water flow, WW loads, water bills

Notes:

Technical Constraints: **L**ayout/space limitations, **S**taff capabilities, **T**echnology constraints, time **F**rame Constraints, impacts on **P**roduction
Economic Assessment: **L**ow < LE10,000, **M** <LE50,000, **H**igh > LE50,000
Benefits: **H** (>25%), **M** (<25%), **L** (<10%) improvement to product **Q**uality and/or increase in **P**roductivity and/or reduction in **S**olid **W**aste/**W**aste**W**ater /**A**ir

1. Improve Supplier Quality Assurance

At Edfina Company for Preserved Foods the acceptance of fruits and vegetables is done by sampling for sorting and grading. At Misr Company for Milk and Food, acceptance of incoming raw milk is done by testing for fat and solids content. Verification of safety and quality parameters, such as pesticides in fruits and antibiotics in raw milk, could not be achieved by obtaining a supplier certificate. Supplier quality assurance should be achieved through:

- Applying a stringent programme to assess incoming materials for appearance, quality, temperature, pH, water activity and type of packaging. The sources of materials must be clearly known and, if possible, the processing history.
- Obtaining information about the supplier (or manufacturer) quality assurance procedures. Suppliers with a reliable QA System should be favoured. Suppliers with a product produced under a HACCP programme are preferred.
- Strengthening the factory internal quality control laboratory testing to carry out periodical testing of the incoming raw materials to verify satisfactory quality (physical, chemical, and microbial).
- In Misr Company for Milk and Food, milk is received from seven collection centres in areas around Mansoura City. Microbial quality is generally very low (Grade C). The factory prolongs the pasteurisation process beyond the industry standard of 72 15 seconds. This can result in changes in the quality and colour of the milk, and increases the energy use in pasteurisation.
- Baseline monitoring of the milk quality has been performed and samples from individual batches tested for microbial counts, coliforms, titratable acidity, and composition of fat and solids-not-fat (SNF). This has enabled the factory to rank milk supplies in terms of quality and, if necessary, discard collection centres of low quality supply.
- Testing by a specialised external laboratory, for tests that can not be carried out in-house, such as testing for preservatives, pesticides and heavy metals.
- Improper and excessive use of herbicides and pesticides is known to be a problem in some Egyptian crops, as Edfina Company for Preserved Foods has found with its incoming raw fruits and vegetables. The risk is a change in the product quality, i.e. in taste and colour. Detecting the presence of such chemical contaminants is difficult and expensive. Control can best be achieved by educating the growers and farmers, for which the regulatory agencies (i.e. Ministries of Agriculture and Health) are primarily responsible.
- Since incoming batches are usually received from numerous individual traders instead of growers, it was not feasible to acquire a supplier certificate. However, the factory records the geographical source and analyses incoming batches at an external laboratory. A historical database is built, including source and supplier, which can serve as a very important supplier control and assurance tool.
- Samples taken from suppliers may be routinely sent to various specialist agricultural and food laboratories.

2. Develop and Design the Good Manufacturing Practices

2.1 Edfina Company for Preserved Foods

2.1.1 Low Cost Housekeeping Measures

Some housekeeping measures can be applied in the different production units particularly the tomato paste, juice and cooked beans production departments. Measures mainly include:

- Improving fuel oil transfer to reduce spills.

- Improving techniques of loading and unloading raw vegetables and fruits in the receiving area to reduce damage and losses of raw materials.
- Increasing the frequency of cleaning and removal of solid wastes and in-process residues.
- Removal of scrap, barrels and unused objects from pathways and open areas.
- Waste oil should be collected and sold instead of being disposed of in the sewer system.

2.1.2 Upgrade Drainage and Sewers (Facility Upgrade)

The existing drainage and sewer system should be upgraded through:

- The rehabilitation of factory open sewer system.
- The installation of stainless steel screens to cover drainage channels to prevent the passage of fruit peels and other residues. This will reduce the load of suspended solids washed out to the drain, thus reducing the organic load by almost 30% and reducing the wastewater treatment requirements.
- The conversion of open sewers to closed sewer lines, should be applied, wherever possible.

2.1.3 Pest Control Programme (Facility Upgrade)

On-site inspection of areas for the presence of insect and rodent activity revealed a potential for non-microbial contamination from a nearby beehive. The current pest control program was upgraded by installing window screens and insectocuters to control flying insects. Frequent inspection and pest surveys were also initiated. These improvements were required to bring the factory into line with international hygiene specifications.

2.1.4 Ingredient Mixing in Fruit Drink Manufacturing (Process Elimination)

Non-juice dry ingredients such as acids, preservatives, etc. are added to a collection tank and pumped to the mixing tank where it is mixed with the pulp and syrup. Unnecessary process steps should be eliminated to save on processing time and reduce chances of contamination. It is proposed that ingredients be directly added to the mixing tank.

2.1.5 Fruit Jam Packaging (Process/Equipment Re-design)

The loss of product during the packaging of jam in single-use foil pots is high, amounting to approximately 15% of production. An improved design to the trimming and cutting mechanism in the packing machine is introduced to provide higher quality packaging with no physical defects and thus eliminate the potential for leakage and post-process contamination of the jam pots.

2.1.6 Manual Mixing and Addition of Ingredients (Process Re-design)

Wooden tools are sometimes used in the various manual mixing operations. It is proposed that stainless steel mixers are used. Also in pouring operations such as pulp addition for mixing with ingredients in the mixing tank is manual done by emptying from drums using utensils. A special drum loader is recommended.

2.1.7 Vegetable Washing and Cooling (Process Change)

The production of frozen vegetables currently involves a lot of manual handling. The risk to the product through contamination is high, and the loss of leaves is significant, resulting in an increased pollution load in the wastewater stream. This intervention improves the cooling of Molokhia after blanching by installing a special pressurised sprinkler system with screens.

2.1.8 Vegetable Paste Packaging (Process Change)

The blanched and chopped vegetable leaves particularly the Molokhia leaves are packed manually. Handling losses are high, as is the risk of contamination, and has resulted in product and packaging losses. A semi-automatic packaging assemblage made of a dispensing system, pipes and a sealing device has been introduced to eliminate these losses with a target to increase the process productivity and save in packaging time and labour.

2.1.9 Dry Sorting at Fruit Receiving (Process Addition)

Fruits are directly unloaded into a water basin for soaking. It is then manually sorted while being spray washed on a conveyor. It is proposed that fruits are manually dry sorted before being soaked for the following reasons:

- Increase sorting efficiency
- Eliminate the risk of healthy fruits being infected from contaminated fruits during the soaking stage. Contaminated fruits should be discarded as early as possible in the process.

2.1.10 Bottle Rinsing in Fruit Drink Manufacturing (Process Addition)

Sterilised bottles are received from suppliers and occasionally stored in open areas where they are exposed to dirt, dust, pests, etc. It is proposed that bottles are rinsed by water or direct steam before being placed on the conveyor for juice filling.

In fruit drink product rework, bottles are emptied of the fruit drink and reworked by rinsing, soaking and brushing. It is proposed that bottles be sterilised prior to being reused in the filling operations.

2.1.11 Labelling Instructions of Fruit Drink (Product Specifications and Packaging)

There are established labelling regulations and standards of identity of food products. Current instructions printed on pasteurised fruit drink packaging does not clearly state that it is a pasteurised product. Not having such labelling may create confusion to regulatory agencies and consumers.

Not labelling fruit drink products as pasteurised is practically equivalent to labelling them unpasteurised. A pasteurised product is treated by heat to substantially reduce the enzymatic activity and the number of viable micro-organism. In this case the product is considered commercially sterile, in a shelf-stable form and in hermetically sealed containers. Without clear labelling, consumers will not be able to make an informed choice and this could cause concerns, especially those at risk, such as children and the elderly.

Other labelling instructions should be added, such as safe distribution instructions for safe handling, consumer handling instructions and the use tamper evident packaging features.

2.1.12 Water and Energy Conservation

An effective energy conservation programme should applied to reduce electricity and steam losses. The programme includes:

- Boiler tune-up to increase boiler efficiency and reduce fuel consumption.
- Rehabilitation of steam valves to eliminate high amounts of steam leakage.
- Installation of steam traps to optimise steam and condensate system operations.
- Regulation of excess steam use though installation of automatic pressure regulators, regulating steam pressure to jacketed equipment and steriliser tunnels.

- Installation of condensate return system to return the condensate from the tomato pre-cooker and the evaporators to the boiler house.
- Thermal insulation of bare hot water and steam pipe network to prevent heat losses.
- Power factor improvement.

An effective water conservation programme should also be applied to include:

- Installation of hose nozzles.
- Rehabilitation of existing water collection system at the Dow-Pack line.
- Installation of cooling systems for the tomato paste production and the juice bottles steriliser.

A Guidance Manual has been produced which explains in detail the actions required to achieve improved water and energy conservation (see SEAM Guidance Manual Water and Energy Conservation for detailed guidelines and description of the above measures).

2.1.13 Installation of Clean-In-Place System (Technology, Process Change)

The installation of a Clean-in-Place system for closed circuit cleaning and sanitation can result in direct savings on water and chemicals and provide better hygienic procedures for producing high-levels of product safety. The installation of a CIP system requires considerable input to its integration into existing factory conditions and practices and upgrading the cleaning staff capabilities and practices. This measure was discarded due to technical and economic constraints, particularly the high costs involved.

2.2 Misr Company for Milk and Food

2.2.1 Low-Cost Housekeeping Measures

The in-plant housekeeping of the factory units and buildings requires improvement. Factory drainage, sewers and manholes need to be maintained and upgraded to eliminate blockage and overflow problems. In-plant roadways should be paved and signposted to allow for better traffic flow of factory vehicles. Unattended areas may be planted with trees and greened. Overall, improvements to the factory image and cleanliness can be achieved through simple housekeeping measures.

2.2.2 Solid Waste Collection and Sale (Waste Segregation and Out-Process Reuse)

Solid wastes generated by the factory can be segregated and either disposed or sold. Garbage and packaging wastes are trucked daily and disposed of at the city general dump area. Solid wastes such as scrap iron and metal objects are sold in auctions or to special scrap dealers. This action can achieve an efficient removal of wastes from the site and improve the cleanliness of the factory premises.

2.2.3 Whey Reuse (In-Process Recycling/Reuse)

Great quantities of whey are generated as a by-product from the ultra-filtration process in white cheese manufacture. Originally, this was disposed directly to the sewer. The factory now reuses 50% of the whey in the white cheese packaging stage as brine, in place of salted fresh water. Only a pipe diversion was necessary with minimum design requirements or equipment addition to the white cheese department layout.

2.2.4 Used Garage Oil Collection and Sale (Out-Process Reuse)

Oil, grease and lubricants that are generated from the garage and workshops should be collected instead of being disposed of in the sewer. Approximately 0.75 tons of oil can be accumulated monthly and sold to outside workshops and recycled. Other benefits are the reduction in pollution loads and the prevention of serious blockage of sewers and overflow as oil and grease from the garage and workshops effluent mix with other effluent streams from the production units which tend to solidify milk products.

2.2.6 Installation of Milk Level and Flow Controls (Process Control)

Raw milk coming into the factory is transferred directly from the delivery vehicles into the storage tanks. As there were no level gauges or controls on the tanks, overfilling and spillage frequently occurred. Milk storage tanks should be equipped with level sensors and stopcocks to prevent overflow, particularly during the receiving stage. This type of sensor was selected rather than infra-red sensors, as foaming of the milk during transfer can result in inaccurate readings and subsequent overflow.

Leakages of milk from valves throughout the system were common, resulting in milk loss and an increased organic load of the final effluent. The installation of food quality, stainless steel control valves throughout the factory, including the milk receiving, storage and pasteurisation areas, can eliminate considerable milk losses. Additional benefits are reduced pollution loads, the elimination of floor spills, and improved hygiene and safety. 40 valves are required.

9% (2.1 ton/day) milk losses could be saved in the different departments. The receiving and pasteurisation processes being the greatest source of wastage, followed by white cheese and yoghurt manufacturing.

2.2.7 Improve White Cheese Manufacturing (Layout Change and Process Re-design)

The white cheese department has been re-designed according to sanitary design principles to guarantee linear product flow and traffic control, to minimise cross contamination. The improvements have arisen from the product flow and traffic movement analysis of the white cheese production line, during the assessment stage. This intervention required investment in a collection and disposal system for brine, a semi-automated method for the filling of the trays with renneted milk, and improvements to the cutting and packaging of cheese.

2.2.8 Milk Product Flow and Storage (Process Control, Layout and Equipment Change)

The refrigeration room of the pasteurised milk should be relocated from a restricted area to be adjacent to the packaging unit thus preventing handling losses in bulk and packaged milk. The milk storage units and refrigeration rooms were also upgraded to prevent spoilage and loss. This requires investment in a modern refrigeration system with temperature controls.

2.2.9 Water and Energy Conservation

The ratio of air to fuel in the boilers must be optimised to increase the efficiency of the boilers, hence reducing fuel consumption and gas emissions. In addition, restoration of the softening unit of the boiler feedwater can prevent the scaling of the boiler by chemical treatment of the feedwater. Benefits of this measure include reduction of mazot, solar and electricity consumption and can result in a 16% increase in boiler efficiency.

Box 7

Upgrade of Laboratory and Monitoring Equipment and Application at Edfina Company for Preserved Foods and Misr Company for Milk and Food

	Provide or Upgrade	To Achieve (Application)
Misr Milk and Food	Laboratory facilities including enclosure, air conditioning, surfaces and utensils	■ Improved laboratory conditions ■ Increased testing reliability
	On-line process control equipment including: 1. Portable refractometers; 2. Digital pH meters with special food product probes; 3. Hand held digital thermometers.	■ Quick and reliable on-line process controls and checks ■ Less reliance on end-product testing ■ Monitoring tools for HACCP implementation for white cheese production ■ Reduced product losses of pasteurized milk, white cheese, blue cheese, and yogurt.
	Bench scale laboratory equipment including: 1. Lab glassware, media, and multi-scale digital balance for microbiology testing; 2. Digital pH meters; 3. Humidity meters, hygrometers; 4. Food quality and safety regulations and testing methods.	■ Improved laboratory testing methods and efficiency ■ Capability to carry out microbiology tests and reduce dependence on external laboratories ■ Improved control and monitoring of incubation and storage conditions in cheese making.
	Milk Scan with computer interface	■ Efficient, uncomplicated and reliable fast production line testing of fat, protein, lactose and solids in milk and other dairy products ■ Improved quality records and documentation through interface to computer system
	Environmental quality test kit including: 1. BOD incubator 2. COD Hack meter and incubator	■ Measurements of environmental performance ■ Monitoring of processing efficiency and success of waste reduction efforts through food wastes in wastewater discharges ■ Verification of compliance to industrial wastewater discharge regulations
	Computers, software and printers including word-processing, spreadsheet, HACCP programming and printing capabilities	■ Accurate monitoring of processing data, testing results ■ Improved record keeping and reporting ■ Computer tools for ISO, HACCP management control and documentation
	Rapid testing qualitative detection of toxins	■ Improved supplier quality assurance of receiving milk ■ Improved quality control procedures
	Total Dissolve Solids (TDS) test kit	■ Testing of water quality ■ Environmental testing of effluent pollution loads
Edfina for Preserved Foods	Laboratory facilities (including enclosure, air conditioning, surfaces and utensils)	As above
	On-line process control equipment including: 1. Portable refractometers; 2. pH meters; 3. Thermometers; 4. Portable/bench colour meter.	■ Quick and reliable on-line process controls and checks ■ Less reliance on end-product testing ■ Monitoring tools for HACCP implementation for fruit drink ■ Reduced product losses of tomato paste, juice, frozen vegetables and cooked beans
	Turbidity meter	Means to assess and test processing water quality
	Equipment for can quality testing including: 1. Digital coat thickness meter; 2. Can seaming computer projector; 3. Can vacuum gauge for integrity tests.	■ Improved supplier assurance of supplied cans ■ Improved quality of finished canned products and prevent leaks and contamination ■ Reduced losses in canned tomato paste and canned fruit drinks due to defects in seaming and vacuum
	BOD incubator and TDS meters	As above
	Computers, software and printers including word-processing, spreadsheet and HACCP software and printing capabilities	As above
	Muffle furnace	■ Determination of ash content in finished products, heavy metals and other foreign impurities ■ Improved quality control of toxic elements and foreign matters

3. Upgrading Laboratory and Monitoring Equipment

At Edfina Company for Preserved Foods and Misr Company for Milk and Food, a survey was carried out to assess requirements for upgrading the following equipment:

- On-line process controls.
- Quality control laboratory equipment.
- Instruments for environmental monitoring and measurements.
- Record keeping and data analysis tools.

Requirements were identified with details of their intended use. Considerations were given to equipment that are critical for the support of the designated GMPs and can complement the application of an integrated QA/HACCP system. (See Box 7.)

4. ISO 9000 Documentation

SQA and GMPs require a written programme made up of Standards Operating Procedures (SOPs) which will serve as the base for the other components of the QA system particularly the HACCP system. A good written programme includes the who, what, where, why and how of the operating procedures. It clearly explains the scope, responsible individuals, monitoring activities and records.

The QA Team should write the SOPs at a level that is appropriate for the operational conditions of employees and in a language they can understand. The written programme of procedures should clearly set out the record keeping system. This can be achieved using the ISO 9000 Standards.

In food processing, ISO 9001 is often selected if the factory carries out the innovative design of products or services. Otherwise, ISO 9002 should be adopted. The only difference in the standards' requirements is in section 4.4 Design Control. This section is required in ISO 9001 and is not applicable in ISO 9002. Any description or interpretation of ISO 9001 pertains equally to ISO 9002, excluding section 4.4.

If ISO standards are already in place, improvements in the factory have to be incorporated into the existing system and documentation has to be revised to reflect changes in operating procedures, purchasing methods, materials inventory control, etc.

5. Designing the HACCP System

In most factories a quality management plan can be established using Hazard Analysis Critical Control Point techniques to determine potential problems, establish process specifications and ways in which hazards can be controlled. HACCP is discussed in detail in the following sections.

5.1 Objectives

In the past, the food industry has concentrated on the inspection and checking of end products in a traditional Quality Control (QC) System. However, this does not provide a comprehensive management system and is ineffective in ensuring unvarying product quality.

Management of quality will include GMPs through consistent inspection of premises and process reviews, together with the microbiological testing of factory and products. This can be applied in a unified, comprehensive, systematic approach through the use of HACCP:

- To assess the hazards to products and to decide on the control measures to limit the risks.

- To define the responsibilities of the work-force in relation to the control of hazards.
- To improve the efficiency of the production process, reduce wastage and ensure safe and attractive products.
- To provide the procedures and documentation to complement an ISO 9000 approach to quality management.

5.2 Hazards and Critical Control Points (CCPs)

HACCP systems were originally designed to ensure the microbiological safety of food, but the technique is such that it can be applied to other types of problems. In this context, a hazard is any factor that can have a detrimental effect on the food product.

Before developing a HACCP system, hazards must be identified and assessed for their risk factors. Hazards have the potential to cause harm either to: (1) the consumers (safety aspect), (2) the product (quality aspect), or (3) the presentation of the product (commercial aspect). This can be present due to any of the following:

- **Biological contamination** - including presence of pathogens, parasites, etc.
- **Chemical contamination** - including presence of either naturally occurring chemicals such as Mycotoxins or added chemicals such as agricultural and industrial chemicals.
- **Physical contamination** - including glass fixtures, plastics, etc.
- **Quality or commercial faults** - including product compositional faults, packaging faults, etc.

It is essential to distinguish between hazards and risks. Hazards are qualitative while risks are quantitative and indicate the likelihood of a problem occurring. The risk or the probability that a hazard will occur may be ranked as either: (1) high, (2) medium, or (3) low. The degree of concern should be ranked in order to prioritise decisions on the control strategy.

Even when a hazard has been identified and the risk assessed, the date or time when it will occur can not be predicted. It is frequently useful to look for indicators of hazardous conditions that may arise, in order to predict fault conditions and to take action before the problem arises. The most frequently used indicators are:

- Time.
- Temperature.
- Humidity.
- Water activity (a_w).
- Titratable acidity.
- Salt concentration.
- Viscosity.
- Available chlorine.

The above parameters are predominantly used in control and verification procedures, as described in the following sections.

Occurrence of hazards can be affected by a variety of factors. Consideration has to be given to management routines such as shift patterns, working practices, skill levels and training programmes. The design of equipment and layout, maintenance schedules and hygiene routines will all influence the analysis. In summary, normal production methods should be considered but also process interruptions, accidents and abnormal situations, as well as potential abuse by the consumer.

The hazards associated with food processing operations will vary between processes and products. However, the general sources of hazards can be described as:

- **Ingredients** - which are likely to contain **pathogens**. Raw meat, poultry and fish usually embody a variety of enteric pathogens. Spices, sugar, and starch may contain **bacterial spores**. Water may be contaminated by **enteric pathogens** or **spoilage micro-organisms**. **Mycotoxins** may form in grains and nuts. Physical and chemical contaminants may also be present.
- **Processes** - designed to inactivate contaminants can create hazards when they fail, for example in preparation, formulation, heat treatment, storage, etc. The following sections give more detailed information on certain processes that can cause hazards.
- **Mishandling** - of materials or products by the food-handler either within the food establishment or at consumption (i.e. by the consumer). Particular attention should be paid to foods that can support the growth of food-borne pathogens. The food processor must consider the product stability, the intrinsic factors of the product that can inhibit growth of pathogens and the potential consequences of consumer abuse.

Working to GMPs will assure the realisation of most of the above issues. GMPs are considered the foundation for effective HACCP implementation and therefore often described as HACCP Prerequisite Programs. If any portion of GMPs is not adequately controlled, the integrity of a HACCP system cannot be maintained.

Any point identified in the factory work-place, process or product formulation that eliminates or minimises hazards is termed a Critical Control Point (CCP). Failing to implement effective GMPs will result in an increased number of CCPs.

5.3 HACCP Systems

To ensure product quality and safety, HACCP systems provide a systematic, preventative approach to the control of ingredients, processes, the processing environment, packaging and the distribution system.

The HACCP approach is suitable for any size of food business operating anywhere along the food chain. HACCP systems are an essential component of food safety legislation and have become mandatory in Europe and the United States. Any type of food product can benefit from the application of a HACCP system.

HACCP systems determine:

- What are the problems?
- How are they controlled?
- Who is responsible?
- What is the action?
- Where is the action taken?
- How often is it done?
- What are the control limits?
- Who checks that the system is working correctly?

5.4 Why traditional QC methods need to be changed?

Traditional methods based on snap-shot inspection and testing of intermediate and end products have the disadvantage of being reactive in nature. In addition, they are: (1)

statistically unreliable, (2) expensive and resource intensive, (3) not on-spot and only provide historical data, and (4) incapable of identifying faults during process.

On the other hand, the advantages of HACCP are attributed to the system being:

Systematic:	All the potential hazards are identified. Problems are foreseen and forestalled.
Efficient:	It concentrates the control effort at the critical points.
Economical:	Checks are cheap, quick and easily done.
Prompt:	Fast checks allow rapid response when action is needed.
On the spot:	Control is where it is needed and by the operator; not by a remote laboratory.

5.5 How HACCP is Developed Step-by-Step?

A structured approach to the design of a HACCP system considers all the relevant factors, ensuring a systematic development. As part of an overall quality assurance scheme there is a need for commitment from senior management and throughout the work-force.

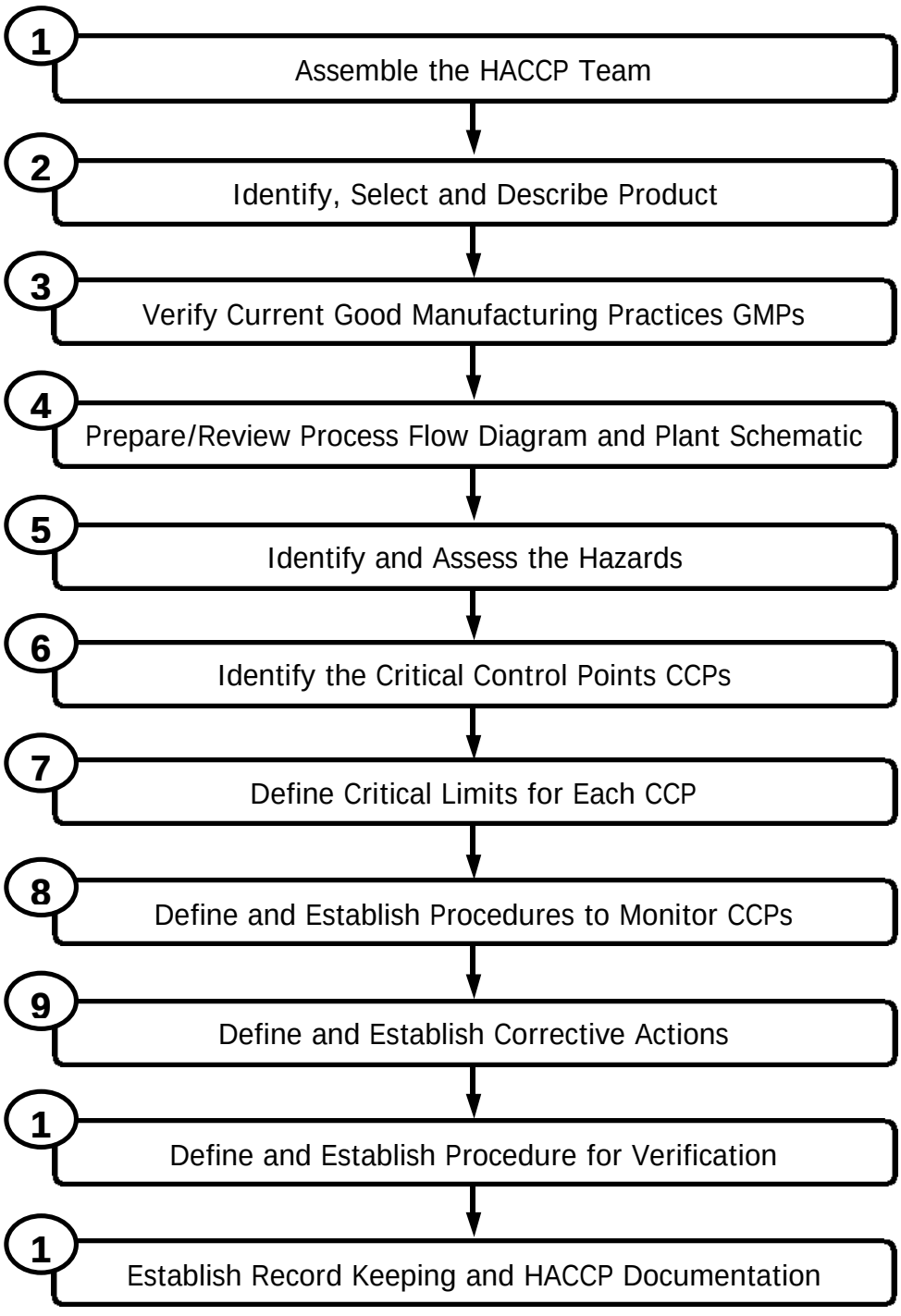
It is not possible to give a prescription for a HACCP system, as every product and production centre needs to be specifically assessed. An 11-step logic sequence, showing the application of HACCP to specific products at Edfina Company for Preserved Foods and Misr Company for Milk and Food, appears in Box 8.

5.5.1 Assemble the HACCP Work Group The HACCP Team

The first step in the application of HACCP is to assemble a group of individuals who have specific knowledge and expertise appropriate to the production lines and processes where HACCP is to be applied. It is the group responsibility to develop the HACCP plan. The HACCP group may require outside expertise of a HACCP expert.

This group should form an integral part of the QA Team and may include additional members such as the food technologist, microbiologist, cleaning specialist, and other group members that might be selected for their specific technical expertise. It is recommended that a coordinator for the group be independently assigned and reports directly to the factory QA Team.

Box 8
Logic Sequence for the Application of HACCP



Different production lines may require different group members to accommodate specific knowledge and expertise appropriate to the product and process. Box 9 is an example of the group composition and responsibilities for HACCP application to the white cheese production line at Misr Company for Milk and Food.

Box 9

White Cheese HACCP Work Group Composition and Responsibilities at Misr Company for Milk and Food

HACCP Group Member	Specific Responsibilities
Quality Control/Assurance Manager	■ HACCP Group leader ■ Coordinator of activities and tasks. ■ Provide the expertise in microbiological, chemical and physical hazards and preventative measures. ■ Set-up sampling plans and initial HACCP studies and carry an assessment of process control data. ■ Co-ordination with QA Team and waste reduction efforts
Production Line Manager/ Supervisor	■ Render detailed knowledge of the day-to-day operational activities and expertise appropriate to the product and process. ■ Define process and production flow diagram. ■ Assist in GMPs development and supervise implementation. ■ Assure efficient HACCP plan execution through preventative measures, corrective and monitoring actions.
Microbiologist	Provide knowledge of microbiological hazards and methods for monitoring and control.
Toxicologist/Chemist	Provide knowledge of chemical and physical hazards and methods for monitoring and control.
Engineering Manager/ Supervisor	Provide a working knowledge of process equipment and capability Implement housekeeping measures, and maintenance of equipment
Laboratory Manager	Provide historical knowledge of product testing and hazards. Analysis of raw materials or products Carry monitoring activities that require sampling or testing
Purchasing Manager	Provide details of supplier activities and supplier auditing procedures
Senior Operators/Workers	Factory level implementation of operating practices, HACCP control and monitoring documentation.
HACCP external expert	■ Evaluate training needs and carry training of HACCP group and production line supervisors and on-line workers. ■ Training of the group on HACCP development and implementation. ■ Verify existing SQA and GMPs. ■ Provide knowledge in the potential hazards associated with the product and the process and verify the completeness of the hazard analysis. ■ Assist in development aspects and provide recommendations for controls and critical limits, monitoring and verification procedures. ■ Verification of HACCP plan and routine auditing of implementation.
Trainer (delegated to the HACCP external consultant)	See above
Sales/Export Manager	■ Advise on client/consumer requirements ■ Inform and familiarise clients particularly in export markets

5.5.2 Identify and Describe the Production Line

There are various production lines at both factories and it is not feasible to consider the application of HACCP to all products at the same time. The HACCP Team should consider the following criteria to select production lines where HACCP application is most strategic:

- **Achievability of implementation,** to yield significant improvements in an acceptable time frame and with minimum obstacles.
- **Reproducibility to other products,** to be applicable to other production lines that are similar or requiring similar system design.
- **Production consistency,** to ensure that the production patterns of the selected product are uniform and not affected by seasonal factors.
- **Benefits of implementation** to be attractive and to yield significant quality improvements and financial savings.
- **Export potential.** Selected product should possess export potential and sale opportunities to markets where HACCP has become mandatory.

Box 10 shows the selection criteria applied at Edfina Company for Preserved Foods and Misr Company for Milk and Food. Pasteurised bottled fruit drink and *Mansoura* packaged white cheese were selected, respectively.

Box 10

HACCP Product Selection at Edfina Company for Preserved Foods and Misr Company for Milk and Food

	Product	Achievability	Reproducibility	Production Constancy	Benefits and Financial Savings	Capital Investment Requirements	Export Potential
Misr Co. for Milk and Food	**White Cheese**	M	**M**	**H**	**M-H**	**L**	**L-M**
	Blue Cheese*	M	**M**	L	L	L	L-M
	Pasteurized Milk	L-M	H	H	H	L-M	L
	Yogurt	M	L-M	H	L	L-M	L
	Ghee	M	L	L-M	L	L	L-M
Edfina Co. for Preserved Foods	Tomato Paste**	M	L-M	M	L-M	L	L
	Fruit Drink	**M-H**	**H**	**H**	**M-H**	**L**	**M**
	Frozen Vegetables	L-M	M	H	H	M	H
	Jam	M	L-M	M	M	L-M	L
	Canned Beans	M	L	H	L-M	L-M	L-M

Notes:

* Blue cheese production is low and highly seasonal (January-March). Pasteurised milk production is associated with difficulties caused by poor incoming milk quality and poor storage of the finished product at distributor outlets. The actual pasteurisation process may be considered part of the white cheese production process. Yogurt is a stable product and the current number of returns to the factory is low. White cheese production has a high value, the process also encompasses many of the other procedures operated at the factory and elsewhere and significant improvements in quality are anticipated.

** Tomato paste production is seasonal. Frozen food production is high, low cost improvements may be implemented but there is need for greater automation of the process to achieve significant benefits. Juice production, particularly mango, has a long season (more than 50% of overall throughput), the process is automated and enjoys a healthy export potential.

Ideally, a factory could target HACCP implementation across all its product range, and there should be a unique HACCP plan for each product. Input from specialists is particularly important at this stage, especially when a new system is being developed. For products under consideration, detailed knowledge is needed of:

- Recipe control, cooking regimes, etc.
- Storage regimes, temperature control, handling
- Preservation, additives, etc.
- Packaging quality and protection.
- Consumer practices and product abuse.
- Different requirements for various consumer groups.

5.5.3 Verification of Current GMPs

The first step is verify the adequacy of the factory operational activities with particular emphasis on GMPs. At this point factory employees should have GMPs in place as part of the operation routine. In all cases GMPs and SQA need to be integrated into the HACCP system, as should aspects related to process control techniques SPC.

5.5.4 Prepare/Review Production Flow Diagram and Plant Schematic

During the assessment stage, all aspects of production should have been defined in a series of flow charts that include a range of operating conditions. These flow charts should be reviewed, taking into consideration the improvements to GMPs and adjusted accordingly.

5.5.5 Identify and Assess the Hazards

The hazard points are identified and the relative risks are assessed and categorised. Hazards are identified through:

- **Brainstorming** by studying types of foods being produced, processes applied, and the habits, training and skills of the food-handling personnel.
- **Factory complaints files** should be studied and the causes of the complaints reviewed with relation to hazard identification.
- **Epidemiological information,** reports from the Ministry of Health on food safety related illnesses, recalls and complaints should be acquired and studied for information on cases of hazard occurrence and causes.
- **Previous performance,** the factory records and logs should be thoroughly reviewed as they can point to hazards that need to be controlled.
- **Published information** from scientific research or food journals for relevant information about specific hazards or food products.

The results of the identification process must be summarised in a specific Reference Database for Hazard Identification that focuses on the product under review (i.e., each HACCP plan will require a specific database). This will provide the HACCP group with up-to-date scientific information and a review of the following:

- The types of actual and potential hazards.
- The nature of the hazards.
- The health and commercial risks.
- The methods of transmission and control.

After the background work has been completed and the hazards identified, each hazard must be analysed. The Hazard Analysis can be a lengthy and complicated process, but the time

spent on this activity can be minimised by using a logic sequence that breaks the analysis procedure into the following key issues:

1. The Raw Materials, Ingredients and Processing Aids

- Assess the recipe for the product being investigated, including all the ingredients and relative proportions.
- Check if raw materials contain susceptible ingredients that are likely to present a hazard.
- Ascertain whether pathogens are likely to be associated with these ingredients, particularly the use of animal origin foods, spices, cereals and foods grown in soil or water.
- Confirm if it is likely that the raw materials will contain any contaminants.
- Appraise the SQA and determine if it can be improved to eliminate or reduce the hazards.

2. The Intrinsic Factors of Foods and Product

- Is it likely that the characteristics and composition of the food during and after processing can cause or prevent a hazard?
- Determine what inherent factors of the food should be examined to ensure prevention and control of hazards.
- Collect samples or carry measurements (water activity a_w, pH, microbial quality, as applicable) for testing product composition and contamination presence
- Ensure that the presence of preservatives inhibits growth of microbes or germination of spores.
- Ascertain the factory experience or safety records for such a product.
- If possible, collect samples for laboratory study purposes. For example, time-temperature simulations can provide valuable information on micro-organisms behaviour and activity in a certain foods or product which could be useful in improving process control and operation.

3. Food Preparation and Processing

- Study each process using the PFD and appraise the operational conditions (e.g., temperature) and times of each process step.
- Determine the operations during which contamination could occur. Attention should be paid to processes that are likely to have an impact on micro-organisms (e.g. heat, acidification, drying, etc.).
- Assess whether it is possible for a hazard to arise as a result of inadequate processing. For example, in cooking time-temperature exposure of food should be reviewed to determine whether pathogens of concern could survive the cooking.
- Ensure that there is a procedure along the production line that can eliminate or reduce the hazards.

4. Facility, Equipment and Utensils

- Review the Product Movement and Traffic Flow Diagram.
- Assess if the layout provide adequate space for traffic patterns.
- Observe potential modes of contamination including cross contamination.

- Ensure that there is enough separation between mobile equipment, stationary equipment and food ingredients to prevent cross contamination.
- Ensure that the processing equipment provides the necessary control to guarantee food safety and hazard elimination (e.g. time-temperature exposure).
- Ensure that the equipment is sufficiently controlled and maintained.

5. Transport, Holding and Storage

- Appraise methods of storing raw, frozen, chilled and dry foods to identify any circumstances that could permit contamination or promote microbial growth.
- Measure the length of time that foods are usually stored and, if possible, the temperatures of the foods during storage.
- Establish the transport and storage conditions that could lead to hazards occurring. Attention should be given to any period during which the foods are within the temperature range that leads to rapid microbial growth (20-50
- Ensure that transport and storage conditions are maintained adequately and consistently to guarantee hazard prevention and safe food.
- Observe whether heat-treated foods are kept at room temperature and the duration, to determine whether pathogenic bacteria could multiply or generate toxins.

6. Sanitation

- Measure the concentration of the cleaning solutions and the contact time.
- Perform swabbing and take contact samples from surfaces.
- Determine whether current sanitation and cleaning practices provide the necessary requirements for food safety.
- Determine whether cleaning and disinfecting procedures are adequate to remove or inactivate pathogens from equipment and utensils.
- Determine what sanitation and cleaning procedures are required to permit safe handling of food.

7. Final Product

- In considering the final product compositional characteristics, determine whether the storage conditions are designed and maintained adequately and consistently to ensure hazard prevention and safe food.
- Does the method of packaging allow the introduction of hazards, and is the packaging resistant to damage and leaks?
- Does the intended use by the consumer present involve any hazards?
- Determine whether changes in packaging (e.g. due to handling or consumer use) can cause a hazard.
- Does the food product present any hazards to certain susceptible consumers (e.g. the very young, sick or elderly)?
- Ascertain that the product is correctly and accurately labelled and coded.

8. Employee Hygiene and Training

- Review the knowledge of personnel regarding the safe handling of foods.
- Ensure that employee hygiene and personal practices do not affect the safety of food.
- Ensure that employees are properly trained on food quality and safety implementation skills.

Once the above key issues have been analysed, the HACCP team members should have an extensive list of documented potential hazards and can proceed to determine critical control points.

5.5.6 Identify the Critical Control Points (CCPs)

Practically any point, step, or procedure in food production is a Quality Control Point (QCP). A CCP, however, is a QCP at which control can be applied and as a result a safety hazard is prevented, eliminated, or reduced to acceptable levels. CCPs must be carefully developed and documented. In addition, they must be used only for the purposes of product safety and not for general quality issues.

A useful method of CCP determination is a step-by-step critique of the QCPs along the product Process Flow Diagram. The CCP Decision Tree shown in Appendix C is helpful in verifying which QCP is truly a CCP. Selection of CCPs mainly depends on the potential hazards and their risk and the operations to which the product is subjected during processing.

Examples of CCPs for various food operations are discussed below.

1. Ingredients and receiving

- The incoming ingredients or foods that are considered raw materials are frequently contaminated. Microbial contamination by bacterial spores in rice, beans, potatoes and vegetables and pathogens present in raw milk is common. If subsequent processes cannot control this hazard (e.g. by cooking of vegetables, pasteurising of milk) then the incoming food must be obtained from a safe supplier or tested for contamination to ensure that it is completely free of hazards (i.e. SQA).
- Receipt of raw fruits and vegetables may be considered a CCP due to the presence of pesticides.
- Water used as an ingredient may be a CCP depending on its source and treatment.

2. Preparation

- **Cutting** or **handling** in vegetables and meat are considered a CCP where hazards from contamination by handler can be reduced but not eliminated.
- If **washing** activities can eliminate or reduce pesticide presence in raw fruits and vegetables then it may be considered a CCP and in such a case **receiving** them would be a QCP instead of a CCP.
- **Formulation** processes can be CCPs if the ingredients added contain contaminants or affect pH or a_w of the formulated food. Certain chemicals (e.g. salt, nitrites, acids) inhibit microbial growth, but if the mixture is not properly blended or concentrated it may be considered a CCP.

3. Processing

- Certain operations may be CCPs, such as **heat-treatment** (i.e. steaming, boiling, cooking, pasteurisation, sterilisation). **Heating** and **cooking** are considered CCPs because they can eliminate or significantly reduce the hazards found in previous receiving or preparation stages. For example, cooking vegetables and heating milk can efficiently inactivate pathogenic micro-organisms. Other examples are the **blanching** of fruits and vegetables, and **retorting** in canning operations.
- Slow or incomplete **drying** of certain products (e.g. milk, eggs, chocolate, meat, fish, cereals) may be a CCP because it permits growth of micro-organisms.

- **Cooling** processes may be a CCP in heat processed foods because bacterial multiplication continues until the product is cold.
- **Fermentation** can be a CCP because specific conditions of temperature and humidity promote multiplication of particular micro-organisms (e.g.. meat products, fish, cheese, yoghurt). If fermentation is delayed, microbial growth may occur with the formation of toxins that can survive subsequent fermentation.
- **Acidification** may be a CCP if the final product pH is sufficiently low (e.g. fish and mayonnaise).

4. Sanitation

- The **cleaning** activities of equipment used in heated food and ready-to-eat food production are considered CCPs. Since the beneficial effects of heat treatment may be nullified by contamination of the treated food, equipment located downstream from the heat treatment process steps are CCPs.
- **Cleaning water** may be critical for the safety of the product and thus its receipt or treatment may be a CCP.
- **Handling** - the handling of processed foods can also be CCPs, particularly in handling activities that follow heat treatment.
- **Packaging** - in packaged food, the packaging material, its treatment or sanitation and handling may be CCPs. Packaging may also be a CCP due to package quality (e.g. milk, eggs, grains).
- **Storage** - **chilling** and **cold storage** are CCPs in various cold-stored products, such as meat, poultry, pasteurised milk and pasteurised milk/poultry. **Freezing** is a CCP in frozen food products (e.g. frozen vegetables, fruits, meat, poultry, fish and shellfish).

Different factories preparing the same type of food product can differ in their processes (PFD), and in the risk of hazards, and they can therefore differ in CCPs. CCPs that appear in the above list are common to other products and can serve as a useful guide to food factories producing similar food.

5.5.7 Define Critical Limits for Each CCP

A practical approach to the control of hazards should be adopted whenever possible. It is essential for the control limits to be defined at this stage. Most hazards will be controlled by simple on-line checks whilst others will require more sophisticated control procedures.

Control limits can be thought of as boundaries for safety that have to be set for preventative measures and can be derived from:

1. The nature of preventative measures.
2. Regulatory standards.
3. Scientific literature.
4. Factory standards and product specifications.
5. Experimental studies.

More than one critical limit can be set to control a hazard, such as temperature, time, physical product dimensions, water activity, moisture content, etc.

Once the critical limits are established, they should be documented together with the description of the process step, CCP number and hazard description, as shown in the above example.

5.5.8 Define Procedures to Monitor CCPs

Monitoring should be conducted as a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control and to produce an accurate record for use in future verification procedures. Monitoring continuously tracks the system operation by establishing on-line controls such as visual inspection and rapid testing. This is accomplished by:

- **Defining monitoring parameters** - which must be quick, rapid, on-line measurements of physical and chemical parameters related to on-line processes, such as temperature and pH.
- **Setting a monitoring interval** - to be reliable enough to indicate that the hazard or CCP is under control.
- **Assigning responsibility** - to delegate employees, preferably ones directly associated with the operation, such as production supervisors or on-line workers, to carry the monitoring procedures.
- **Using monitoring tools** - to be readily available for the designated individuals with instantaneous access and in calibrated conditions. This can be achieved by taking readings from the processing equipment instrumentation and gauges or by using mobile monitors such as portable thermometers and pH meters.
- **Documenting monitoring procedures** - by using operational records and on-line check forms. Documentation should be filled according to the monitoring interval and verified/signed by the responsible employee.

Examples of Critical Control Points and monitoring procedures for Edfina Company for Preserved Foods and Misr Company for Milk and Food are given in Box 11.

5.5.9 Define Corrective Actions

Lack of control at a CCP is defined as being a failing or deviation. Deviations will result in the production of a hazardous or unsafe product. Deviations must be corrected by applying appropriate procedures which are a predetermined and documented set of corrective actions. Corrective actions result from monitoring and are normally accomplished by the employees responsible for monitoring as part of their duties.

Box 11

Examples of Critical Control Points and Monitoring Procedures for Food Processing Operations at Edfina Company for Preserved Foods and Misr Company for Milk and Food

Food	Operation (CCP)	Hazards	Monitoring Procedures
White Cheese Production at Misr Milk and Food	Milk pasteurisation	Survival of spores, pathogens	■ Measure time-temperature exposure ■ Observe indicator thermometer and recording charts ■ Evaluate function of flow diversion valve ■ Check pump speed, and time flow through holding tubes; ■ Check plates for leaks (high-temperature, short-time pasteurization) ■ Collect samples and test for phosphates
	Milk cooling, holding filling (after milk pasteurisation)	Microbial growth if temperature too high or duration of storage too long, cross contamination	■ Inspect cleanliness of equipment ■ Take swabs from contact surfaces ■ Inspect valves ■ Collect samples and test for coliforms ■ Measure temperature of product and time of storage
	Fermentation	Microbial growth if temperature too high or duration of fermentation too long	■ Measure temperature and duration of aging
	Packaging	Contamination during packaging, bacterial growth	■ Observe integrity of package ■ Observe worker practices
	Storage	Microbial growth if temperature too high or storage duration too long	■ Measure temperature of product and time of storage
	Distribution		■ Measure temperature of product and time of storage
Fruit Drink Production at Edfina for Preserved Foods	Receipt of fruits, dry ingredients	Faeces, irrigated with sewage, containing pesticides	■ Set purchase specifications and check for compliance (SQA) ■ Observe practices of pesticide use and fertilisation ■ Observe irrigation practices for sewage content
	Pulp freezing	Microbial growth in thawed pulp	■ Measure time-temperature exposure during freezing; observe whether product is frozen
	Storage, holding of thawed pulp	Bacterial growth, contamination by thaw water	■ Measure temperature of product and time held after thawing
	Drink pasteurisation	Survival of spores, pathogens	■ Measure time-temperature exposure ■ Observe indicator thermometer and recording charts ■ Collect samples and test for contamination
	Packaging	Bacterial growth, contamination by thaw water	■ Observe integrity of package ■ Observe worker practices
	Cool storage	Microbial growth if temperatures too high or duration of storage too long; cross contamination	■ Observe condition of food ■ Measure food and unit temperature ■ Observe storage practices ■ Measure duration of storage ■ Look for potential routes of contamination

In Box 12 examples are given for deviation procedures in fruit drink production and white cheese production at Misr Company for Milk and Food.

Box 12

Examples of Deviation Procedures at Misr Company for Milk and Food

Activity	Deviation Procedures (Corrective Actions)
Raw milk receipt (CCP)	Monitoring procedures performed by the milk receiving operator indicate that antibiotics in incoming raw milk are detected by a rapid screening test. The milk receiver refers to the deviation procedures: ■ Incoming milk to be rejected and held in the delivery truck. ■ Milk receiver notifies the supplier assurance/inspection authority to follow-up with supplier. ■ Corrective actions are recorded.
Milk pasteurisation (CCP)	Monitoring procedures performed by operator indicate that a deviation has occurred before the end of the process time. The operator refers to the written deviation procedures for the corrective actions: ■ Additional processing time must be added. ■ Corrective action is recorded. ■ Release of the affected lots must be authorised by the designated authority.
Cheese cutting and packaging (CCP)	White cheese is being cut into blocks by workers using hand utensils and is manually packed into tubs. Monitoring procedures by the designated foreman/supervisor indicate that worker practices and equipment used are not hygienic and that the cheese may be subject to bacterial contamination. The supervisor refers to the deviation procedures for corrective actions: ■ The Supervisor orders workers to hold all product since the last recorded utensils clean-up. ■ The affected product is stored under hold and samples are taken to the microbiology laboratory. ■ The product is subjected to microbiological testing and is not released until the laboratory results are satisfactory. If results are not satisfactory, affected lots are diverted to mish manufacturing or discarded. ■ The worker(s) responsible is questioned as to the reason for the deviation from the specified cutting and packaging procedure and is retrained as necessary. ■ All corrective actions are recorded.

5.5.10 Define Procedures for Verification

As well as the monitoring controls, there will often be the need for verification activities or confirmatory checks which are methods, procedures and tests used to determine if the HACCP plan for the product is valid and operating as planned.

Verification activities generally involve:

- Microbiological and chemical sampling and testing of end products.
- Observing operations at CCPs, collecting samples and taking measurements to confirm accuracy of monitoring activities.
- Auditing of monitoring procedures and checking records.
- Auditing of deviation procedures and records.
- Interviewing staff about they way they operate and monitor processes and CCPs.

- Carrying factory inspection audits.
- Environmental sampling and tasting of waste streams.
- Review of the HACCP plan in its entirety including PFD, GMPs, SOPs, etc.

Practically, verification activities are the ultimate element of quality assurance. Results from such activities are not intended to confirm the acceptability of batches of products. It is intended to establish confidence in the HACCP plan and should form part of the overall verification of the QA System. This role is likely to be taken by the QA Department.

Verification procedures should be conducted:

- Routinely according to appropriate verification schedules.
- Randomly as spot checks and random sampling and testing.
- To confirm correctness after modifications such as introducing GMPs.
- When consumers or regulatory agencies concerns arise regarding the safety of the product.

In Box 13, examples are given of verification procedures in fruit drink production and white cheese production at Edfina Company for Preserved Foods and Misr Company for Milk and Food, respectively.

Box 13

Examples of Verification Procedures at Edfina Company for Preserved Foods and Misr Company for Milk and Food

Activity	Verification Procedures
	Examples of CCP Monitoring
Validating operations at fruit receiving (CCP)	The acceptability of the fruits is done by visual examination of contamination presence, the verification of the monitoring activity includes: ■ Audit of the supplier contamination-free claim by having fruits analysed at an external laboratory for contamination levels. Done every tenth batch.
Checking milk pasteurisation operations (CCP)	The pasteurisation verification activities are numerous, including: ■ Microbiological testing of the finished product to ensure that the pasteurisation is adequate. Every batch. ■ Check validity and accuracy of the pasteuriser instrumentation and measurements. Done monthly.
Checking operations at cheese cutting and packaging (CCP)	Verification activities of the monitoring procedures done by the supervisor of the cleanliness of equipment and utensils in the packaging area (after milk pasteurisation) can be achieved through: ■ Unexpected audits by the quality assurance staff. Randomly done. ■ Taking swab samples from the product contact surfaces and performing microbiological testing to determine the microbiological cleanliness of the area. Done on weekly basis.
	Examples of HACCP Plan Verifications
Review control procedures	Review of preventative and monitoring procedures and corrective action records to assure compliance with plant. Done by the quality assurance manger or staff every month.
Complete verification	Comprehensive HACCP system verifications. Done on yearly basis by an independent external expert.

5.5.11 Establish Record Keeping and HACCP Documentation

HACCP design and documentation is usually referred to as a HACCP Plan. A HACCP plan has very much in common with ISO 9000. Both are driven from management systems that require active commitment by all factory employees and take a structured approach to controlling key issues related to food quality and safety.

HACCP intrinsically integrates with ISO 9000 systems, and will have a bearing on the way in which food factories comply with many sections of the ISO Standards. Every one of the 20 clauses of ISO 9001 has relevance to HACCP, as shown in Appendix D.

Edfina Company for Preserved Foods has based its Quality Management System (QMS) on ISO 9000. The challenge was how can the factory integrate its operations which are already running under ISO 9000, with a newly developed HACCP plan in one of its production lines.

Appendix D shows how HACCP could be integrated into an existing ISO 9000 and the commonality of approach and similarities between the two systems.

On the other hand, Misr Company for Milk and Food is not operating to an ISO scheme and views its compliance as a goal to be reached within the next 5 years. HACCP introduction into its operations has created a framework for an in-factory QMS that could be further developed and accredited according to ISO 9000.

Generally, the following are examples of documents that can be included in a HACCP plan:

1. A form listing the HACCP Work Group and their assigned responsibilities.
2. A form for product description and intended use.
3. A chart for the Process Flow Diagram.
4. A table for the Hazard Reference Database for Hazard Analysis.
5. Form(s) for the Hazard Analysis of biological, chemical and physical hazards.
6. A form for the Critical Control Points (CCPs) determination.
7. A chart for the Process Flow Diagram indicating CCPs.
8. Form(s) for control procedures and critical limits of hazards.
9. Form(s) for on-line monitoring and record keeping.
10. Form(s) for procedures of verification of the HACCP system.
11. Summary of HACCP plan.

HACCP documentation is discussed in detail in STEP 7 as part of the QA System documentation.

6. Develop Workplan for Implementation

It is important to develop a time frame workplan for implementing the QA System. The purpose is to draw up the different activities within an achievable time scale. This requires effective project management skills and is likely to be the responsibility of the QA Team .

This can be provided in an timetable with the different steps broken down into specific activities.

STEP 7 - Implement the Quality Assurance System

1. QA Documentation - The Quality Management Plan

The quality assurance system must be documented in a Quality Management Plan (QMP). The format of QMPs varies. In many cases the plan will be product or production line specific similar to a HACCP plan. However, an integrated QMP of the factory will be an assortment of all product specific QMPs together with all SOPs which are readily documented using ISO 9000 management systems. Altogether, a factory QMP must cover all factory products, processes, and procedures.

Once in place, the QMP needs to be amended as required to keep it current with changes made in process or products. The maintenance of the QMP is the responsibility of the QA Team Leader/Coordinator. Similarly, the maintenance of the HACCP plan should be the responsibility of the HACCP Work Group Coordinator.

Verification of the QMP needs to be established routinely to check its accuracy and completeness. Also a complete revalidation of the plan should at least be carried annually.

Box 14 provides the contents of the QMP developed for the fruit drink production at Edfina Company for Preserved Foods. This model plan is provided as a tool to assist food industries in developing their own product specific QMP. It is intended as a general guideline and considered not to be all inclusive as the size and attributes of the plan is specific to each factory unique conditions.

Box 14

Table of Contents of the QMP of Pasteurised Bottled Fruit Drink Production at Edfina Company for Preserved Foods

Section 1. Process and Product Information
- 1.1 Product Description
- 1.2 Process Flow Description
- 1.3 Process Flow Diagram
- 1.4 Factory Schematic and Layout
- 1.5 Product Movement and Traffic Flow Plan

Section 2. Good Manufacturing Practices (GMPs)
- 2.1 General GMPs
- 2.2 Factory Specific GMPs

Section 3. HACCP Plan
- 3.1 HACCP Work Group
- 3.1 Hazard Reference Database
- 3.2 Hazard Analysis
- 3.3 Determination of Critical Control Points
- 3.4 Process Flow Diagram with CCPs
- 3.5 HACCP Plan

Section 4. Supporting Information
- 4.1 Standard Operating Procedures
  - 4.1.2 Standard Sanitation Programme
  - 4.1.3 Other
- 4.2 Forms and Checklists
  - 4.2.2 Factory Checklist
  - 4.2.3 QMP Plan/Amendment Sheet
  - 4.2.4 Others

Section 5. Other Documents

2. Implementation and Review

In accordance with the timetable workplan for implementation, the GMPs and HACCP should be initiated. As the implementation process continues, situations may arise which would usually require changes. The plan is revised and adjusted accordingly.

STEP 8 - Monitor Performance

Now that the QA System is operational it is very important to measure the performance against the goals set in the early stages of identifying the QA/waste reduction improvements. By measuring successes and failures, it is possible to reassess and adjust the system.

Indicators that can show the success of the QA system include:

- Improved product quality.
- Improved factory and product image.
- Improved regulatory compliance.
- Improved worker heath, safety and morale.
- Increased sales.
- Reduced raw material and resource consumption.
- Reduced losses and wastes.
- Reduced waste handling, treatment and disposal costs.
- Accreditation by an international body or regulatory agency.

Performance could be effectively measured through:

- Quantitative evaluation of most indicators enables the factory to compare its performance with the rest of the industry. This comparison identifies the pros and cons in the implemented techniques. To be able to carry a correct comparison it is necessary to normalise the quantities/indicators measured (using factors such as units produced, hours of production, etc.).
- Quantitative evaluation of the financial savings achieved can also measure the factory fulfilment of its goals, compared to past performances. This requires a financial analysis of costs and benefits.

Part C explains how to quantify and measure performance and provides a financial analysis of the costs and benefits realised from the application of the improved QA system and the associated waste reduction measures.

STEP 9 - Maintain the Quality Assurance System

Quality assurance does not end with implementation. The task of maintaining a viable QA System can be effectively achieved through:

- Integrating quality assurance and waste reduction into corporate planning and policy.
- Carrying out on-going training and education of employees at all levels.
- Providing incentive programmes for employees.
- Carrying out continuous assessment and verification of the QMP, including GMPs and HACCP.
- Continuing to measure and monitor performance.

Part C

Costs and Benefits

1. **The Cost of Quality and the Cost of Waste**
2. **The Hierarchy of Product Value**
3. **Economic Assessment and Productivity**
4. **Direct Costs and Benefits**
5. **Food Safety and Quality**
6. **Environmental Benefits**

This section gives a qualitative and quantitative analysis of the full range of costs and benefits associated with initiating a quality assurance system and implementing opportunities for waste reduction in food industries.

1. The Cost of Quality and the (Cost of Waste)

In making cost-benefit calculations for quality improvements and waste reduction, many dimensions of cost and benefits are involved. Although food quality and waste reduction appear to be an effectual management decision, it must be supported by sound economic analysis.

Aspects related to quality and waste are not easily addressed using traditional financial analysis methods because:

- Many costs are hidden and complex to quantify.
- Lack of measurements and consistent monitoring systems that effectively track quantities or costs related to quality and waste generation.
- Certain quality and waste types are often overlooked.
- Quality and waste issues incorporate certain areas of cost and relate to several overhead accounts and budget items. As a result, their costs and benefits are not disaggregated but are lumped together with other financial data.
- They entail long term and probabilistic benefits.

To be able to assess the economic feasibility of quality assurance measures, financial factors must be considered which may include:

- **Direct costs.** Costs or revenues directly linked to the process or product could include materials, labour, management costs and resources.
- **In-direct costs.** Costs not directly linked to the process or product, often linked to regulatory compliance activities (i.e. product quality, wastewater discharge standards, etc.) and health and safety issues.
- **Liability costs**. Costs linked to regulatory penalties, non-compliance, discharge fines or damage costs. In the food industry food poisoning claims are common.
- **Less tangible benefits.** Costs associated with image and relationship. These are generally difficult to identify and quantify.

The remainder of this section establishes a cost-benefit analysis built on numerous aspects of quality assurance and waste reduction. Much of the information is drawn from the experience gained at Edfina Company for Preserved Foods and Misr Company for Milk and Food.

(Cost of quality) or costs associated with implementing a quality assurance system can be categorised into three main elements:

- **Preventative costs**. Costs covering the QA preventative activities that are designed to ensure that the different processes and products meet the criteria set with minimum waste in the different inputs.
- Preventative measures should: (1) reduce assessment activities, and (2) eliminate failure or non-conformance measures.
- **Assessment and appraisal costs**. Costs associated with assessing a process and/or a product, including all inspection, testing, approval and audit activities.
- Assessment measures should: (1) show that the process or product is meeting the set criteria of specifications or efficiency, (2) verify if a failure measure is necessary.

- **Failure or non-conformance costs**. Costs incurred due to the failure of the current QA system or one of its activities. Failure measures are carried out to: (1) bring back control into the QA system, (2) make an unacceptable product or process satisfactory, or (3) minimise waste.

  Failure or non-conformance measures are a result of either the preventative measures or the assessment measures, in which case all costs incurred in the prevention, assessment and failure are considered waste.

Table 2 shows examples of the above costs in the food processing industry. The categories have been adapted to focus attention on the many factors associated with waste, including other cost dimensions.

Table 2

Examples of the Cost of Quality in Food Processing Industries

	Preventative Costs	Appraisal Costs	Failure Costs
Direct Costs	■ Costs associated with capital expenditure on buildings and equipment. ■ Costs associated with material improvements (i.e. material substitution) ■ Costs associated with preventative maintenance (i.e. labour, equipment upgrade, etc.) ■ Technology upgrade		■ Rework ■ Waste disposal or treatment ■ In-process waste (i.e. spillage or leaks) ■ Waste in raw materials ■ Waste in product ■ Waste labour ■ Downtime due to machine failure ■ Product recalls ■ Downgraded product sold at reduced price ■ Reduced efficiency of lines if time is spent handling reworked product. ■ Recycling or reuse (i.e. value of recovered materials) ■ Excess use of energy and water ■ Repair costs due to poor maintenance
Indirect Costs	■ Training of employees ■ Costs associated with SQA ■ Audit and inspection activities ■ Documentation and record-keeping ■ Laboratory and Monitoring Equipment ■ Insurance	■ Monitoring and verification procedures (i.e. supervision, lab testing, sampling, record-keeping ■ Costs associated with SQA ■ Product testing ■ Audit and inspection activities	■ Handling customer complaints ■ Costs associated with investigating problems ■ Equipment depreciation
Liability Costs			■ Penalties ■ Fines ■ Law suits and claims
Less Tangible Benefits	■ Increased sales ■ Improved product quality ■ Enhanced company image ■ Improved health and safety ■ Improved relations with supplier and regulatory agencies.		■ Decreased sales and loss of profit ■ Declined product quality ■ Diminished company image ■ Improved health and safety ■ Poor relations with supplier and regulatory agencies.

Failure costs account for the bulk of costs associated with quality. It should be noted that the Cost of Waste or waste generation is categorised under a QA system as a failure cost. Waste recycling is also a failure cost while waste prevention is a preventative cost.

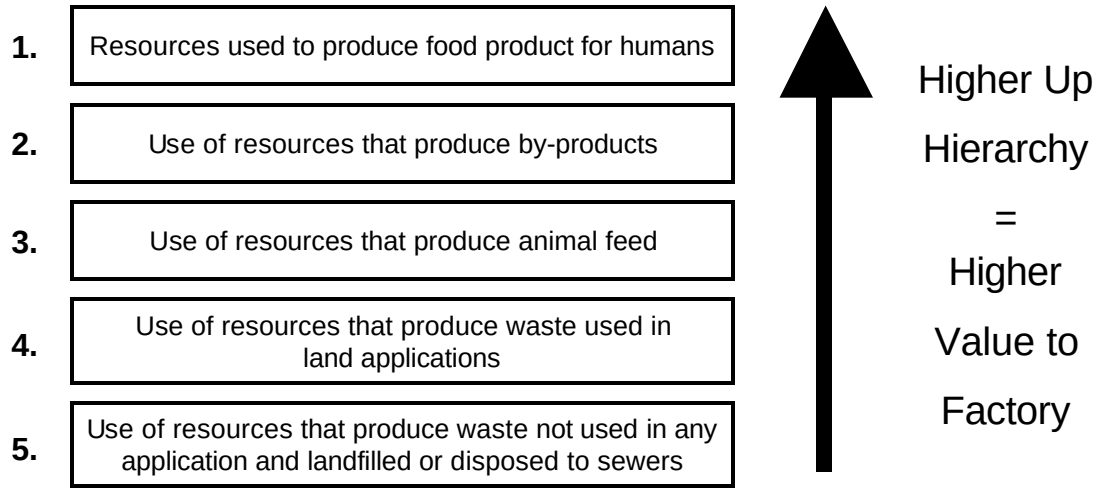
It can be seen that implementing GMPs, SQA, HACCP and other QA instruments signifies a move toward preventative costs and away form failure and appraisal costs. In conclusion, quality assurance will:

- Require investment in preventative costs.
- Reduce failure costs including waste generation.
- Improve the Right First Time (RFT).
- Reduce appraisal costs associated with inspection and product testing activities.

2. The Hierarchy of Product Value

It is recognised that one of the important wastes occurs in materials and products. Figure 4 outlines a hierarchy of value for the various products and by-products that result from factory operations. This hierarchy corresponds to the pollution prevention hierarchy illustrated in Figure 1. Higher up in the hierarchy equates to a higher value of the product or by-product to the plant.

Figure 4
Hierarchy of Value for Food Product*



* Value includes products and materials or resources used to produce such product

3. Economic Assessment and Productivity

When evaluating options for quality improvement or waste reduction, financial tools must be used for economic evaluation and prioritisation. If the option proposed has no direct costs, the decision is relatively simple. Options with direct costs attached will require more detailed analysis.

Financial indicators that can provide a useful mechanism for quantifying the economic feasibility and impacts of adopting proposed options include:

- **Payback period** - measures the time to return the direct costs.

- **Internal Rate of Return (IRR)** - measures the interest rate that produces a return on invested capital equal to th
- **Benefits Cost Ratio** - measures the profitability index which is calculated by dividing the sum of all financial savings by the value of all the costs. A ratio of greater than 1 means the benefits exceed the costs.

Payback period has been used as the main economic indicator in assessing the financial feasibility and benefits of this project.

4. Direct Costs and Benefits

4.1 The Costs and Benefits at Edfina Company for Preserved Foods

A summary of the costs and financial benefits at Edfina Company for Preserved Foods is presented in Box 15.

4.2 The Costs and Benefits at Misr Company for Milk and Food

A summary of the costs and financial benefits at Misr Company for Milk and Food is presented in Box 16.

5. Food Safety and Quality

The main benefits of this project have been to reduce raw material wastage and product rejects through better quality control. Employee training, improved process monitoring and the preventive approach of HACCP have led to greater efficiencies and operational controls, yielding benefits that are better quantified over time.

The application of HACCP will be essential in maintaining and even expanding the export market for Edfina Company for Preserved Foods. Pressures for quality assured products from the United States and European buyers are already evident for the following:

- **Frozen Vegetables ,** for which Edfina Company have exported 2,000 tons to Europe and the United States, valued at LE 7.6 million.
- **Fruit drinks,** for which Edfina Company presently exports 25 tons per year, valued at LE 73,000.

6. Environmental Benefits

HACCP that was implemented for bottled fruit drink production is being replicated by Edfina Company for Preserved Foods in other production lines.

Box 15

Summary of Results of Cost Benefit Analysis at Edfina Company for Preserved Foods

All costs in Egyptian Pounds (LE)

Measure and Cost/Benefit Items	Basis	Before	After	Savings	Benefits
Low cost housekeeping measures:					
design and installation of receiving platform			-(5,000)	-(5,000)	
elimination of raw fruit/vegetable handling losses at receipt	avg. LE3,416/ton	8,201	(8,368)	(570,500)	100% savings in raw materials losses, 2% of total equivalent to 167 ton/year
costs of collection and disposal of raw material waste	LE10/ton	840	(0)	(840)	100% savings on raw material waste collection and disposal costs
costs to collect garage/workshop oil in barrels	LE500/year	0	-(500)	-(500)	
collection and off-site recycling of used garage oil	LE275/ton	0	11,000	11,000	90% off-site recycling of used oil waste (40 ton/year)
Upgrade drainage and sewers:					
rehabilitation and screens installation costs		0	-67,000	-67,000	
collection of by-product waste previously drained	LE5/ton	0	-1,150	-1,150	
waste sold as animal feed or for land application	LE60/ton	0	12,000	12,000	75% off-site recycling of used oil waste (200 ton/year)
Pest Control Programme:					
installation of pest control measures		0	-(22,500)	-22,500	
canned jam production (due to elimination of rejects/recalls)	LE3880/ton	(3,449,320)	(3,518,306)	(68,986)	100% savings in product rejects and 3% increase in productivity (29.3 ton/year)
cost of collection, trucking and disposal of canned jam waste	LE15/ton	(440)	(0)	440	100% savings on reject/recall collection and disposal costs
Fruit Jam Packaging (process redesign):					
redesign and installation costs		(0)	-(18,000)	-18,000	
production (due to elimination of process waste)	LE4,330/ton	1,247,040	1,434,096	187,056	100% (43.2 ton) savings in product waste and 15% increase in productivity
cost of collection, trucking and disposal of jam pots waste	LE15/ton	648	0	648	100% savings on reject/recall collection and disposal costs
maintenance cost due to malfunctioning	LE1,560/season	1,560	0	1,560	100% savings on reject processing costs
Production capacity (due to elimination of maintenance shut down)	22days/season	1,358,000	1,439,480	81,480	80% saving in shut down time increasing capacity by 6% (36ton/season @LE450 net margin)
Vegetable washing/Cooling in frozen foods:					
design and installation of new equipment		0	-(10,750)	-(10,750)	
maintenance of new equipment	6% of investment	0	-645	-645	
production increase (due to elimination of process waste)	LE3880/ton	6,188,600	6,227,400	38,800	100% (10ton) savings in product waste and 1% increase in productivity
washwater used in process	LE1/ton	43,680	32,760	10,920	25% savings in washwater requirements
labour use	LE3,000/man-year	(18,000)	(12,000)	6,000	33% savings in labour requirements
Productivity capacity increase (due to processing time reduction)	LE3880/ton	6,285,600	6,914,160	628,560	10% (1hour/day) reduction in processing time increasing capacity by 162ton/year @LE400 net margin
Vegetable paste packaging:					
design and installation of a semi-automatic dispensing machine		(0)	-(13,950)	-13,950	
maintenance of new equipment	6% of investment	(0)	-(840)	-840	
production increase (due to elimination of process waste)	LE2500/ton	(875,000)	(918,750)	43,750	100% (17.5ton) savings in product waste and 5% increase in productivity
cost of collection, trucking and disposal of paste pouches waste	LE15/ton	(263)	(0)	263	100% savings on reject/recall collection and disposal costs
labour use	LE3,500/man-season	28,000	14,000	14,000	50% savings in labour requirements
productivity capacity increase (due to processing time reduction)	LE2,500/ton	925,000	(1,387,500)	(462,500)	50% (5hour/day) reduction in processing time increasing capacity by 175ton/season at @LE250 net margin

* For cost benefit analysis of water and energy conservation measures see SEAM Guidance Manual "Water and Energy Conservation"

Box 16

Summary of Results of Cost Benefit Analysis at Misr Company for Milk and Food

All costs in Egyptian Pounds (LE)

Measure and Cost/Benefit Items	Basis	Before	After	Savings	Benefits
Solid Waste Collection and Sale:					
daily trucking and transportation of solid waste			(3,000)	(3,000)	
one "off sale" of recyclable metal waste	LE1,000/ton		120,000	120,000	
Used Garage/Workshop Oil Collection and Sale:					
costs to collect garage/workshop oil in barrels	LE500/year		(500)	(500)	
collection and off-site recycling of used garage oil	LE275/ton		2,500	2,500	90% off-site recycling of used oil waste (40 ton/year)
Whey Reuse as Brine in White Cheese Manufacturing:					
savings in brine (water and salt) use	LE2.4/ton	5,280		5,280	50 % (2,200 m ^{3}/year) reduction in brine requirements
Installation of Milk Level and Flow Controls:					
installation of 40 quality valves			(64,000)	(64,000)	
raw milk losses from leaky valves	LE1,000/ton	(308,000)	(123,200)	184,800	60% (185 ton/year) savings in raw milk losses
pasteurised milk losses from leaky valves	LE1,600/ton	620,800	(248,320)	372,480	60% (233 ton/year) savings in pasteurised milk losses
installation of 5 milk tank level controls			(10,250)	(10,250)	
raw milk losses from tank overspills	LE1,000/ton	(127,200)		127,200	100% (127 ton/year) savings in raw milk losses
pasteurised milk losses from tank overspills	LE1,600/ton	(136,320)		136,320	100% (85 ton/year) savings in pasteurised milk losses
wet clean-up and washwater of milk spills	LE1/ton	(6,056)	(1,856)	4,200	70 % (4,200 m ^{3}/year) savings in washwater requirements
pasteurised milk production (before and after elimination of milk losses)	LE1,600/ton	2,880,000	3,379,200	499,200	17% (318 ton) increase in pasteurised milk production (LE62,400 profit @LE200/ton net margin)
white cheese production (before and after elimination of milk losses)	LE6,600/ton	7,920,000	8,521,920	601,920	7.6% (91 ton) increase in white cheese production (LE36,400 profit @LE400/ton net margin)
yogurt production (before and after elimination of milk losses)	LE3,600/ton	3,888,000	4,212,000	324,000	9% (98 ton/year) increase in yogurt production (LE29,400 profit @LE300/ton net margin)
Improve Milk Product Flow and Storage:					
reallocation of the refrigeration room			(6,500)	(6,500)	
upgrade refrigeration system			(20,000)	(20,000)	100% (43.2 ton) savings in product waste and 15% increase in productivity
raw milk handling losses	LE1,000/ton	39,000		39,000	100% (39 ton/year) savings in raw milk handling losses
pasteurised milk production (before and after elimination of milk losses)	LE1,600/ton	2,880,000	2,942,400	62,400	2.2% (39 ton/year) increase in pasteurised milk production (LE7,800 profit @LE200/ton net margin)
wet clean-up and washwater of milk spills	LE1/ton	195		195	100 % (195 m ^{3} /year) savings in washwater requirements
labour use	LE3,000/man-year	(54,000)	(48,000)	6,000	11% savings in labour requirements
Water and Energy Conservation:					
boiler tune up and upgrade and restoration of softening unit			(2,000)	(10,750)	
mazout consumption	LE180/ton	(105,840)	(95,040)	10,800	10% (60 ton/year) savings in mazout requirements
solar consumption	LE0.4/lit	(107,962)	(103,162)	4,800	4.5% (12,000 lit/year) savings in solar requirements
electricity consumption	0.2LE/kWh	(28,800)	(26,245)	2,555	9% (12,775 kWh/year) savings in electricity requirements
steam generation (due to increased boiler efficiency)	LE20/ton	(117,188)	(135,939)	18,750	16% (937 ton) increase in steam generation
Improve White Cheese Manufacturing:					
design and installation of a filling system and cutter			(32,550)	(32,550)	
losses in handling and filling of rennet milk concentrate	LE5,400/ton	(97,200)	(9,072)	88,128	91% (16.3 ton/year) reduction in concentrate milk losses
wet clean-up and washwater of milk concentrate spills	LE1/ton	(190)	(56)	134	70 % (132 m ^{3}/year) savings in washwater requirements
cutting losses (LE5,400/ton) downgraded/sold as Mish (LE3,000/ton)	LE5,400/ton	(10,080)	(2,880)	7,200	66% (3 ton) reduction in cheese cutting losses previously downgraded to Mish (a loss of LE2,400/ton)
cheese wasted due to overweight filling and packaging	LE5,400/ton	(58,320)	(6,480)	51,840	88% (9.6ton/year) reduction in overweight cheese tubs
white cheese production (before and after elimination of dairy losses)	LE6,600/ton	7,920,000	8,110,740	190,740	2% (28.9 ton/year) increase in white cheese production (LE11,560 profit @LE400/ton net margin)
labour use (before and after)	LE3,000/man-year	(78,000)	(71,400)	6,600	8.5% savings in labour requirements

Appendices

A Wastewater Discharge Regulations in Egypt

B Decision Tree for Reducing Waste in Food Production at Edfina Company for Preserved foods

C Example of Decision Tree to Identify Critical Control Points (CCPs)

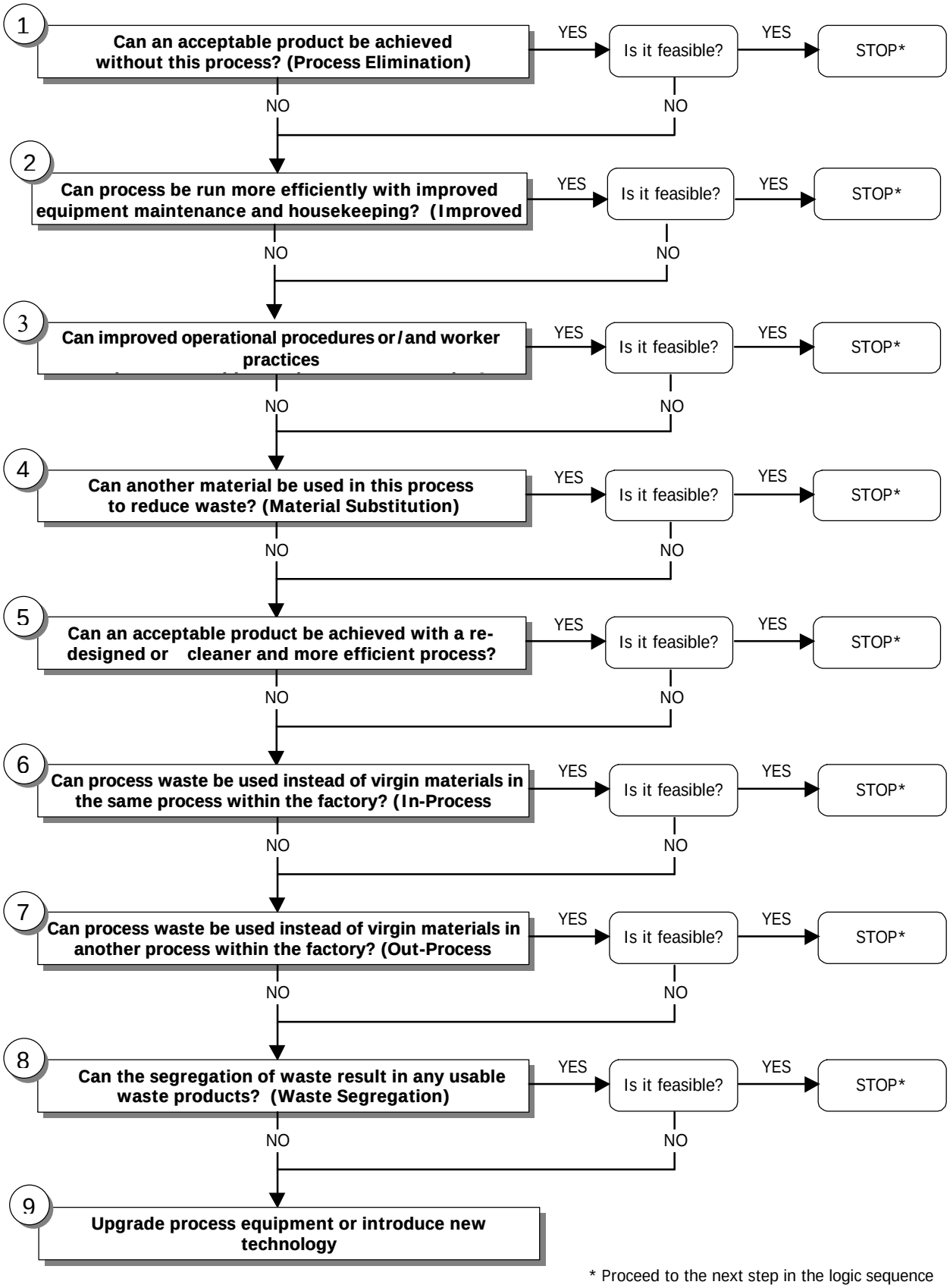
D ISO 9000 and its Application to HACCP Systems the Integrated Approach

Appendix A
Wastewater Discharge Regulations in Egypt

Parameter ppm or mg/L (unless otherwise noted)	Law 4/94: Discharge to Coastal Environment	Law 93/62 Discharge to Sewer System (as modified by Decree 9/89)	Law 48/82			
			Underground Reservoir & Nile Branches/ Canals	Nile (Main Stream)	Non Potable Surface Water	
					Municipal	Industrial
BOD (5 day,20	60	<400	20	30	60	60
COD (Permanganate)	n/a	350	10	15	40	50
COD (Dichromate)	100	<700	30	40	80	100
pH (units)	6-9	6-10	6-9	6-9	6-9	6-9
Oil & Grease	15	<100	5	5	10	10
Temperature ( )	10 C>temp of receiving body	<40	35	35	35	35
TSS Total Suspended Solids	60	<500	30	30	50	60
SS Settable Solids (ml/l)	n/a	n/a	n/a	n/a	n/a	n/a
TDS Total Dissolved Solids	2000	2000	800	1200	2000	2000
PO_4	5	30	1	1	n/a	10
NH_3-N (Ammonia)	3	<100	n/a	n/a	n/a	n/a
NO_3-N (Nitrate)	40	<30	30	30	50	40
Total Recoverable Phenol	1	<0.005	0.001	0.002	n/a	0.005
Fluoride	1	<1	0.05	0.05	n/a	0.5
Sulphide	1	<10	1	1	1	1
Chlorine	n/a	<10	1	1	n/a	n/a
Surfactants	n/a	n/a	0.05	0.05	n/a	n/a
Probable counting for colon group/100 cm^3	5000	n/a	2500	2500	5000	5000
Aluminum	3	n/a	n/a	n/a	n/a	n/a
Arsenic	0.05	n/a	0.05	0.05	n/a	n/a
Barium	2	n/a	n/a	n/a	n/a	n/a
Beryllium	n/a	<10	n/a	n/a	n/a	n/a
Cadmium	0.05	<10	0.01	0.01	n/a	n/a
Chromium	1	Total metals: <10, <50 m^3/d < 5, >50 m^3/d	n/a	n/a	Total concentration for these metals should be <1 for all flow streams	
Chromium Hexavalent	n/a		0.05	0.05		
Copper	1.5		1	1		
Iron	1.5		1	1		
Lead	0.5		0.05	0.05		
Manganese	1		0.5	0.5		
Mercury	0.005	<10	0.001	0.001	n/a	n/a
Nickel	0.1	<10	0.1	0.1	n/a	n/a
Silver	0.1	<10	0.05	0.05	n/a	n/a
Zinc	5	<10	1	1	n/a	n/a
Cyanide	0.1	<0.1	n/a	n/a	n/a	0.1
Total Metals	n/a	Total metals: <10, <50 m^3/d < 5, >50 m^3/d	1	1	1	1
Organic Compounds	0	0	0	0	0	0
Pesticides	0.2	0	0	0	0	0
Colour	None	None	None	None	None	None

n/a = not available

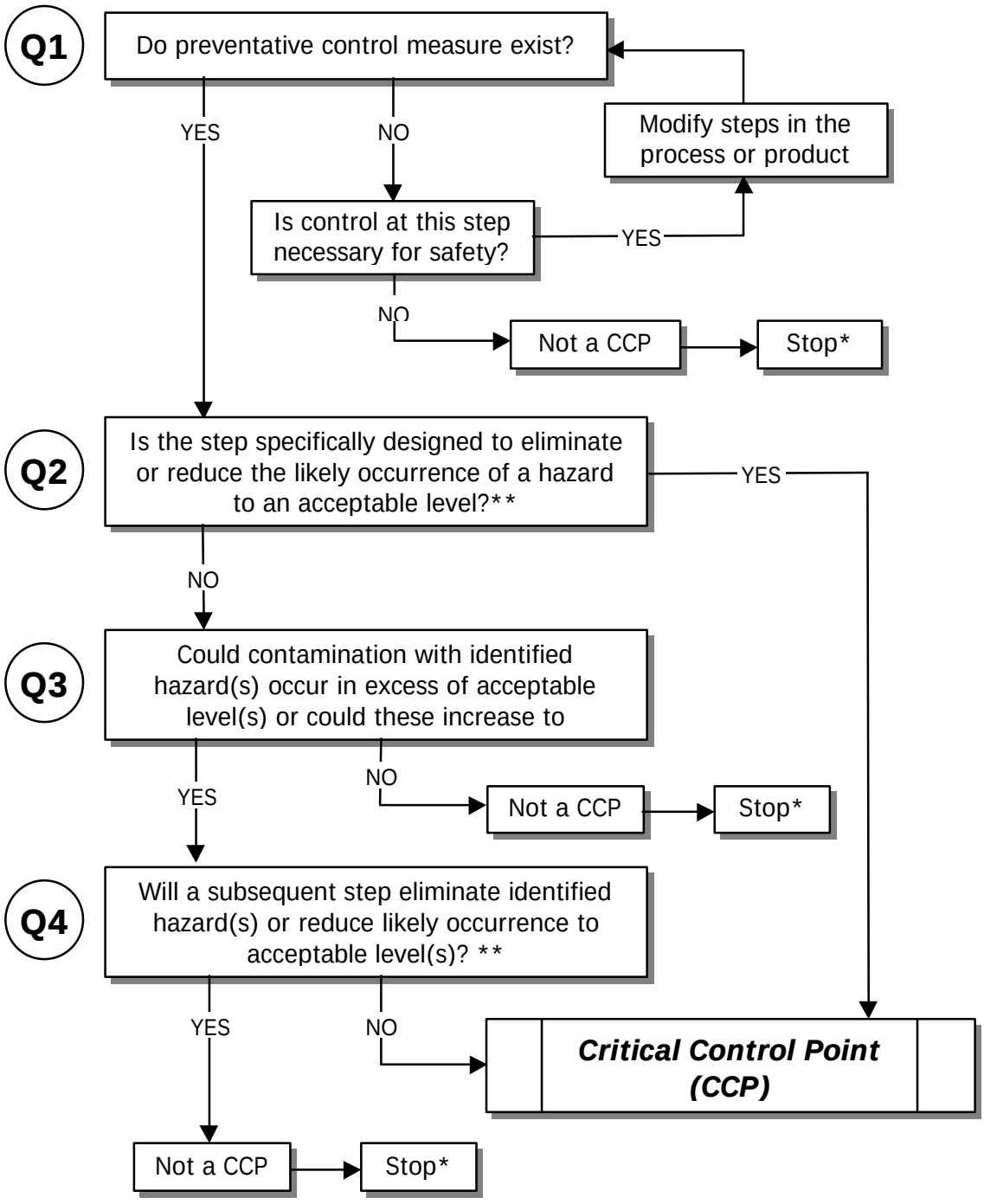
Appendix B
Decision Tree for Reducing Waste in Food Production at Edfina Company for Preserved Foods



* Proceed to the next step in the logic sequence

Appendix C
Example of Decision Tree to Identify CCPs

(answer questions in sequence)



* Proceed to the next identified hazard in the described process

** Acceptable and unacceptable levels need to be determined within the overall objectives in identifying the CCPs of the HAACP plans

Appendix D

ISO 9000

ISO 9001 Clause		HACCP Application
4.1	Management responsibility	■ The quality policy should include specific references to using HACCP in managing food product safety. The policy will demonstrate management commitment to company employees, clients and regulatory agencies. ■ Responsibility and authority within the HACCP System must be defined. ■ Verification of the effectiveness of the System is periodically, at least annually, done by the management. Results of audits, customer complaints, status of training, status of the HACCP System should be discussed within the management's overall responsibilities and duties.
4.2	Quality System	■ A quality product is invariably a safe product. and HACCP itself is a Quality System. ■ This clause specifically considers all activities which could impact on the Quality of the product and ensures that all quality aspects are consistently documented.
4.3	Contract review	■ This is relevant to Supplier Quality Assurance with regard to the relationship between the purchaser (i.e. factory) and the provider (i.e. supplier). ■ All requirements should be clearly specified and the supplier must meet the requirements. ■ Some raw materials may be Critical Control Points and it will be essential to have tight control over their supply.
4.4	Design control	■ The design control clause is included in ISO 9001 and not included in ISO 9002 (i.e. the system that food companies usually apply) ■ The HACCP process ideally starts as early as possible, at the product concept stage (i.e. design of product and processes). Control through a Quality Management System would be beneficial because design control should include a hazard analysis and risk assessment at the concept stage to assure a safe design during processing. ■ HACCP is more oriented to ISO 9002.
4.5	Document control	■ All HACCP documents need to be controlled, reviewed, signed and dated by a designated authorized personnel. ■ Each HACCP document must have a unique reference number for cross referencing with other documents (e.g. log sheets). ■ When changes to the HACCP Plans are made newer issues must be shelved and circulated and obsolete documents must be invalidated. ■ Uncontrolled copies should be avoided and be clearly marked Uncontrolled. ■ Control of artwork and package design should be reviewed, signed and dated.
4.6	Purchasing	■ Purchasing covers everything from raw materials to subcontractors. Everything purchased should be clearly specified through written specifications. ■ Control of suppliers/subcontractors should be through specifications, assessment and records, including equipment servicing/calibration, hygiene and pest control.
4.7	Control of supplied products	■ This applies to ingredients and packaging materials which are supplied for processing into products. ■ It is essential that this is included in the hazard analysis and HACCP assessment and that as much information as is needed is available.

ISO 9001 Clause		HACCP Application
4.8	Product identification and traceability	■ It is fundamental within the HACCP System to be able to trace lots of raw materials or products in the event of a CCP failure. This is essential for control procedures of diversions. ■ A written recall system (i.e. plan) must be maintained in order to minimize the effect of any failure by being able to carry corrective actions including withdrawal of defective product. ■ Also raw materials used without a supplier certificate that ensures that specifications are met should be traceable in order to allow a recall at a later stage if necessary (also see 4.6).
4.9	Process control	■ This is the heart of HACCP. It is essential to include several key control areas in the different factory processes along the production line where HACCP is being applied. Control should be applied in areas such as: ■ Buildings - including all facilities from raw material storage areas, through process and dispatch. ■ Plant and equipment - including process capability, preventative maintenance, hygienic design and cleaning and process layout for cross-contamination risk. ■ Personnel - including training, health screening, hygienic practices. ■ Waste materials - must be clearly identified, segregated and safely disposed. ■ Computer failure - in the case of HACCP control or documentation through computers, contingency plans should be in place to assure control is not lost in case of malfunction. ■ Environmental control - including atmospheric conditions and ground water (particularly if used as process water).
4.10	Inspection and testing	■ Raw materials - that are CCPs should not be used until confirmation of conformance has been received. ■ Finished products - should be held until confirmation that all CCPs have met conformance in full. ■ Records - of all inspection and test results should be reviewed and maintained. ■ Personnel - carrying out testing should be trained and qualified appropriately. Routine assessment and questionnaires may be done for verification.
4.11	Inspection measuring test equipment	■ Effective control of CCPs relies on accurate measurements, test methods and equipment. Monitoring and verification activities at CCPs must be performed using equipment of known accuracy and accurately calibrated on a regular basis. ■ Failure to effectively monitor and verify the activities due to improper calibrated and maintained equipment will peril the effectiveness of the HACCP system. ■ All measuring equipment should be status marked so as to make it clear to all personnel what is calibrated and what is to be used for general guidance only. ■ Equipment must be maintained and stored correctly in-between calibration in order to avoid damage. ■ Records of calibrations should be maintained.
4.12	Control of Inspection and test status	There should be a clearly defined method for identification of the inspection and test status of any raw material, product, or equipment to prevent it from being used inadvertently.

ISO 9001 Clause		HACCP Application
4.13	Control of non conforming product	■ The HACCP control charts will define the responsibility for control procedures to include who will take the corrective action(s) in the event of a deviation, the control measure and what to do with the affected product (i.e. rework, recycle, reject, dispose). ■ Procedures must be developed to ensure that all non-conformities at a CCP are recorded. This will enable trends to be analyzed and for the system to be evaluated and refined. ■ Verification of a non-conforming product that has been brought back into specification must be done through testing again to confirm conformance (also see 4.10).
4.14	Corrective action	■ Control lost at a CCP must be regained by identifying the underlying cause in order for the problem to be permanently resolved and not repeated. ■ The corrective action taken in the event of any problem arising must be the right corrective action. Unidentified hazards may arise if the wrong corrective action is taken. ■ The effectiveness of any corrective action must be verified for confirmation. ■ All corrective actions must be recorded.
4.15	Handling, storage, packaging and delivery	■ The following issues are very important in a HACCP system and may be an important factor in its effectiveness: ■ Improper Handling and storage of a raw materials or product. ■ Contamination risks posed by food contact surfaces. ■ Hygiene and pest control. ■ Use of unsuitable packaging (e.g. unable to withstand distribution). ■ Control of artwork (usage instructions, ingredients and nutritional data). ■ Storage and distribution temperatures. ■ Stock rotation. ■ Shelf-life.
4.16	Quality records	■ HACCP records will need to be retained in a controlled manner. They may form part of a due diligence defense required by a regulatory inspector or a client as demonstration of the effective management of food safety. ■ Quality-related records will form part of the Quality Management Plan which includes product and raw material specifications, the HACCP Plans, process control records including CCP log sheets, Standard Operating Procedures, etc. ■ A Quality Management Plan must be verified annually. ■ Retention time of quality records must reflect both statutory regulations and product shelf-life. Three years as a minimum for those records that demonstrate system management.
4.17	Internal quality audits	■ Process Flow Diagrams must be audited as part of the verification. ■ The HACCP System itself should be regularly audited by members of the HACCP Team in order to assess whether it is working, correct, and applicable. ■ Check lists may form part of the Internal audit. Non-compliance must be documented and corrected, allowing continued improvement of the HACCP System. Verification is important for the sustainability of the HACCP system ■ Auditors must be trained and independent of the department being audited and records of audits must be kept.

ISO 9001 Clause		HACCP Application
4.18	Training	■ Effective HACCP relies on the participation of knowledgeable and trained people across a wide range of disciplines. ■ It is important that future training needs are considered on an ongoing basis as the factory HACCP and food safety management continues to develop. ■ Training issues may include management aspects, system development, emerging food safety issues, new processes and skills or awareness activities. ■ Training documents and manuals should be available for all members of staff and include all types of training.
4.19	Servicing	Equipment may be a source of hazards if not cleaned and maintained correctly. Servicing of equipment must be documented and controlled. This needs to be considered together with the servicing frequency.
4.20	Statistical techniques	■ The construction of the HACCP Control Chart requires sampling regimes at each CCP to be documented. ■ If decisions of conformance are being based upon results of sampling and testing then it must be ensured that schemes are mathematically based i.e. the use of statistical sampling plans. ■ Other relevant statistical techniques include process capability assessment and statistical process control during CCP monitoring.