LAKE VICTORIA ENVIRONMENTAL MANAGEMENT PROGRAMME II
SUB-COMPONENT 2.2: PROMOTION OF CLEANER PRODUCTION TECHNOLOGIES

RESOURCE EFFICIENT AND CLEANER PRODUCTION (RECP) GUIDANCE MANUAL FOR FISH PROCESSING INDUSTRY

2011

PREFACE

The purpose of this Resource Efficient and Cleaner Production Sector Manual guide is to raise awareness of the environmental impacts associated with industrial and manufacturing processes. It also serves to highlight the approaches that industry and government can take to avoid or minimize these impacts by adopting Resource Efficient and Cleaner Production approach.

This guide is designed for two principal audiences.

- People responsible for environmental issues at tea sector (environmental managers or technicians) who seek information on how to improve production. In many countries, managers are ultimately responsible for any environmental harm caused by their organization's activities, irrespective of whether it is caused intentionally or unintentionally.
- Environmental consultants, Cleaner Production practitioners, employees of industry bodies, government officers or private consultants that provide advice to the tea industry on environmental issues.

This guide describes Cleaner Production opportunities for improving resource efficient and preventing the release of contaminants to the environment. The Cleaner Production opportunities described in this guide will help improve production as well as environmental performance.

Chapter 1: Gives an introduction covering mainly background information about the sector and its contribution to the GDP and impacts to the environment.

Chapter 2: Describes Resource Efficiency and Cleaner Production opportunities for each of the unit operations within the process and examples where these have been successfully applied. Quantitative data are provided for the inputs and outputs associated with each unit operation as an indication of the typical levels of resource consumption and waste generation.

Chapter 3: Provides an overview of the industry including process descriptions, environmental impacts and key environmental indicators for the industry.

Chapter 4: Describes the Resource Efficient and Cleaner Production opportunities

Chapter 5: Describes the RECP assessment methodology in detail. This can be used as a reference guide for carrying out a RECP assessment within an organization.

Chapter 6: Provides a case study demonstrating the application Cleaner Production in a factory.

Chapter 7: Describes barriers to RECP and how to overcome them

ACKNOWLEDGEMENT

This manual (self guide) has been jointly developed by the Kenya National Cleaner Production Centre (KNCPC), Uganda Cleaner Production Centre (UCPC) and Cleaner Production Centre of Tanzania (CPCT). This is a step-by-step guide to implementing RECP in a fish processing plant. It is a tool to help managers and staff thinks about RECP in a strategic way by assessing the company's current resource use and waste generation, determining whether there is room for improvement, identifying ways to make the improvements, and then progressively implementing the changes.

The method described in this guide is based on an assessment that involves participation by several staff members in a company. It requires a significant amount of time, resources and commitment from management. Alternatively, the assessment can be undertaken by one or two individuals within an organization, or perhaps by an external consultant. It is a complete assessment, which includes raw materials, energy, water consumption, and waste generation. However, the company has the option of simply focusing on one aspect of RECP such as water or energy use.

EXECUTIVE SUMMARY

This manual has been jointly developed by the Kenya National Cleaner Production Centre (KNCPC), Uganda Cleaner Production Centre (UCPC) and Cleaner Production Centre of Tanzania (CPCT). The development of this Resource Efficient and Cleaner Production (RECP) manual is meant to guide in the implementation of Resource Efficient & Cleaner Production (RECP) in the fish industries. This manual is one of the outputs of the project "*Lake Victoria Environmental Management Program, II LVEMP II*", through Sub component 2.2: Promoting Cleaner Technologies in Industries.

This manual contains an analysis of the industrial production processes, including a description of the entire production cycle, main environmental problems and water, energy and material productivity issues. It provides a Resource Efficiency improvement and pollution reduction opportunities for the sector.

This guide contains the background information about the industry and its environmental issues including, quantitative data on rates of resource consumption and waste generation, where available. It presents opportunities for improving the environmental performance of industries through the application of Resource Efficient and Cleaner Production. Case studies of successful Cleaner Production opportunities are also presented.

Table of Contents

1: INTRODUCTION

1.0 COUNTRY OVERVIEW OF THE FISH INDUSTRY

1.1 KENYA

1.1.1 Background

Agricultural sector is the principal sector in the Kenyan economy accounting for about 24% of the Gross Domestic Product. The sector is the largest contributor of foreign exchange through export earnings. Agriculture also provides employment and livelihood to a large percentage of the population with an estimated 75% of the population depending on the sector either directly or indirectly.

Kenya has a large agro-processing industry, reflecting the importance of the agricultural sector in the Kenyan economy. The majority of the pioneer industries during the colonial period were agro- based. A wide range of agro-industries still exist today, ranging from processing staple foods and fruits, to fish processing for both domestic and foreign markets. Food processing is thus one of the key activities in Kenya's agro-processing industry.

Kenya has a long history of fishing with the Luo, Luhyia, and Abasuba ethnic groups having been active fishermen for more than five centuries. Until 20 years ago nearly all fish caught in Kenyan waters was consumed locally. Kenya started to export fish in the early 1980s, when fish processing factories were established around Lake Victoria. Thus over the past 20 years, the fisheries sub-sector has gradually evolved from a domestic consumption oriented industry to an export oriented industry with value added processing being applied.

Kenya is a coastal state with a marine coastline of 536 Kilometres and a well-developed marine fishing industry. In spite of this, Lake Victoria continues to dominate Kenya's fishing output source. The lake currently accounts for over 90% of the tonnes of fish caught while marine fishing accounts for only 4% of the total output. Kenya claims 6% of Lake Victoria's total surface area, with 43% being owned by Uganda and 51% by Tanzania. Lake wide fish production is estimated at between 400 – 500 metric tons with Tanzania landing 40%, Kenya 35% and Uganda 25%. The landed value of this catch is between USD 300 – 400 million annually.

The fisheries sub-sector provides employment and income to over 500,000 Kenyans engaged in fish production and related enterprises. In terms of contribution to the gross domestic product (GDP), Kenya's fishing industry has accounted for 0.3% of GDP for the period 1999-2003. Kenya's annual average production for the period 1999-2003 was 171,000 metric tonnes with a value of approximately KShs 8 billion in 2003. About 30% of the fish is exported to countries in Europe and other non-European countries.

Fishing in Kenya is mostly carried out by artisanal fishermen operating small fishing boats in inland lakes and marine waters. A small proportion of fish in Kenya is obtained from fish farming (aquaculture). The inland lakes are Lake Victoria, Lake Turkana, Lake Baringo, Lake Naivasha and smaller Lakes including Chala and Jipe. About 92% of fish comes from Lake Victoria and the rest from the Indian Ocean (4%), inland lakes and rivers (3%) and aquatic culture (1%).

Some fish is sold fresh while a significant proportion is processed for later consumption. Artisanal Fish Processors (AFPs) prepare dried and smoked fish mostly for local market, while Industrial Fish Processors (IFPs) freeze or chill fish for export and to a lesser extent, for consumption in Kenya's urban areas.

Table 1: Number of fishermen & fishing vessels in Lake Victoria (Kenya)

Source of information	No. of Fishers	No. of vessels
Fisheries Dept (1971)	11,000	-
FAO (1973)	10,000	4,100
Fisheries Dept (1979)	18,000	4,600
Fisheries Dept (1991)	25,000	7,279
Fisheries Dept (1994)	25,000	7,425
Fisheries Dept (1995)	30,000	8,000
Fisheries Dept (1998)	40,000	15,000

Source: The Macro-economy of The Export Fishing Industry In Lake Victoria (Kenya,) Crispin Bokea &Moses Ikiara April 2000

According to The Lake Victoria Environmental Management Program, the number of total fishers on the lake (from the three East African countries) increased from 129,305 to 175,890, fishing crafts from 42,483 to 52,479, and gillnets from 655,053 to 984,084 between the years 2000 to 2002.

IFPs' have become the industry's driving force. They collect fish from the beaches using refrigerated trucks, buying through intermediary medium and large-scale traders and process them for export. The number of vessels and fishermen in Lake Victoria has been increasing gradually over the last 20 years as shown in table 1 below. As of 1998 when the fisheries department last established the number of vessels in Lake Victoria, there were over 15,000 active boats, 3% of which were motorised while the rest were manually propelled.

A survey carried out by KNCPC in 2010/2011 established that the fish industries in L. Victoria discharge their effluent to the sewer. From the laboratory results, the fish processing industries did not meet the NEMA recommended COD, BOD TN and TP effluent discharge limit values. Effluent BOD and COD discharged to the environment was at the height of 390 mg/litre and 1,450 mg/litre.TN AND TP was also a challenge as no industry was within the discharge limit values. The lowest TN and TP were 4.2 mg/litre and 7.38 mg/litre. High BOD and COD levels in the fish industry are associated with the fats, blood and washing detergents.

Table 2 gives the provisional pollution loading of the effluent from these industries.

Table 2: Pollution loading of the effluent from the fish industries 2010/2011

	BOD (kg/yr)	COD (kg/yr)	TN (kg/yr)	TP(kg/yr)
Fish	125,310	271,430	9649	5367

This baseline survey provides a basis of assessing the progress that will have been achieved after the implementation of Resource Efficient and Cleaner Production (RECP) interventions in *sub-component 2.2 on Promotion of Cleaner Production Technologies* of the LVEMPII.

1.1.2 Fish production and Processing Capacity

Production of fish, which was on a downward trend for 4 years from 1999 to 2002, increased by 15.2%, from 128,227 in 2002 to 147,665 tonnes in 2003. The tonnage of fresh water fish landed increased by 15.2% from 121,366 in 2002 to 139,811 tonnes in 2003. Lake Victoria continued to dominate by contributing 94.8% of all the freshwater fish landed in 2003. Fishing in Lake Baringo is currently banned by the fisheries department as a conservation measure.

Table 3: Quantity of fish landed, 1999 – 2003

	1999	2000	2001	2002	2003
Quantity in Tonnes					
Freshwater fish					
Lake Victoria	200,153	192,738	151,804	114,812	132,561
Lake Turkana	5,239	2,108	3,787	4,004	4,328
Lake Naivasha	449	384	5	95	110
Lake Baringo	406	463	117	0	0
Lake Jipe	101	54	65	78	96
Tana River Dams	1,196	364	232	569	673
Fish Farming	984	967	998	962	1109
Other areas	913	798	802	846	934
TOTAL	**209,441**	**197,876**	**157,810**	**121,366**	**139,811**
Marine fish	4,125	3,779	5,144	5,570	6,289
Crustaceans	881	777	1,033	939	1,164
Other Marine Products	265	207	277	352	401
GRAND TOTAL	**214,712**	**202,639**	**164,261**	**128,227**	**147,665**

Sources: Economic Survey, 2004, Central Bureau of Statistics, Ministry of Planning and National Development

The decline earlier witnessed can be attributed to the banning of trawling in Lake Victoria by the government. The downward trend was reversed due to increases in fish landed in Lake Jipe, Lake Naivasha, Tana River Dams, and Lake Victoria with respective increases of 23.1%, 15.8%, 18.3% and 15.3%.

1.2 TANZANIA

1.2.1 Background

The fishing industry in Tanzania like in many other countries comprises both marine and inland water species whereas Aquaculture contributes a very small portion. The water bodies in general forms 6% of the total area of the country. 85% of the total fish landings is from the inland waters even though Tanzania has 800Km of coastline. It could be expected that marine fisheries would be more productive, however it is less productive due to the narrow continental shelf and lack of upwelling and thus the contribution is less than 20%. Of all the total fish landings, 25 to 30% is Nile Perch which is wildly caught in the famous Lake Victoria. Artisanal fishing is most prominent in Tanzania.

Most of the fish processing factories in Tanzania are located around the Lake Victoria basin since their entire raw material is Nile Perch species. The target end products in these factories include frozen skinless fillets, chilled skinless fillets, frozen skin-on fillets, frozen headed & gutted whole fish and frozen or dried fish maws which are basically exported to the markets of Europe, Far East, Middle East, Australia and America. The resulting by-products consist of fillet trimmings, fish chest and law quality fillets which are either frozen and sold to the neighbouring countries like Democratic Republic of Congo, Kenya, Rwanda and Burundi or locally sold in fresh state. Other by-products are fish frames which are sold to fish meal factories or local people. Even though Tilapia is also greatly caught in Lake Victoria, the Competent Authority does not allow fish factories to process Tilapia for export.

Nile Perch processing industries always stick to fillet processing because the high fat content is a disincentive that makes it difficult to move away from the traditional fillet forms and as a result 80% of the Nile perch landed from Lake Victoria goes to the processing factories.

The sea food / marine industries in the Tanzanian coast depend on marine fish like Prawns, Octopus, Squids, Cattle fish and fin fish and processing may be seasonal.
Fish processing factories are known for producing large amounts of effluent which eventually ends up in the adjacent natural water bodies and may easily interrupt the ecological set up of the water bodies. For this reason, the Tanzanian environmental authorities through the Environmental Management Act have made it a mandate for all fish processing factories to construct effective effluent treatment plants which would purify the effluents before getting discharged into the water bodies. All the nine fish factories around Lake Victoria discharge their waste water into the lake after passing through treatment facilities. These factories also have their own raw water treatment facilities to treat the water they extract from the lake.

Big volumes of water are extracted from the lake for the production of flake ice and block ice, however; production of ice is necessary for preservation of whole fish as it is transported from fish landing sites miles away from the processing plants.

A survey carried out by CPCT in 2010/2011 established that the fish industries in L. Victoria discharge their effluent directly to the lake. Table 4 gives the indicative pollution loading of the effluent from these industries.

Table 4: Pollution loading of the effluent from the fish industries 2010/2011

	BOD (kg/yr)	COD (kg/yr)	TN (kg/yr)	TP(kg/yr)
Fish	375,033	70,887	1,106	1,540

This baseline survey provides a basis of assessing the progress that will have been achieved after the implementation of Resource Efficient and Cleaner Production (RECP) interventions in *sub-component 2.2 on Promotion of Cleaner Production Technologies* of the LVEMPII.

1.3 UGANDA

1.3.1 Background

In 2010, Uganda adopted the National Development Plan (NDP) (2010/11-2014/15). The NDP is the country's medium term strategic direction, development priorities and implementation strategies with a thrust to accelerate socio-economic transformation to achieve the National Vision of a transformed Ugandan society from a peasant to a modern and prosperous country within 30 years. The Plan categorizes agriculture as one of the 8 primary growth sectors i.e. sectors and sub-sectors that directly produce goods and services. Fishery is one of the sub-sectors that constitute the Agricultural sector.

Agriculture has for a long time been a core sector of Uganda's economy in terms of its contribution to GDP and employment. By 2005 it employed 73 per cent of the labour force (UBOS, 2005). In 2008/09, the sector accounted for 23.7 per cent of total GDP. Agricultural exports accounted for 47 per cent of total exports in 2007 while at the same time much of the industrial activity in the country is agro-based. Even though its share in total GDP has been declining, agriculture remains important because it provides the basis for growth in other sectors such as manufacturing and services.

From the foregoing, it is evident that Uganda's economic development is natural resource-based. It is against that background, therefore, that Uganda's development programmes should be able to make use of natural resources gainfully and sustainably to promote competitiveness, while supporting stability and protection of biological and physical systems.
A survey carried out by UCPC in 2010/2011 established that the fish industries in L. Victoria discharge their effluent directly to the lake. Table 5 gives the indicative pollution loading of the effluent from these industries.

Table 5: Pollution loading of the effluent from the fish industries 2010/2011

	BOD (kg/yr)	COD (kg/yr)	TN (kg/yr)	TP(kg/yr)
Fish	68,659	305,481	55	96

This baseline survey provides a basis of assessing the progress that will have been achieved after the implementation of Resource Efficient and Cleaner Production (RECP) interventions in *sub-component 2.2 on Promotion of Cleaner Production Technologies* of the LVEMPII.

1.3.2 Production and Processing

The fisheries sub-sector contributes greatly to the Ugandan economy in terms of income, employment and export revenue. Fish exports are the second largest export earner for Uganda. Fish exports have increased from 4,687 tonnes in 1991 to 31,681 tonnes in 2007. They peaked in 2005 when 39,201 tonnes were exported valued at USD 143 million (UBOS, 2008).

The average growth rate in fish exports is an impressive 48 per cent per year. The growth potential is considered high because of the forward and backward linkages and other multiplier effects over other sectors. The number of people depending on the sector has also increased from 700,000 to over 1.2 million people. This good past performance in fisheries sub-sector is, however, being threatened by declining catches mainly due to the use of destructive fishing methods. Beyond the biological factors, the causes of this decline include use of illegal fishing gears and fishing in breeding areas. Current trends in catches are not likely to sustain the growth rates in demand.

There are two major types of fish sources in the country, namely; fish farming and natural lakes such as Lake Victoria. The commonly reared fish include North African Catfish, Nile tilapia and carp with North African Catfish being the most popular accounting for 60 per cent of Uganda's fish farming. Most of the fish from fish farming are sold fresh at the local level. The major reservoirs catches are dominated by Nile perch, *Lates niloticus* (Lakes Victoria, Kyoga and Albert), Nile tilapia (*Oreochromis niloticus*), and mukene (*Rastreneobola argentea)*. By far the most important species in economic terms is the Nile perch, which contributed some US $ 87 million in exports in 2003. Mukene, on the other hand, is a small, relatively low value pelagic species, which is important to the nutrition of the poor in the domestic market.

Approximately 60% of the fish landed is marketed fresh, while 20% is processed by traditional methods, mainly smoking. Industrial processing is still limited and almost exclusively to fish for export. Twelve processing plants (mainly for export) are active, and three more are to start. The exported products include frozen fillets, chilled fillets, whole frozen fish, frozen gutted and headed fish, and dried fish maws.

From the above, it is evident that fish processing activities concentrate the consumption of a number of resources that include energy in form of electricity, fossil fuels and wood biomass; water and other inputs. The consumption naturally results into the generation of wastes such as noise, odour, emissions, solid waste and effluents. All the above-mentioned wastes if not well managed may negatively impact on the environment. To mitigate the negative effects while enhancing the positive ones Cleaner Production Practices and Techniques should be adopted.

2: RESOURCE EFFICIENT AND CLEANER PRODUCTION (RECP)

2.0 What is Resource Efficient and Cleaner Production (RECP)

Over the years, industrialized nations have progressively taken different approaches to dealing with environmental degradation and pollution problems, by:

- Ignoring the problem;
- Diluting or dispersing the pollution so that its effects are less harmful or apparent;
- Controlling pollution using 'end-of-pipe' treatment;
- Preventing pollution and waste at the source through a 'resource efficient and cleaner production' approach

The gradual progression from 'ignore' through to 'prevent' has culminated in the realization that it is possible to achieve economic savings for industry as well as an improved environment for society. This, essentially, is the goal of Resource Efficient and Cleaner Production.

2.1 Definition of RECP

Resource Efficient and Cleaner Production (RECP) is defined by UNIDO and UNEP as the continuous application of an integrated preventive environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment.

It specifically works to advance the three dimensions of sustainable development in an integrated manner, by catalyzing:

- Production Efficiency through optimization of the productive use of natural resources (materials, energy and water) by enterprises and other organizations;
- Environmental Management through minimization of the impact on environment and nature, by preventing the generation of waste and emissions and improving the use of chemicals in enterprises and other organizations; and
- Human Development through minimization of risks to people and communities from enterprises and other entities and supporting their own development.

2.2 RECP Techniques

Good Housekeeping

Good work practices and techniques such as proper maintenance can produce significant benefits at no or low cost

Process optimization

Resource consumption can be reduced by optimizing existing processes.

Raw material substitution

Environmental problems can be avoided by replacing hazardous materials with more environmentally benign materials.

New Technology

Adopting new technologies can reduce resource consumption and minimize waste generation through improved operating efficiencies. Technological improvements can occur in a number of ways:

- Changing manufacturing processes and technology;
- Changing the nature of process inputs (ingredients, energy sources, recycled water etc.)
- Changing the final product or developing alternative products;
- On-site reuse of wastes and by-products

New product Design

Changing product design can result in benefits throughout the life cycle of the product, including reduced use of hazardous substances reduced waste disposal, reduced energy consumption and more efficient production processes. New product design is a long-term strategy and may require new production equipment and marketing efforts but payback can ultimately be very rewarding

Changing attitudes

It is important to stress that RECP is about attitudinal as well as technological change. In many cases, the most significant RECP benefits can be gained through lateral thinking, without adopting technological solutions. A change in attitude on the part of company directors, managers and employees is crucial to gaining the most from RECP.

2.3 Difference between RECP and Pollution Control

The key difference between pollution control and RECP is one of timing. Pollution control is an after-the-event, 'react and treat' approach, whereas RECP reflects a proactive, 'anticipate and prevent' philosophy. Prevention is always better than cure. This does not mean, however, that 'end-of-pipe' technologies will never be required. By using a RECP philosophy to tackle pollution and waste problems, the dependence on 'end-of-pipe' solutions may be reduced or in some cases, eliminated altogether. RECP can be and has already been applied to raw material extraction, manufacturing, agriculture, fisheries, transportation, tourism, hospitals, energy generation and information systems.

2.4 Why invest in Resource Efficient and Cleaner Production?

Investing in RECP, to prevent pollution and reduce resource consumption is more cost effective than continuing to rely on increasingly expensive 'end-of-pipe'. The initial investment for RECP options and for installing pollution control technologies may be similar, but the ongoing costs of pollution control will generally be greater than for RECP. Furthermore, the RECP options generate savings through reduced costs for raw materials, energy, waste treatment and regulatory compliance.

Greener products

The environmental benefits of RECP can be translated into market opportunities for 'greener' products. Companies that factor environmental considerations into the design stage of a product will be well placed to benefit from the marketing advantages of any future eco-labeling schemes.

Some reasons to invest in Cleaner Production

- Improvements to product and processes;
- Savings on raw materials and energy, thus reducing production costs;
- Increased competitiveness through the use of new and improved technologies;
- Reduced concerns over environmental legislation;
- Reduced liability associated with the treatment, storage and disposal of hazardous wastes;
- Improved health, safety and morale of employees;
- Improved company image;
- Reduced costs of end-of-pipe solutions

2.5 Cleaner Production and Sustainable Development

In the past, companies have often introduced processes without considering their environmental impact. They have argued that a trade-off is required between economic growth and the environment, and that some level of pollution must be accepted if reasonable rates of economic growth are to be achieved. This argument is no longer valid, and the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in June 1992, established new goals for the world community that advocate environmentally sustainable development.

Economy and environment go hand in hand

RECP can contribute to sustainable development, as endorsed by Agenda 21. RECP can reduce or eliminate the need to trade off environmental protection against economic growth, occupational safety against productivity and consumer safety against competition in international markets.

Setting goals across a range of sustainability issues leads to 'win–win' situations that benefit everyone. RECP is such a 'win–win strategy: it protects the environment, the consumer and the worker while also improving industrial efficiency, profitability and competitiveness.

RECP can provide advantages for all countries

RECP can be especially beneficial to developing countries and those undergoing economic transition. It provides industries in these countries with an opportunity to 'leapfrog' those more established industries elsewhere that are saddled with costly pollution control.

2.6 Cleaner Production and Quality and Safety

Food safety and food quality are very important aspects of the food industry. While food safety has always been an important concern for the industry, it has received even greater attention over the past decade due to larger scales of production, more automated production processes and more stringent consumer expectations. A stronger emphasis is also being placed on quality due to the need for companies to be more efficient in an increasingly competitive industry. In relation to food safety, Hazard Analysis Critical Control Point (HACCP) has become a widely use tool for managing food safety throughout the world. It is an approach based on preventing microbiological, chemical and physical hazards in food production processes by anticipating and preventing problems, rather than relying on inspection of the finished product. Similarly, quality systems such as Total Quality Management (TQM) are based on a systematic and holistic approach to production processes and aim to improve product quality while lowering costs. RECP should operate in partnership with quality and safety systems and should never be allowed to compromise them. As well, quality, safety and RECP systems can work synergistically to identify areas for improvement in all three areas.

2.8 RECP and Environmental Management Systems

Environmental issues are complex, numerous and continually evolving, and an *ad hoc* approach to solving environmental problems is no longer appropriate. Companies are therefore adopting a more systematic approach to environmental management, sometimes through a formalized environmental management system (EMS). RECP helps companies to implement EMS effectively and provides a company with a decision-making structure and strategy in managing the day-to-day operations.

3: OVERVIEW OF FISH PROCESSING

The fish processing industry is widespread and quite varied in terms of types of operation, scales of production and outputs. The end products from fish processing may be fresh, frozen or marinated fillets, canned fish, fish meal, fish oil or fish protein products.

Lake Victoria and connected waterways are home to about 200 fish species of which three – the Nile perch, Nile tilapia and the 'dagaa' (*Restrineobola argentea*) account for over 95% of the 800,000 tonnes catch that the Lake Victoria Fisheries Organisation estimates is taken from the lake each year. Nile perch are the most valuable catch with around 75% being exported to Europe, the US and Middle East.

Nile tilapia and dagaa are caught for sale to the local market and regional fish markets. Dagaa are small sardine-like fish, most of which are dried and sold either for human consumption or for animal feed.

It is not possible to cover all aspects of fish processing in this guide. Instead its focus is on the filleting of white fish and the production of fish meal and oil (Figure 1).The production of fish meal has been included in this guide because, in terms of volume, it is a major product and has significant environmental impacts.

The guide is mainly concerned with the processing of fish at on-shore processing facilities and does not cover at-lake operations specifically.

The following is a general flow diagram for fish processing:

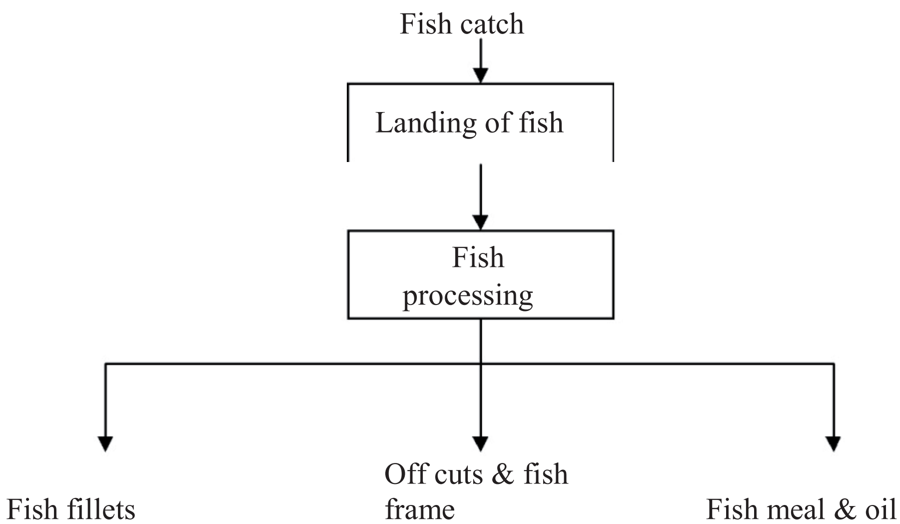


Figure 1: **a general flow diagram for fish processing**

3.1 Fish Processing Methods

3.1.1 Filleting of white fish

Filleting involves a number of unit operations: pretreatment, fish filleting, trimming of fillets, packing and storage. These processes generally take place within separate departments of the fish processing. On arrival at plant fish may be re-iced and placed in chilled storage until required for further processing. Below is a brief discussion of the various stages involved:

Pretreatment

Pretreatment of the fish involves the removal of ice, washing, grading according to size and de-heading, if this has not been done previously. Large fish may also scaled be before further processing.

Filleting

The next step in the process is filleting, which is generally done manually. The filleting department is generally separated from the pretreatment area by a wall, to prevent workers and goods passing from the non-sterile pretreatment area to the sterile filleting area. Some fish fillets may also be skinned at this stage.

Trimming

In the trimming department, pin bones are removed and operators inspect the fillets, removing defects and any parts that are of inferior quality. Offcuts are collected and minced. Depending on the final product, the fillets may be cut into portions according to weight or divided into parts such as loin, tail and belly flap. As a final step before packaging, the fillets are inspected to ensure they meet product standard.

Packaging/storage

Fresh products are packaged in boxes with ice, the ice being separated from the products by a layer of plastic. Frozen products can be packed in a number of ways. Fillets or pieces can be individually frozen and wrapped in plastic, but the most common method is for them to be packed as 6–11 kg blocks in waxed cartons. The blocks are typically frozen and then kept in cold storage.

The steps involved in filleting white fish are summarized in Figure 2

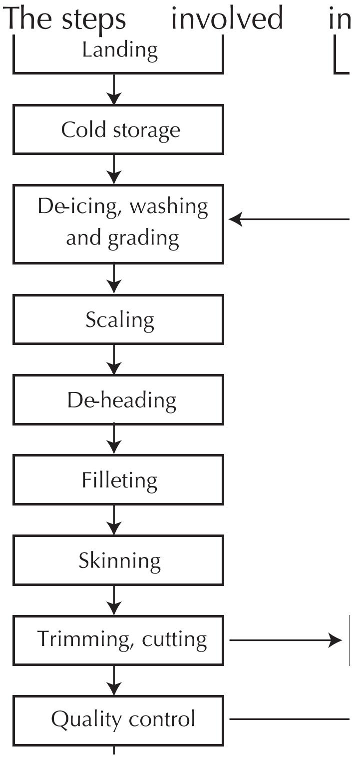


Figure 2 Process flow diagram for the filleting of white fish

3.2 ENVIRONMENTAL IMPACTS

As for many other food processing operations, the main environmental impacts associated with fish processing activities are the high consumption of water, consumption of energy and the discharge of effluent with a high organic content. Noise, odour and solid wastes may also be concerns for some plants.

A characteristic of fish that has a bearing on the waste loads generated, is its highly perishable nature compared with other food products. If not properly refrigerated it spoils rapidly, the flesh becomes soft and loose, and pieces are easily lost. As the quality of the fish deteriorates over time, product yield decreases and product losses contribute to the waste loads. These losses often find their way into the effluent stream.

Fish processing plants often have little direct control over the handling of the fish catch before it arrives at the plant, except where the fishing vessels are owned by the processing company. In this case, the processor can set quality standards and expect certain handling practices.

Water consumption

Fish filleting processes consume very large quantities of fresh water. Water is used for transporting fish and offal around the plant in flume systems, for cleaning plant and equipment, for washing raw materials and product, and for de-icing and thawing.

For fish meal production, water is typically used for cooling and condensing air from the evaporators and scrubbers, and comparatively minor quantities of fresh water are used for producing steam and for cleaning.

Energy consumption

Energy is used for operating machinery, producing ice, heating, cooling, and drying. As well as depleting fossil fuel resources, the consumption of energy also produces air pollution and greenhouse gas emissions, which have been linked to global warming.

Production of fish meal requires significant amounts of energy for drying and evaporation. This energy is usually generated by the combustion of fuels on site.

Effluent discharge

Effluent streams generated from fish processing contain high loads of organic matter due to the presence of oils, proteins and suspended solids. They can also contain high levels of phosphates and nitrates.

Sources of effluent from fish processing include the handling and storage of raw fish prior to processing, fluming of fish and product around the plant, defrosting, gutting, scaling, portioning and filleting of fish and the washing of fish products. For operations where skinning is carried out, the effluent can have a high pH due to the presence of caustic.

Effluent quality is highly dependent upon the type of fish being processed. Pollution loads generated from the processing of oily fish species are much higher than from white fish species, due to the high oil content and the fact that these species are usually not gutted or cleaned on the fishing vessel. The entrails from the gutting of oily fish contain high levels of easily soluble substances, which generally find their way to the effluent stream.

Effluent quality also depends on the type of processing undertaken. For example, additional pollution loads arise from the pickling of fish. Brine is used in this process, the wastewaters from which contain salts and acids, making them difficult to treat.

If the effluent streams described above are discharged without treatment into water bodies, the pollutants they contain can cause eutrophication and oxygen depletion. In addition, fish processing industries have been known to pollute nearby beaches and shores by releasing wastewater containing oils. Since oil floats on water, it can end up on the surrounding coastline.

Refrigerants

For operations that use refrigeration systems based on chlorofluorocarbons (CFCs), the fugitive loss of CFCs to the atmosphere is an important environmental consideration, since CFCs are recognised to be a cause of ozone depletion. For such operations, the replacement of CFC-based systems with non- or reduced-CFC systems is thus an important issue.

Odour

Odour generation can be an important environmental issue. The main causes are the storage and handling of putrescible waste materials, and odorous emissions during the cooking and drying processes used in the production of fish meal

3.3 ENVIRONMENTAL INDICATORS

Environmental indicators are important for assessing Cleaner Production opportunities and for comparing the environmental performance of one fish processing operation with that of another. They provide an indication of resource consumption and waste generation per unit of production.

The consumption of resources and the generation of wastes can vary considerably from one plant to the next. Variations are most obvious when different fish species are being processed. Variations also result from the type of equipment used, the extent of processing and the attention paid to optimising resource consumption.

For the fish processing industry, indicators can be represented either as per tonne of raw material (RM) or per tonne of finished product (FP). The latter takes into consideration the yield of the fish species being processed, but it is often more convenient to calculate the figures per tonne of raw material. Equipment manufacturers often give consumption indicators per tonne of raw material or per hour.

This section contains input and output for each of the processes covered in this guide. The figures are representative of average technology. Also provided are indications of the resource input and waste generation figures that could be achieved by adopting best available technology (BAT).

Filleting white fish

Figure 3 below shows the process for filleting white fish including approximate figures for quantities of inputs and outputs.

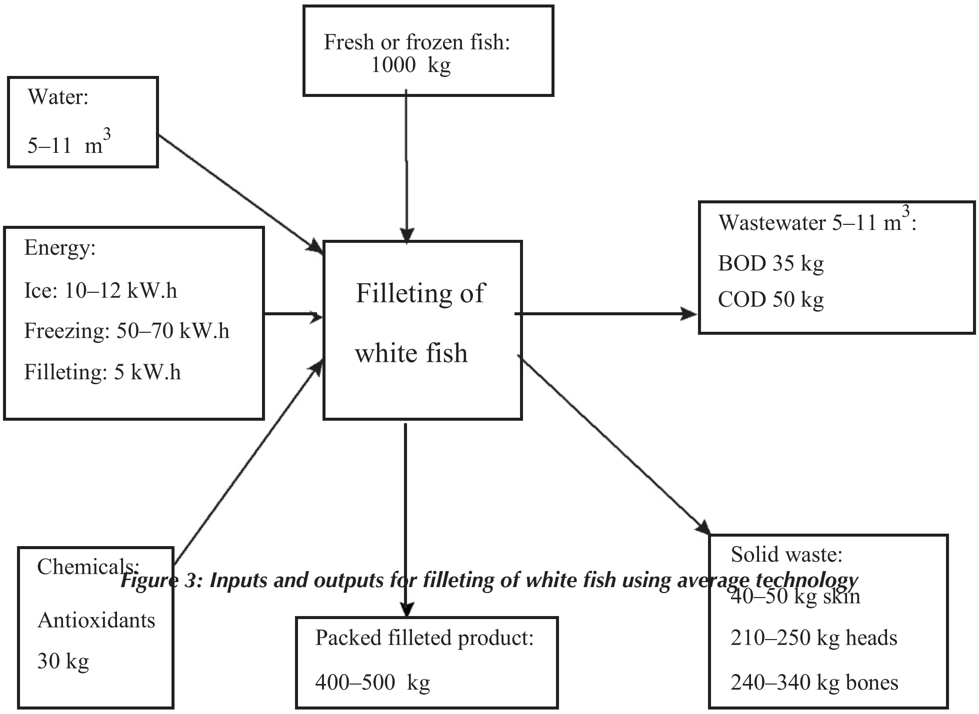


Figure 3: Inputs and outputs for filleting of white fish using average technology

By adopting best available technology, the following rates of resource consumption and waste outputs could be achieved:

- Water consumption and wastewater generation could be reduced to 1.2–4.4 m^3 per tonne of raw material.
- Organic loads in the effluent could be reduced to about 12 kg BOD or 17 kg COD per tonne of raw material.
- Energy consumption could also be reduced, especially if the equipment and rooms for freezing were to be improved.

Product yields would also increase, resulting in a decreased rate of solid waste generation

4: RESOURCE EFFICIENT AND CLEANER PRODUCTION OPPORTUNITIES IN FISH PROCESSING

4.0 GENERAL HOUSEKEEPING OPPORTUNITIES

Fish processing typically consumes large quantities of water and energy and discharges significant quantities of organic material, both as effluent and as solid waste. However, there is very little use of hazardous substances. For this reason, Cleaner Production opportunities described in this guide focus on reducing the consumption of resources, increasing yields and reducing the volume and organic load of effluent discharges.

Although many processes in the industry can be automated, it is difficult to automate the handling of fish and fillets because of the slippery surfaces, variations in size and delicate nature of the product. Therefore, operators generally direct fish and fish products manually through the process. This means that operator practices have a significant impact on the plant performance, particularly in small-scale, less automated operations. As a result, many of the Cleaner Production opportunities described in this section relate to good housekeeping practices, work procedures, maintenance regimes and resource handling.

Section 4.1 provides examples of general Cleaner Production opportunities that apply across the entire process, whereas Sections 4.2 onwards present opportunities that relate specifically to individual unit operations within the process. For each unit operation, a detailed process description is provided along with Cleaner Production opportunities specific to that activity. Where available, quantitative data for the inputs and outputs applicable to each unit operation are also provided.

Many food processors who undertake Cleaner Production projects find that significant environmental improvement and cost savings can be derived from simple modification to housekeeping procedures and maintenance programs

4.1 RECP IN USAGE OF UTILITIES

4.1.1 Water consumption

Water is used extensively in fish processing, so water saving measures are very common Cleaner Production opportunities in this industry. Water is used not only for fish cleaning, but also to flush offal and blood from equipment and floors, and to flume the offal to floor drains and collection sumps. Automated processing equipment generally has permanently installed water sprays to keep the equipment clean and to flush offal away.

The first step in reducing water consumption is to analyse water use patterns carefully, by installing water meters and regularly recording water consumption. Water consumption data should be collected during production hours, especially during periods of cleaning. Some data should also be collected outside normal working hours to identify leaks and other areas of unnecessary wastage. Water consumption data should be presented and discussed at management meetings to formulate strategies for improved water efficiency. Discussion could include whether water needs to be used at all in some processes; for example, could transport systems avoid the use of water?

The next step is to undertake a survey of all process area and ancillary operations to identify wasteful practices. Examples might be hoses left running when not in use, water sprays on process lines operating when no processing is taking place, the continual running of water used for thawing, and so on. Installing automatic shut-off equipment, such as sensors, solenoid valves, timers and thermostats, could prevent such wasteful practices. Automatic control of water use is preferable to relying on operators to manually turn water off.

Once wasteful practices have been addressed, water use for essential process functions can be investigated. It can be difficult to establish the minimum consumption rate necessary to maintain process operations and food hygiene standards. The optimum rate can be determined only by investigating each process in detail and undertaking trials. Such investigations should be carried out collaboratively by production managers, food quality and safety representatives and operations staff. When an optimum usage rate been agreed upon, measures should be taken to set the supply at the specified rate and remove manual control.

Once water use for essential operations has been optimised, water reuse can be considered. Wastewaters that are only slightly contaminated could be used in other areas. For example, wastewater from fish thawing could be used for offal fluming or for initial cleaning steps in dirty areas. Wastewater reuse should not compromise product quality and hygiene, and reuse systems should be carefully installed so that reused wastewater lines cannot be mistaken for fresh water lines, and each case should be approved by the food safety officer.

4.1.2 Effluent

Cleaner Production efforts in relation to effluent generation should focus on reducing the pollutant load of the effluent. The volume of effluent generated is also an important issue. However this aspect is linked closely to water consumption, therefore efforts to reduce water consumption will also result in reduced effluent generation. Opportunities for reducing water consumption are discussed above

Opportunities for reducing the pollutant load of fish processing effluent principally focus on avoiding the loss of raw materials and products to the effluent stream. This means capturing materials before they enter drains and using dry cleaning methods. Therefore, improvements to cleaning practices are an area where the most gains can be made.

4.1.3 Energy

Fish processing uses electricity to operate machinery, lighting, air compressors and cold storage facilities. Thermal energy in the form of steam and hot water is used for cooking, cleaning and sanitising.

Energy is often an area where substantial savings can be made almost immediately with no capital investment. Significant reductions in energy consumption are possible through improved housekeeping and optimisation of existing processes, and additional savings can be made through the use of more energy-efficient equipment and heat recovery systems.

In addition to reducing a plant's demand for energy, there are opportunities for using more environmentally benign sources of energy. Opportunities include replacing fuel oil or coal with cleaner fuels, such as natural gas, purchasing electricity produced from renewable sources, or co-generation of electricity and heat on site. For some plants it may also be feasible to recover methane from the anaerobic digestion of high-strength effluent streams to supplement fuel supplies.

4.1.4 By-products

An important waste reduction strategy for the industry is the recovery of marketable by-products from fish wastes.

Potential uses for fish residue and offal are also being sold to farmers as animal feed. Other fish wastes can be used for fish or pig meal, as well as fertiliser components.

To allow for the efficient collection and utilisation of these by-products, transportation of fish residues and offal without the use of water is very important. Filtering conveyors can be installed under process equipment, or vacuum systems can be used to transport offal directly to storage containers. In plants dominated by manual operations, bins can be provided in suitable locations to collect the offal instead of letting it drop to the floor.

4.2 RECP OPPORTUNITIES IN FISH PROCESSING

4.2.1 FISH FILLETING

i) De-icing, washing and grading

The processes described in this section relate to the preparation of fish for filleting. Boxes of fish containing ice and water are emptied into a de-icer tank, in which the contents are stirred to make the fish sink to the bottom and the ice float to the surface. The ice is then skimmed off the surface, assisted by an overflow system.

In a well-functioning operation, fish are graded according to size and weight to optimise yield in subsequent processing steps.

Figure 4 is a flow diagram showing the inputs and outputs for this process and Tables 6 and 7 provide data for the key inputs and outputs for de-icing and washing fish and for grading fish respectively.

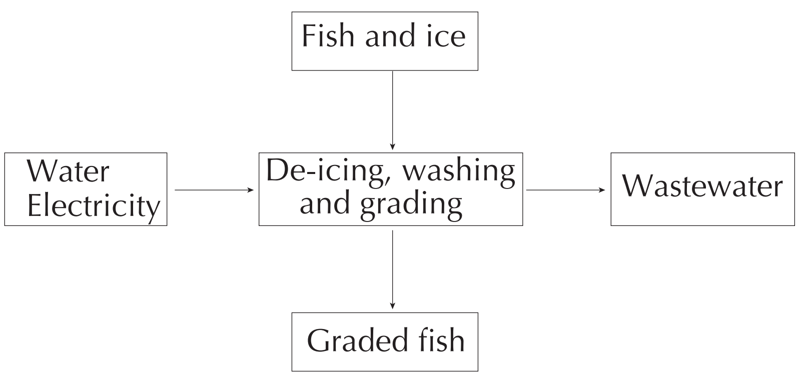


Figure 4 Inputs and outputs for de-icing, washing and grading

Table 6: Input and output data for de-icing and washing

Inputs		Outputs	
Ice and fish	1000 kg	Fish	980–1000 kg
Water	1 m^3	Wastewater	1 m^3
Electricity	0.8–1.2 kW.h	COD	0.7–4.9 kg
		Solid waste	0–20 kg

Table 7: Input and output data for grading fish

Inputs		Outputs	
Fish	1000 kg	Graded fish	980–1000 kg
Water	0.3–0.4 m^3	Wastewater	0.3–0.4 m^3
Electricity	0.1–0.3 kW.h	COD	0.4–1.7 kg
		Solid waste	0–20 kg

Water is supplied to the de-icer tank to compensate for the water that overflows from the tank. The rate of water consumption is about 1 m3 per tonne of fish, but depends on the capacity of the machine. The rate of water consumption for this is about 0.3–0.4 m3 per tonne of fish. Environmental issues arising from this process comprises mainly wastewater discharged from these processes containing minor amounts of organic matter, the quantity of which depends on fish quality.

Cleaner Production opportunities

Reducing the amount of water that overflows from the de-icing tanks can save water. When the de-icer tanks are topped up, the supply should be shut off when the level is approximately 100 mm below the overflow, to accommodate the water level rise that occurs when the ice melts. The water can be shut off manually, but a level-actuated solenoid valve on the fresh water supply is a more effective means of controlling water use. Using an automated shut-off system could save about 1 m3/t RM. The ice/water mixture overflowing from the de-icer tanks may be used for other processes that require chilled water (e.g. Scaling operations).

Case Study: Water savings on de-icer

In a fish filleting plant, it was calculated that water use at the de- icing equipment could be reduced by 80% through improved housekeeping and installation of a level-actuated switch to control water feed. Water savings can be 120 m^3 per day, resulting in a payback time of less than one week

ii) De-scaling

Process description

Scaling is done manually onto which water is applied to flush scales away. If the fillets are to be skinned, it is normally not necessary to scale the fish.

Inputs and outputs

Figure 5 is a flow diagram showing the inputs and outputs from this process and Table 3–8 provides data for the key inputs and outputs.

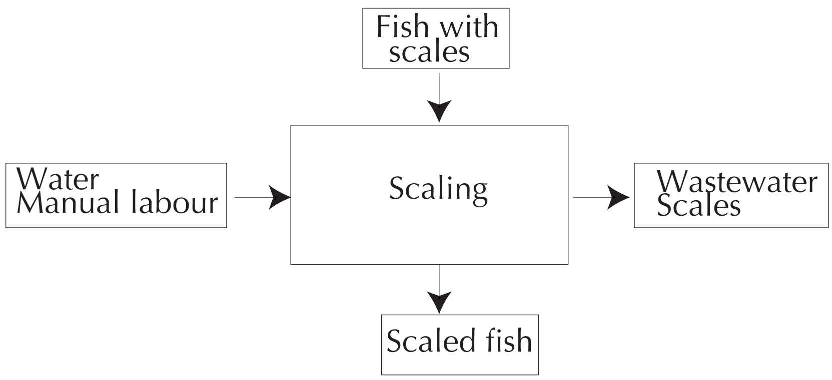


Figure 5 Inputs and outputs for de-scaling

Table 8: Input and output data for the scaling of white fish

Inputs		Outputs	
Fish with scales	1000 kg	Scaled fish	960–980 kg
Water	10–15 m^3 [1]	Wastewater	10–15 m^3
Electricity	0.1–0.3 kW.h	Scales	20–40 kg

Water consumed by scaling equipment is typically around 20–30 m^3 per hour. This equates to 10–15 m^3 per tonne of fish, based on 2 tonnes of fish per hour.

Like most steps in the process, de-scaling has environmental issues. It contributes to the overall water consumption and to the organic load of the effluent stream. In addition, the de-scaling process can influence material losses in subsequent processing steps, due to the harsh nature of this treatment.

Cleaner Production opportunities

The necessity for de-scaling should be assessed on a fish-by-fish basis, bearing in mind that de-scaling is not required if the fish is to be skinned. If de-scaling can be avoided, water savings will be in the order of 10–15 m^3 per tonne fish, with no need for capital investment.

Wastewater from the de-scaling operation can be filtered and recirculated, but the fish must be rinsed with fresh water after the process

iii) Cutting of fillets

The filleting process for white fish differs slightly from that for oily fish. White fish have generally been gutted and cleaned beforehand, so that the filleting processes involve only the removal of the fillet flesh. Fish are manually filleted using knives to cut the fillets from the bone and cut off the collar bones followed by de-skinning.

Figure 6 shows the inputs and outputs from the filleting of white. Table 9 provides data for the key inputs and outputs for white.

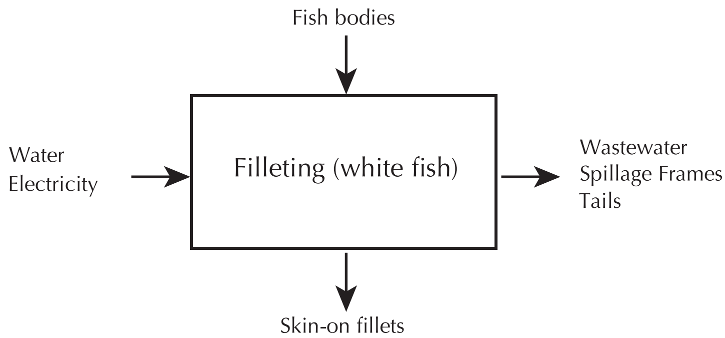


Figure 6 Inputs and outputs for filleting white fish

Table 9: Input and output data for filleting of de-headed white fish

Inputs		Outputs	
Fish bodies	1000 kg	Skin-on fillets	700–810 kg
Water	1–3 m^3	Wastewater	1–3 m^3
Electricity	1.8 kW.h	COD	4–12 kg
		Waste (frames and offcuts)	200–300 kg

The filleting of fish, when done either by hand or by machine, consumes large amounts of water for rinsing the fish and for cleaning knives and equipment. Often continuous rinsing is required to keep work areas free of fish remains. Filleting has environmental issues: water used for cleaning and rinsing subsequently becomes wastewater, carrying with it fish scraps and entrails. Solids that fall to the floor are also washed to the nearest drain with water. The COD for wastewater generated from the filleting of white fish is typically 2000–6000 mg/L

Cleaner Production opportunities

There are various ways of reducing the amount of water consumed in the filleting process. Spray nozzles can be replaced with smaller or more efficient ones, and water pressure can be reduced Sprays can be operated intermittently (e.g. 3 seconds on, 3 seconds off), instead of constantly. In some places, water use can be eliminated by using manual scrapers for removing the build-up of solids on the filleting machines. Solenoid valves should be used to stop water flow when the machines are not in operation.. The capital investments for these water saving ideas are all quite low and the water used for filleting can be reduced by 50–90%. For the highest possible product yields, knives must be correctly aligned and kept sharp. This can be achieved by appropriate operator training, for which capital investment is low. Stainless steel catch trays placed around the filleting machines can capture solid material that falls from the machines. When filleting is done by hand, most solid wastes end up on the floor and spills occur when offal is transferred to storage containers or onto conveyor belts. Chutes can be installed to capture offal from the filleting tables. These measures can considerably reduce the organic matter discharged in the effluent stream when work areas and floors are cleaned. The fish frames that remain after filleting can be sold as secondary product to the fish meal industry.

Case Study: Water savings on a filleting machine

A filleting plant installed nozzles on three filleting machines and a simple switch that stopped water when the operator was not at the machine. The investment was only about US$100 and saved 34 m^3 of water was saved per day. The resulting payback period was less than a week.

iv) Skinning

Process description

In manual processing, the fillets are skinned with a knife at the same work station as the filleting. For automated operations, white fish are

Inputs and outputs

Figure 7 is a flow diagram showing the inputs and outputs from this process. Tables below provide data for the key inputs and outputs for white

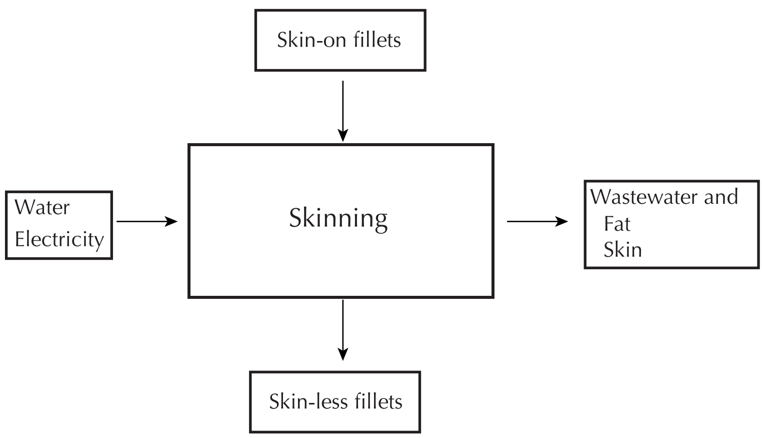


Figure 7 Inputs and outputs for skinning

Table 10: Input and output data for skinning white fish

Inputs		Outputs	
Skin-on fillets	1000 kg	Skinless fillets	930–950 kg
Water	0.2–0.6 m^3	Wastewater	0.2–0.6 m^3
Electricity	0.4–0.9 kW.h	COD	1.7–5.0 kg

	Waste (skin)	~40 kg

The skinning of white fish can contribute significantly to the pollution load of effluent generated from the plant, especially if the quality of the fish is poor. Soft fillets tend to get caught in the skinning equipment and are torn to pieces, reducing yield and increasing waste. The skinning process contributes about one-third of the overall COD load in the effluent stream

Cleaner Production opportunities

An important way of reducing the loss of flesh during the skinning operation is to improve the quality of the fish received into the plant, through proper handling from the moment the fish are caught. Secondly, maintenance of machinery & equipment such as knives is important to ensure that the To save water, the number of spray nozzles on the equipment or the size of the nozzles can be reduced. These measures can reduce water consumption by 75%. Additional savings can result by operating the sprays intermittently instead of constantly. The organic load (COD) of the resulting wastewater can also be reduced by 5–10%. For all of the above options, the capital investment is low.

A vacuum system can be used as an alternative to water for removing the skin, fat and flesh pieces from the skinner drum. This will almost eliminate the water consumption from the process. However the high capital cost of such equipment must be considered.

4.2.2 Trimming and cutting Process description

Trimming and cutting are undertaken to remove bones and defects from the fillets and to portion the fillets into smaller pieces. These are often manual processes, although they can be automated. Any remaining bones are removed, and fins, blood, discoloration and belly membrane materials are cut away. The offcuts from these processes are normally used in the production of fish mince. The trimmed fillets are transported by conveyor belt or in boxes.

Inputs and outputs

Figure 8 is a flow diagram showing the inputs and outputs from the trimming and cutting process. Table below provides data for the key inputs and outputs.

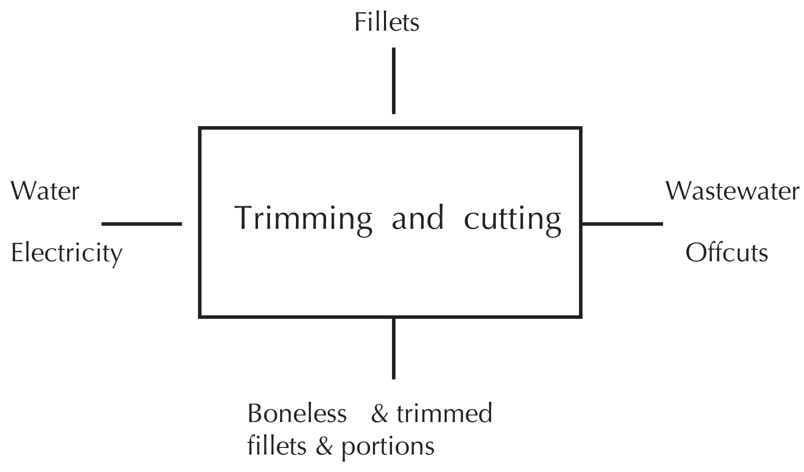


Figure 8 Inputs and outputs for trimming and cutting

Table 11 Input and output data for trimming and cutting white fish

Inputs		Outputs	
Fillets	1000 kg	Boneless fillets	660–760 kg
Water	0.1 m^3	Wastewater	0.1 m^3
Electricity	0.3–3 kW.h	Waste (bones and cut-off)	240–340 kg

Environmental issues Cleaner Production opportunities

Water is used for cleaning the fillets and cutting plates, for rinsing the conveyor and boxes, and for cleaning the workplace in general. In some operations, a constant stream of water is used to clean the cutting plates, conveyors and knives. In these situations, water consumption will be much higher than indicated in the above table.

As in many of the other processing areas, losses of materials from the trimming and cutting lines end up on the floor, and if work areas are not well designed, they can be washed to the drain, contributing to the organic load of the effluent stream.

Spray guns can be installed at work areas for occasional cleaning tasks and automatic spray systems can be fitted with solenoid valves so that they operate intermittently. The capital expenditure for these modifications are low and water consumption can be reduced by 50%

4.2.3 Packaging, freezing and storage

Process description Inputs and outputs

The fillets are packed in cartons and typically frozen in horizontal plate freezers. Once frozen, the cartons are placed in cold storage until required for distribution and retail.

Figure 9 is a flow diagram showing the inputs and outputs from this process. Tables 12 provide data for the key inputs and outputs.

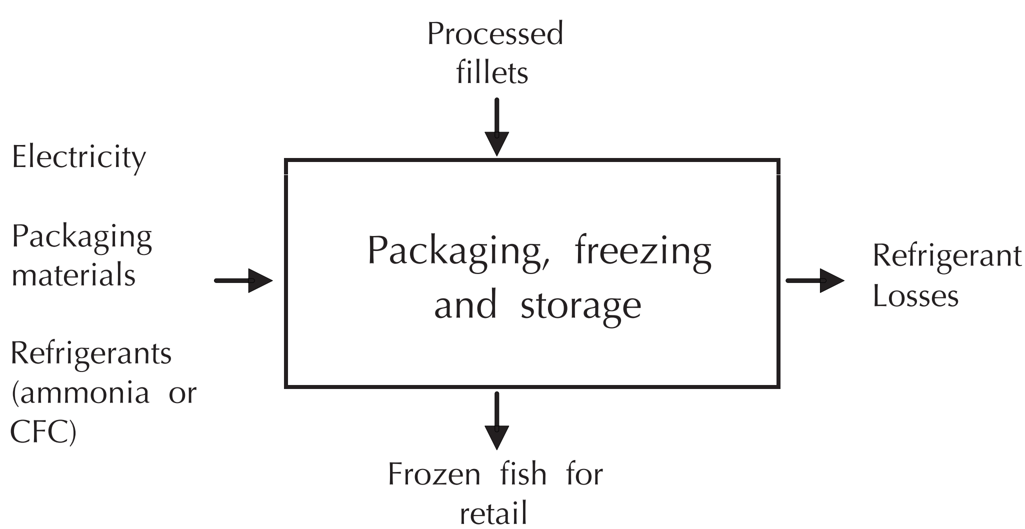


Figure 9 Inputs and outputs for packaging, freezing and storage

Table 12 Input and output data for packaging of fillets

Inputs		Outputs	
Processed fillets	1000 kg	Fish for retail	~1,000 kg
Electricity	5–7.5 kW.h		
Packaging material	NA		

Inputs		Outputs	
Packed fish	1000 kg	Frozen fish	~1000 kg
Water (for ice)	0.2 m^3		
Electricity	10–14 kW.h		
Additives	various		

Environmental issues Cleaner Production opportunities

Freezing and refrigeration consume large quantities of energy, and inefficient equipment can result in emission of refrigerant gases, such as ammonia or CFC, depending on which system is used.

The following is a list of possible ways to reduce energy consumption:

- Ensure that the capacity of the cold storage closely matches the production capacity of the operation. It may be convenient to have additional storage capacity, but the extra energy costs of cooling unused capacity may be considerable. This is best addressed during the planning stage of a new development or during refurbishment or upgrades.
- Ensure that cold storage rooms are well insulated and fitted with self-closing doors with tight seals.
- Strictly enforce procedures that ensure cold storage units are defrosted as necessary. If defrosting occurs either too frequently or too infrequently, energy consumption will increase. Such maintenance measures cost little, but require changes in habits.
- Ensure that refrigeration systems are properly maintained. An ongoing maintenance schedule should be established and, whenever leaks or damaged insulation are detected, repairs should be carried out promptly.
- Use non-CFC refrigeration systems, such as those that use ammonia. It can be costly to change refrigeration systems, but it has become necessary due to the Montreal Protocol related to the use of ozone-depleting substances.

4.2.4 Collection and transport of offal

Process description

The conventional method for collecting and removing offal is to allow it to collect in drains adjacent to work areas and then flume it away with water. Generally, water from the filleting is used for this purpose. It is usually necessary, however, to add some fresh water to transport the solid offal away effectively.

Two environmental issues pose a challenge. Firstly, fluming of offal is responsible for a considerable proportion of the effluent generated from fish processing plants. Secondly, during transportation of the offal in the water flume, organic matter is dissolved in the water stream, contributing to high levels of COD and nutrients.

Cleaner Production opportunities

Instead of transporting offal via drains and water flumes, a conveyor with a mesh size of about 1 mm can be installed underneath each filleting line. As well as transporting the offal away, the conveyor acts as a filter. Wastewaters flowing away from machines and workstations are filtered through the conveyor belt, while the solid offal is retained on the belt, to be transported to the offal collection area. Only particles smaller than 1 mm will pass through the filter, so fish offal is quickly separated from the water stream and contamination of water is limited to small solid particles. The filter conveyor is fitted with a spray system to maintain its filtration capacity and it must also be cleaned thoroughly once a day. In most cases, the filter conveyor can be set up to collect offal from the filleting and skinning processes. In the white fish industry, it is estimated that filter conveyors decrease the total COD of the load from a facility by 5–15% if the factory has a central filter conveyor, or 15–25% if the factory has a rotary sieve. The water used for transport of offal can be filtered and recirculated. This will save water, but there are also drawbacks. When crudely filtered process water is pumped, the oil becomes emulsified in the water. This may cause an increase of consumption of chemicals for flotation or sedimentation at the wastewater treatment plant. The collection of offal without the use of water will result in a larger quantity of offal being collected, and this will provide increased revenue from the sale of the offal to fish meal plants. The material for processing may also command a higher price, due to its reduced water content.

As a rule of thumb, at least 0.3–0.5% of the raw material weight can be collected if filtering conveyors are installed, but this figure can be as high as 1%, depending on the performance of the plant. The removal of offal from white fish by vacuum has also been investigated. This resulted in about 70% reduction in COD of the discharged wastewater. The reduction in water use was similar, and it was estimated that up to 5% more offal was collected. This can be sold for fish meal production and thus generate an income. The system is being used only at the test plant and more experience is need.

5. RESOURCE EFFICIENT AND CLEANER PRODUCTION ASSESSMENT

A cleaner Production Assessment is a methodology for identifying areas of inefficient use of resources and poor management of wastes, by focusing on the environmental aspects and thus the impacts of industrial processes. Many organizations have produced manuals describing Cleaner Production assessment methodologies at varying levels of detail. However, the underlying strategies are much the same. The basic concept centers on a review of a company and its production processes in order to identify areas where resource consumption, hazardous materials and waste generation can be reduced. Table 13 lists some of the steps described in the more well-known methodologies.

Table 13 Methodologies for undertaking a Cleaner Production assessment

Organization	Document	Methodology
UNEP, 1996	*Guidance materials for UNIDO/UNEP* *National Cleaner Production Centers*	1. Planning and Organization 2. Pre-assessment 3. Assessment 4. Evaluation and feasibility study 5. Implementation and continuation
UNEP, 1991	Audit and reduction manual for industrial emissions and waste Technical report series NO. 7	1. Pre-assessment 2. Material balance 3. Synthesis
Dutch Ministry of Economic Affairs, 1991	*Prepare Manual for the Prevention of Waste and Emissions*	1. Planning and Organization 2. Assessment 3. Feasibility 4. Implementation
USEPA, 1992	*Facility Pollution Prevention Guide*	1. Development of pollution prevention 2. Programme 3. Preliminary assessment

The rest of this chapter describes the steps within a Resource Efficiency and Cleaner Production assessment as outlined in the UNEP/UNIDO document, *Guidance Materials for UNIDO/UNEP National Cleaner Production Centers*. (UNEP, 1995).

The steps from this methodology are detailed further in Figure

Phase I: Planning and organization

- Obtain management commitment
- Establish a project team
- Develop policy, objectives and targets
- Plan the Cleaner Production assessment

⇩

Phase II: Pre-assessment (qualitative review)

- Company description and flow chart
- Walk-through inspection
- Establish a focus

⇩

Phase III: Assessment (quantitative review)

- Collection of quantitative data
- Material balance
- Identify Cleaner Production opportunities
- Record and sort options

⇩

Phase IV: Evaluation and feasibility study

- Preliminary evaluation
- Technical evaluation
- Economic evaluation
- Environmental evaluation
- Select viable options

⇩

Phase V: Implementation and continuation

- Prepare an implementation plan
- Implement selected options
- Monitor performance
- Sustain Cleaner Production activities

Figure 10: Overview of the Cleaner Production assessment methodology *(UNEP, 1996)*

5.1 Planning and Organization

The objective of this phase is to obtain commitment to the project, initiate systems, allocate resources and plan the details of the work to come. A project has more chance of success if this groundwork is done well.

5.1.1Obtain management commitment

Experience from companies throughout the world shows that Cleaner Production results in both environmental improvements and better economic performance. However, this message has to reach the management of the company. Without management commitment the Cleaner Production assessment may be only a short-term environmental management tool.

5.1.2 Establish a project team

It is best to establish a project team as early in the process as possible. The project team is responsible for progressing the assessment and will normally undertake the following tasks:

- Analysis and review of present practices (knowledge);
- Development and evaluation of proposed Cleaner Production initiatives (creativity).
- Implementation and maintenance of agreed changes (authority).

5.1.3 Develop environmental policy, objectives and targets

The environmental policy outlines the guiding principles for the assessment. It acts to focus efforts in a way considered most important by management. The environmental policy can be refined as the project team gains more insight into the Cleaner Production possibilities within the company.

The policy contains the company's mission and vision for continuous environmental improvement and compliance with legislation. Objectives describe how the company will do this. For example, objectives could include reducing consumption of materials and minimizing the generation of waste. Targets are measurable and scheduled, and are used to monitor if the company is proceeding as planned. An example of a target might be a 20% reduction in electricity consumption within 2 years. In general, objectives and targets should be

- Acceptable to those who work to achieve them.
- Flexible and adaptable to changing requirements.
- Measurable over time (targets only).
- Motivational.
- In line with the overall policy statement.

5.1.4 Plan the Cleaner Production assessment

The project team should draw up a detailed work plan and a time schedule for activities within the Cleaner Production assessment. Responsibilities should be allocated for each task so that staffs involved in the project understand clearly what they have to do. It is also wise to anticipate any problems or delays that may arise and plan for them accordingly. Lengthy delays and problems arising out of poor planning erode motivation at both the worker and management level.

5.2 Pre-assessment

The objective of the pre-assessment is to obtain an overview of the company's production and environmental aspects. Production processes are best represented by a flow chart showing inputs, outputs and environmental problem areas.

5.2.1 Company description and flow chart

A description of the company's processes should answer the following questions:

- What does the company produce?
- What is the history of the company?
- How is the company organized?
- What are the main processes?
- What are the most important inputs and outputs?

Processes which take place as part of the company's activities can be represented using a detailed process flow chart. Flow chart production is a key step in the assessment and forms the basis for material and energy balances which occur later in the assessment. Process flow charts should pay particular attention to activities which are often neglected in traditional process flow charts, such as:

- Cleaning;
- Materials storage and handling;
- Ancillary operations (cooling, steam and compressed air production);
- Equipment maintenance and repair;
- Materials that are not easily recognizable in output streams (catalysts, lubricants etc.);
- By-products released to the environment as fugitive emissions.

The process flow chart is meant of providing an overview and should thus be accompanied by individual input/output sheets for each unit operation or department. Figure 10 provides an example of an input/output worksheet, however it may be arranged in various ways.

5.2.2 Walk-through inspection

Much of the information needed to fill out the input/output sheets, described above, may be obtained during a walk-through inspection of the company.

The walk-through inspection should, if possible, follow the process from the start to the finish, focusing on areas where products, wastes and emissions are generated. During the walk-through, it is important to talk to the operators, since they often have ideas or information that can be useful in identifying sources of waste and Cleaner Production opportunities. The text box over page provides examples of the types of questions that may be asked to prompt the investigation.

During the walk-through problems encountered along the way should be listed, and if there are obvious solutions to these they should also be noted. Special attention should be paid to no-cost and low-cost solutions. These should be implemented immediately, without waiting for a detailed feasibility analysis.

5.2.3 Establish a focus

The last step of the pre-assessment phase is to establish a focus for further work. In an ideal world, all processes and unit operations should be assessed. However time and resource constraints may make it necessary to select the most important aspect or process area. It is common for

Cleaner Production assessments to focus on those processes that:

- Generate a large quantity of waste and emissions;
- Use or produce hazardous chemicals and materials;
- Entail a high financial loss;
- Have numerous obvious Cleaner Production benefits;
- Are considered to be a problem by everyone involved.

All the information collected during the pre-assessment phase should be well organized so that it is easily accessed and updated.

Some of the Questions to be answered during a walk-through inspection include:

- Are there signs of poor housekeeping (untidy or obstructed work areas etc.)?
- Are there noticeable spills or leaks? Is there any evidence of past spills, such as discoloration or corrosion on walls, work surfaces, ceilings and walls, or pipes?
- Are water taps dripping or left running?
- Are there any signs of smoke, dirt or fumes to indicate material losses?
- Are there any strange odours or emissions that cause irritation to eyes, nose or throat?
- Is the noise level high?
- Are there open containers, stacked drums, or other indicators of poor storage procedures?
- Are all containers labeled with their contents and hazards?
- Have you noticed any waste and emissions being generated from process equipment (dripping water, steam, evaporation)?
- Do employees have any comments about the sources of waste and emissions in the company?
- Is emergency equipment (fire extinguishers etc.) available and visible to ensure rapid response to a fire, spill or other incident?

5.3 Assessment

The aim of the assessment phase is to collect data and evaluate the environmental performance and production efficiency of the company. Data collected about management activities can be used to monitor and control overall process efficiency, set targets and calculate monthly or yearly indicators. Data collation activities can be used to evaluate the performance of a specific process.

5.3.1 Collection of quantitative data

It is important to collect data on the quantities of resources consumed and wastes and emissions generated. Data should be represented based on the scale of production: for example: water consumption per tonne of fish product. Collection and evaluation of data will most likely reveal losses. For instance, high electricity consumption outside production time may indicate leaking compressors or malfunctioning cooling systems.

In determining what data to collect, use the input/output worksheets, described previously, as a guide. Most data will already be available within the company recording systems, e.g. stock records, accounts, purchase receipts, waste disposal receipts and the production data. Where information is not available, estimates or direct measurements will be required.

5.3.2 Material balance

The purpose of undertaking a material balance is to account for the consumption of raw materials and services that are consumed by the process, and the losses, wastes and emissions resulting from the process. A material balance is based on the principle of 'what comes into a plant or process must equal what comes out'. Ideally inputs should equal outputs, but in practice this is rarely the case, and some judgment is required to determine what level of accuracy is acceptable.

A material balance makes it possible to identify and quantify previously unknown losses, wastes or emissions, and provide an indication of their sources and causes. Material balances are easier, more meaningful and more accurate when they are undertaken for individual unit operation. An overall company-wide material balance can then be constructed with these.

The material balance can also be used to identify the costs associated with inputs, outputs and identified losses. It is often found that presenting these costs to management can result in a speedy implementation of Cleaner Production options.

While it is not possible to lay down a precise and complete methodology for undertaking a material balance, the following guidelines may be useful

- Prepare a process flow chart for the entire process, showing as many inputs and outputs as possible.
- Sub-divide the total process into unit operations. (Sub-division of unit operations should occur in such a way that there is the smallest possible number of streams entering and leaving the process).
- Do not spend a lot of time and rescues trying to achieve a perfect material balance; even a preliminary material balance can reveal plenty of Cleaner Production opportunities

Environmental performance indicators for the process can be developed from the material balance data. This is achieved by dividing the quantity of a material input or waste stream by the production over the same period. Performance indicators may be used to identify over-consumption of resources or excessive waste generation by comparing them with those of other companies or figures quoted in the literature. They also help the company track its performance towards its environmental targets.

5.3.3. Identify Cleaner Production opportunities

Identifying Cleaner Production opportunities depends on the knowledge and creativity of the project team members and company staff, much of which comes from their experience. Many Cleaner Production solutions are arrived at by carefully analyzing the cause of a problem.

Another way of identifying Cleaner Production opportunities is to hold a 'brainstorming' session, where people from different parts of the organization meet to discuss solutions to specific problems in an open and non-threatening environment.

Some other sources of help from outside the organization could be:

- this guide;
- external industry personnel or consultants;

- trade associations;
- universities, innovation centers, research institutions, government agencies;
- equipment suppliers;
- information centers, such as UNEP or UNIDO;
- literature and electronic databases

5.3.4 Record and sort options

Once a number of Cleaner Production opportunities have been suggested and recorded, they should be sorted into those that can be implemented directly and those that require further investigation.

It is helpful to follow the following steps:

- Organize the options according to unit operations or process areas, or according to inputs/outputs categories (e.g. problems that cause high water consumption).
- Identify any mutually interfering options, since implementation of one option may affect the other
- Opportunities that are cost free or low cost, that do not require an extensive feasibility study, or those are relatively easy to implement, should be implemented immediately.
- Opportunities that are obviously unfeasible, or cannot be implemented should be eliminated from the list of options for further study.

Table 11 Example of information recorded for identified options

Problem type	**Problem description**	**Cleaner Production Options**
Examples:	Examples:	Examples:
• Resource Consumption	• name of process and Department	• how the problem can be solved
• energy consumption	• short background of Problem	• short-term solution
• air pollution		• Long-term solution
• solid waste	• amount of materials lost or concentration of pollutants	• estimated reductions in Waste resource consumption and generation
• Wastewater	• money lost due to lost resources	
• Hazardous waste		
• occupational health and safety		

5.4 Evaluation and feasibility study

The objective of the evaluation and feasibility study phase is to evaluate the proposed Cleaner Production opportunities and to select those suitable for implementation.

The opportunities selected during the assessment phase should all be evaluated according to their technical, economic and environmental merit. However, the depth of the study depends on the type of project. Complex projects naturally require more thought than simple projects. For some options, it may be necessary to collect considerably more information. An important source of this information may be employees affected by the implementation.

5.4.1 Preliminary evaluation

The quickest and easiest method of evaluating the different options is to form a group, consisting of the project team and management personnel, and discuss the possible solutions one by one. This process should give a good indication of which projects are feasible and what further information is required.

5.4.2 Technical evaluation

The potential impacts on products, production processes and safety from the proposed changes need to be evaluated before complex and costly projects can be decided upon. In addition, laboratory testing or trial runs may be required when options significantly change existing practices. A technical evaluation will determine whether the opportunity requires staff changes or additional training or maintenance.

5.4.3 Economic evaluation

The objective of this step is to evaluate the cost effectiveness of the Cleaner Production opportunities. Economic viability is often the key parameter that determines whether or not an opportunity will be implemented.

When performing the economic evaluation, costs of the change are weighed against the savings that may result. Costs can be broken into capital investments and operating costs. Standard measures used to evaluate the economic feasibility of a project are payback period, net present value (NPV), or internal rate of return (IRR).

Capital investment is the sum of the fixed capital costs of design, equipment purchase, installation and commissioning, costs of working capital, licenses, training, and financing. Operating costs, if different to existing conditions will need to be calculated. It may be that operating costs reduce as a result of the change, in which case, these should be accounted for in the evaluation as an ongoing saving.

5.4.4 Environmental evaluation

The objective of the environmental evaluation is to determine the positive and negative environmental impacts of the option. In many cases the environmental advantages are obvious: a net reduction in toxicity and/or quantity of wastes or emissions. In other cases it may be necessary to evaluate whether, for example, an increase in electricity consumption would outweigh the environmental advantages of reducing the consumption of materials.

For a good environmental evaluation, the following information is needed: changes in amount and toxicity of wastes or emissions;

- Changes in energy consumption;
- Changes in material consumption;
- Changes in degradability of the wastes or emissions;
- Changes in the extent to which renewable raw materials are used;
- Changes in the reusability of waste streams and emissions;
- Changes in the environmental impacts of the product.

In many cases it will be impossible to collect all the data necessary for a good environmental evaluation. In such cases a qualified assessment will have to be made, on the basis of the existing information.

Given the wide range of environmental issues, it will probably be necessary to prioritize those issues of greatest concern. In line with the national environmental policy of the country, some issues may have a higher priority than others.

Aspects to be considered in the evaluation are:

i) Preliminary evaluation

Is the Cleaner Production option available?

- Can a supplier be found to provide the necessary equipment or input material?
- Are consultants available to help develop an alternative?
- Has this Cleaner Production opportunity been applied elsewhere? If so, what have been the results and experience?
- Does the option fit in with the way the company is run?

ii) Technical evaluation

- Will the option compromise the company's product?
- What are the consequences for internal logistics, processing time and production planning?
- Will adjustments need to be made in other parts of the company?
- Does the change require additional training of staff and employees?

iii) Economic evaluation

- What are the expected costs and benefits?
- Can an estimate of required capital investment be made?
- Can an estimate of the financial savings be made, such as reductions in environmental costs, waste treatment costs, material costs or improvements to the quality of the product?

iv) Environmental evaluation

- What is the expected environmental effect of the option?
- How significant is the estimated reduction in wastes or emissions?
- Will the option affect public or operator health (positive or negative)? If so, what is the magnitude of these effects in terms of toxicity and exposure?

5.4.5 Select options

The most promising options must be selected in close collaboration with management. A comparative ranking analysis may be used to prioritize opportunities for implementation. An option can be assigned scores, say from 1 to 10, based on its performance against a set of evaluation criteria. By multiplying each score by a relative weight assigned to each criterion, a final score can be arrived at. The options with the highest scores will probably be best suited for implementation. However, the results of this analysis should not be blindly accepted. Instead, they should form a starting point for discussion. All simple, cost-free and low-cost opportunities should of course be implemented as soon as possible.

5.5 Implementation and continuation

The objective of the last phase of the assessment is to ensure that the selected options are implemented, and that the resulting reductions in resource consumption and waste generation are monitored continuously.

5.5.1 Prepare an implementation plan

To ensure implementation of the selected options, an action plan should be developed, detailing:

- Activities to be carried out;
- The way in which the activities are to carried out;
- Resource requirements (finance and manpower);
- The persons responsible for undertaking those activities;
- A time frame for completion with intermediate milestones.

5.5.2. Implement selected options

As for other investment projects, the implementation of Cleaner Production options involves modifications to operating procedures and/or processes and may require new equipment. The company should, therefore, follow the same procedures as it uses for implementation of any other company projects.

However, special attention should be paid to the need for training staff. The project could be a failure if not backed up by adequately trained employees. Training needs should have been identified during the technical evaluation.

5.5.3 Monitor performance

It is very important to evaluate the effectiveness of the implemented Cleaner Production options. Typical indicators for improved performance are:

- Reductions in wastes and emissions per unit of production;
- Reductions in resource consumption (including energy) per unit of production;
- Improved profitability.

There should be periodic monitoring to determine whether positive changes are occurring and whether the company is progressing toward its targets.

5.5.4 Sustain Cleaner Production activities

If Cleaner Production is to take root and progress in an organization, it is imperative that the project team does not lose momentum after it has implemented a few Cleaner Production options. Sustained Cleaner Production is best achieved when it becomes part of the management culture through a formal company environmental management system or a total environmental quality management approach.

An environmental management system provides a decision-making structure and action plan to support continuous environmental improvements, such as the implementation of Cleaner Production.

If a company has already established an environmental management system, the Cleaner Production assessment can be an effective tool for focusing attention on specific environmental problems. If, on the other hand, the company establishes a Cleaner Production assessment first, this can provide the foundations of an environmental management system.

Regardless of which approach is undertaken, Cleaner Production assessment and environmental management systems are compatible. While Cleaner Production projects have a technical orientation, an environmental management system focuses on setting a management framework, but it needs a technical focus as well.

To assist industry in understanding and implementing environmental management systems, UNEP, together with the International Chamber of Commerce (ICC) and the International Federation of Engineers (FIDIC), has published an *Environmental Management System Training Resource Kit*. This kit is compatible with the ISO 14001 standard.

Like the Cleaner Production assessment, an environmental management system should be assessed and evaluated on an ongoing basis and improvements made as required. While the specific needs and circumstances of individual companies and countries will influence the nature of the system, every environmental management system should be consistent with and complementary to a company's business plan. (see attached checklist in appendix 1)

6: BARRIERS TO RESOURCE EFFICIENT AND CLEANER PRODUCTION AND HOW TO OVERCOME THEM

The foregoing chapters have established that RECP is a proactive approach to improve profitability, internal working environment and pollution and waste and emission reduction in the fish industry. Often times however, several types of barriers can block or slow the progress of a RECP programme.

Discussed here below are major barriers to be overcome for smoother RECP implementation.

1. Attitudinal barriers
2. Systemic barriers
3. Organizational barriers
4. Technical barriers
5. Economic barriers
6. Government barriers

The numbering of the barriers does not in any way suggest order of importance just as the categorization may not be reflective of prevailing circumstances in all tea processing plants. The actual combination of barriers prevailing in each tea processing plant as well as their importance may differ widely from one plant to another even though they may be operating in the same locality.

This would then mean that enabling measures will be individual plant specific and no generalized solution would be suggested to fit all players.

6.1 Attitudinal barriers

There is misconception that implementation of RECP costly. However, in actual fact this has been found to be not always true as in each enterprise there are RECP opportunities which can be adopted at very minimal cost. But this mind set tends to act as an attitudinal barrier to RECP implementation. RECP audits or other studies often reveal that various obstacles formulated in financial or technical terms are in fact attitudinal.

Attitudinal barriers can be classified as:

- Indifference towards housekeeping and environmental affairs
- Resistance to change

Indifference towards housekeeping and environmental affairs

Good housekeeping is more a matter of culture than technique. Many small scale enterprises are set up and run by family members and lack housekeeping culture because in most cases they have no professional management systems. This ignorance and systemic failure allows continued environmental degradation by tea processing enterprises in the context of short term profit making business strategies.

Resistance to change

Plant employees generally resist change that demands adoption of RECP out of fear of failure of the unknown. Many operators lack formal training and resist experimentation, fearing that any deviation from standard practice would cause them to lose control of the processes and reduce productive output. Experimentation with RECP measures is often resisted. Such reluctance to try out new practices is breeding ground for the "not me first" syndrome where people are only willing to try out an idea if it has already been successfully implemented elsewhere.

Attitudinal barriers can be overcome by ***enabling factors*** including the following:

- Early success
- Employee involvement
- Encouraging experimentation
- Publicizing early RECP successes

Early success: Since early success might encourage management as well as staff to continue experimentation with RECP, plant audits should first identify obvious no cost or low cost options. Such options often entail eliminating lapses in housekeeping, maintenance and process control have clear financial pay offs and are easily identified in the first joint on site visit of experts to the company.

Employee involvement: Involving company employees in the process of RECP options generation from an early stage increases chances of success as this helps to change their attitudes towards RECP.

Encouraging experimentation, especially with no and low cost options. Fear of the unknown or failure might be eliminated by specific, on the spot guidance and instructions for experimentation, e.g. modifying working procedures or choosing alternative raw or auxiliary materials. To minimize risks, experimentation should start with no and low cost practices such as improved housekeeping and process optimization, and gradually be extended on the basis of lessons learned and experience gained.

Publicizing early RECP success: Mills should emphasize both the financial and the environmental benefits of early RECP successes in order to create awareness among the entire workforce and to sustain commitment and involvement from key decision makers.

6.2 Systemic barriers

Production monitoring data and routine procedures for analysis of such data are essential to avoiding subjective and tendentious discussions in CPA process. Data collection and the development of information systems within the company are prerequisites for establishing a basis of accuracy and reliability in RECP and other operations.

The immediate financial benefits of not keeping production records might, however, often appear to outweigh the advantages of appropriate data collection and evaluation for production process optimization. Although collection of baseline data is an important starting condition for RECP activities, it is most often not necessary to do until obvious lapses in housekeeping and equipment maintenance have been eliminated. Systemic barriers can be identified as follows:

- Lack of professional management skills
- Low quality production records
- Inadequate and ineffective management systems

Lack of professional management skills

Professional management skills can be lacking in the following areas:

Leadership: Small scale enterprises are run as family affairs generally. The owners and decision makers are seldom fully qualified professional managers and often fail to provide the leadership and guidance required to develop the business. Consequently, the outlook of employees is also limited to the day to day details of work with no future targets in mind.

Supervision: Supervisors in SSE's are often persons who have been promoted because of good performance and are not necessarily trained to perform as supervisors to instruct control and guide other workers. Operators thus view the supervisor as one of their senior colleagues instead of as a shop floor manager with direction and foresight to whom they are accountable.

Job security: In SSEs, job security is often more dependent on the whims of the employer than on the performance of employees, who are therefore concerned about retaining their jobs by doing what pleases the employer and would generally prefer not to risk failure in a new activity. Even in larger units, professional managers often decline to try new things for fear of failure.

Low quality production records

Mills often fail to maintain proper records of water, energy or material consumption, inventories of chemicals, fuels and raw materials, daily floor level log sheets of inputs, output, downtime etc. or environmental records of the quality and quality of liquid, solid and air emissions. In the absence of record keeping practices, data analysis and evaluation skills do not develop a deficiency which hampers the systematic identification of options.

Inadequate and ineffective management systems

In the absence of a well defined management system, the lines of authority, reporting, responsibility and accountability are often unclear. Ambiguity about performance criteria encourages employees to avoid non routine work such as RECP related measures.

Flaws in management systems are particularly evident in the following areas:

Professional upgrading of employees: Systematic training to upgrade employee job skills is inadequate or nonexistent at many companies, where employees are thus not exposed to new industrial concepts such as RECP.

Production Planning:Production schedules are usually prepared on a day to day basis which hampers systematic long term work such as baseline data collection or assessment of impact of implemented measures.

Enabling measures

The following enabling measures are proposed to deal with

Systemic constraints:

- Proper documentation and plant layout
- In house RECP maintenance provisions
- Training a plant level RECP team.
- Developing simple management indicators
- Conducting a top down housekeeping drive.
- Disseminating success stories.

Proper documentation and plant layout

Plants can improve their plant site drawings and documentation inclusive of the most recent revamping and capacity expansion projects. Such documentation serves as an excellent basis for collecting and evaluating the data needed for CPAs.

In-house CP maintenance provisions

Generally companies with in house maintenance are a step ahead of companies that rely on outside contractors for equipment maintenance and revamping.

Training a plant level CP team:

Conducting a training session with plant level RECP team at the start of a CPA is highly recommended. Such training should clarify the objective of RECP to reduce environmental impacts by improving productive efficiency and illustrate the benefits of planned production and the need for collecting and evaluating realistic production records. Attention should also be given to illustrating problem solving approaches preferably with examples from within the company such as lapses in housekeeping or maintenance. For best results, key decision makers including the proprietor as well as shop floor supervisor should participate.

Developing simple management indicators

In the absence of professional management skills simple indicators should be developed to enable management and supervisors to gain control over the production processes and to minimize wastage of materials, water and energy. Indicators as simple as input material and water and energy consumption per unit of productive output might be sufficient to illustrate the benefits of improved housekeeping and initiate ongoing efforts in this field.

Conducting a top down housekeeping drive

Housekeeping improves once key decision makers take the lead. Top management can routinely pin point lapses in housekeeping such as leaking equipment and pipes and material spills and follow up on their elimination.

Disseminating success stories

RECP success stories can help to create and raise RECP awareness. Such accounts should be well documented with before and after financial as well as environmental data in order to pinpoint the crucial role of accurate information systems in achieving RECP. Sectoral as well as generic manuals and workshops can contribute to the dissemination of such success stories.

6.3 Organizational barriers

A company's organizational structure could hamper the introduction of proactive environmental management practices. It is therefore essential to assess how the tasks and responsibilities related to production management and environmental issues are divided in the company, and to suggest changes favorable to RECP. Shop floor supervisors and technical staff members should be involved in the project team, which in turn should cooperate with outside consultants.

Organizational barriers can be categorized in three separate but interrelated characteristics of industries (particularly SSIs):

- Concentration of decision-making powers
- Over-emphasis of decision making powers
- Over –emphasis on production
- Non-involvement of employees

Concentration of decision making powers

Generally the owner is chief executive who makes all decisions, even for low cost measure. Such leaders tend to be unaware of the positive impact of motivational tools such as public recognition and awards or systems of incentives and rewards. Denied a share of decision-making responsibility, employees lack the initiative to take up new and challenging assignments such as RECP, and if a RECP team is formed, its members might not feel they have a real stake in the process.

Over-emphasis on production

An owner's stress on production can relegate low priority on the time and effort required to conduct a CPA. In some companies, such emphasis is sustained by the fact that payment of employees is on a production basis, by which the higher the output, the higher the payment. In such a system, there is a built-in tendency to overlook RECP and housekeeping standards to boost output.

Non-involvement of employees

Production personnel do not participate in RECP activities unless ordered to do so by the chief executive. Technical staff often faces excessive workloads and poor remuneration, especially at the junior level, which causes a high turnover rate. This condition hampers RECP efforts, as the expertise of a RECP team member often disappears when he or she departs.

Enabling Measure

- Mechanism to cope with organizational barriers include:
- Sharing information
- Organizing a capable project team
- Recognizing and rewarding RECP efforts
- Assigning cost to production and waste generation

Sharing Information

Sharing cost data between managers and operators encourage operators to work more carefully with high-cost materials. Sharing information on perceived courses of equipment failure or off-specification products, among operators, and between supervisors and technical staff, facilitates problem- solving approaches to eliminate waste-generation causes.

Organizing a capable project team

A capable well organized RECP team is key to developing the CPA and eliminating barriers to RECP. It might be difficult to establish and effective team, however, given the widespread lack of recognition and low prioritization of RECP, the low rate of employee involvement, and the concentration of decision-making powers. A balance must be found between the preferred situation of a properly functioning project team able to develop and implement RECP on its own, and the prevalent situation, in which the organization structure inhibits the delegation of decision-making power and blocks creative problem solving. The team should also include one or several of the most concerned supervisors and operators (shop floor workers).

Recognizing and awarding CP efforts.

Once the team has identified and evaluated RECP opportunities, motivational schemes to encourage the team should set up, such as public recognition programmes, rewards, and publicizing early successes.

Assigning cost to production and waste generation

To expend the scope f management beyond production output to more comprehensive control over the efficiency of production, it is necessary to assign costs to the different production factors and waste streams. Normally managers can be incited to action by simple calculation of the monetary value of the raw materials, chemicals and products lost with particular waste stream.

6.4 Technical barriers

RECP often requires technical changes to installations, tools, input materials, auxiliaries, process and equipment. Given that RECP implementation depends upon technology, technical factors often emerge as barriers to it. The technical barriers in small and medium sized industries or enterprises (SMEs) can be categorized as follows:

- Limited Technical capabilities
- Limited access to technical information
- Technology limitations

Limited technical capabilities

For most MEs, production ability is limited to the experience of workers, most of whom lack technical capabilities to monitor, control and improve production technology. Limitation in technical skills may take the form of:

`*Limited or non-availability of trained manpower*: lacking in-house or locally available technical personnel, many companies must depend on external expertise to perform CPA

Lack of monitoring facilities: Lacking in-house monitoring facilities for conducting the CPA, many companies must depend on external agencies which are scant, expensive and often based long distance away. Without adequate monitoring facilities, basic data collection suffers*Limited maintenance facilitie*s: The maintenance department at SMEs are normally equipped with just enough facilities and personnel for routine maintenance, which unfortunately cannot be safeguarded in the event of equipment failure.. At such companies' major maintenance jobs, such as machine overhaul, motor rewinding, and boiler cleaning, must be entrusted to external firms whose time-intensive work is an expense that represents a burden to SMEs and hinder their undertaking RECP.

Limited access to technical information

Generally, SMEs have limited access to technical information and success stories on low resource consumption and low waste technique. Moreover there is an almost total absence of pertinent technical literature. The information available from abroad is not directly relevant or tailor made to the technical status and size of SME operations.

Technology limitations

Technical gaps exist at SMEs in spite of modernization efforts, because most of the old conventional technology has been modified by a trial and error process without analyzing the system's basic chemistry and engineering. Such oversight has resulted in efficient, suboptimal equipment utilization and consequently, higher waste generation.

Enabling measures

Dairies which have an edge in overcoming technical barriers are those with staff trained in the appropriate technical skills and those which do not rely on outside sources for their fabrication Barriers to appropriate technology can be surmounted by the following measures:

- Technically skilled staff
- In-house fabrication facilities
- Disseminating success stories about RECP techniques and technologies.
- Need-based support for environment driven research and development

Technically skilled staff

Companies with technically skilled staff members have less trouble getting started with RECP. This staffs members easily absorb the RECP concept and can transfer the general working method to the specific circumstances in their company.

In-house fabrication facilities

SMEs have a tradition of resourcefulness, modifying old, discarded equipment to function in often new and improved ways and accumulating expertise in finding smart but simple technical fixes. The companies that operate in-house fabrication facilities (mechanical, electrical, or civil workshops) are especially well endowed with such expertise, which they can employ to identify appropriate RECP solutions or to translate improvements suggested by outside experts in such solutions.

Disseminating success stories about RECP techniques and technologies

Disseminating success stories of RECP techniques and technologies could do a great deal to abate existing technical constraints. The publication of RECP technical manuals and the organization of workshops and seminars are useful media for disseminating such stories. To standardize the practice of successful RECP techniques and technologies within the industry, they should be dispensed to companies by intermediary organizations, such as small industries service institute, professional organizations, industry associations, and even equipment suppliers.

Need-based support for environment driven research and development

Research and development would help to eliminate those areas in which state-of-the-art technology is not yet able to prevent environmental problems at production scales typical for SMEs.

6.5 Economic Barriers

Major economic barriers to RECP are:

- Prevalence of fiscal incentives that favour production quantum over production costs.
- Low prices and easy availability of raw materials
- *Ad hoc* investment policy
- High cost and low availability of capital

Prevalence of fiscal incentives that favour production quantum over production costs

The prevailing fiscal incentives, such as concessions in excise duty, sales tax etc are mostly related to quantum of production with little or no relevance to cost of production. Entrepreneurs therefore tend to concentrate on maximizing production to derive maximum financial benefit, relegating cost-reduction exercises such as RECP to secondary levels of importance.

Low prices and easy availability of raw materials

The impetus to identify and implement RECP measure is too often dampened by the prevailing low prices and abundant availability in many areas of natural resources such as agro residues, water and fuel. Resource scarcity, however, has become a major concern for entrepreneurs in heavily industrialized areas.

***Ad hoc* investment policy**

The ad hoc nature of investment practices in the industry is detrimental to CP in several interrelated ways:

Limiting economic analysis to obvious direct costs and benefits: The economics of all investments, including RECP measure, are computed mainly on the basis of direct financial returns and short term financial gains. Therefore, only increases in production capacity, reductions in the consumption of raw materials and fuels, and reductions in obvious production costs, such as the workforce, are typically accounted for. The benefits accruing form reduced electricity or pollution control costs are such savings have not been incurred. Savings derived from environmental measure are often a major part of the economic benefit of RECP measures. Failure to include such criteria in economic analysis is therefore unfavorable to the acceptance of RECP.

Ad hoc investment criteria: Small entrepreneurs, who are generally short of capital, tend to overlook the most attractive measures because of their higher expense, selecting instead those that are the least capital-intensive.

Inadequate investment planning: Investments, including those for RECP, are often made without proper planning, which may result in partial implementation. Expected results are thus not achieved causing decision makers to lose faith in the programme.

High cost and low availability of capital

Most financial institutions are not willing to finance cost incentive RECP measure with longer (over one year) pay-back period. In countries where financing is available, interest rates are high, in the range of 15-20 per cent, making major RECP investment a challenge.

Enabling measures

Mills with sound financial basis, and those which do not hesitate to implement no – and low-cost options improve their chances to overcome economic barriers. Companies can make use of the following enabling measure for overcoming economic barriers:

- Financial soundness
- Implementing financially attractive options
- Proper cost allocation and planned investment
- Long term industrial policies
- Financial incentives

Financial soundness

Since financially sound companies are less vulnerable to economic barriers, the perceived financial soundness of a company should be used as a criterion in its selection as a demonstration of RECP investment.

Implementing financially attractive options

Implementing cost-effective low- and no-cost RECP options can pave the way for implementing selected higher-cost options in the near future. Demonstrating the financial viability of such measure could enable a company to qualify for increasing amounts of financial assistance.

Proper cost allocation and planned investment

Awareness of costs due to waste is a crucial starting point for any RECP programme. To illustrate the potential for savings from RECP, the company must prepare an estimate of the costs of the various components in a waste stream e.g. energy, raw materials, water, and product. Once it has allocated the costs of these components, the company can assign cost to a waste stream and estimate the savings that arise from minimizing or eliminating it. Such an exercise also identifies how much is lost through the drain.

Long term industrial policies

Governments should avoid making frequent changes in industrial policies, a pattern which sustains short-sighted investment planning in the private sector. Long-term industrial policies would help industries merge RECP in to their investment planning and encourage them to become more competitive without artificial fiscal protection

Financial incentives

To foster the implementation of high-cost RECP options, financial schemes that give priority to RECP proposals over end-of-pipe proposals could be developed by government or donor agencies. Such schemes, made easily accessible and procedurally simple, could have a huge impact on the capital cost and availability of RECP investments for SMEs. Governments could also institute fiscal incentives for RECP, such as a 100 per cent depreciation allowance on private RECP investments, a government purchasing policy favorable to companies committed to RECP and a concessional corporate tax for companies that perform automatic capacity enhancements.

6.6 Government Barriers

Government policies affect company decision-making and can thus either hamper or encourage companies to adopt RECP. Government barriers to RECP include industrial policies that discourage

RECP undertakings and environmental policies that promote end-of-pipe instead of preventive solutions.

Industrial policies

As discussed above on the economic barriers, frequently changing industrial policy is not conducive to RECP efforts. Incentive schemes, as discussed in the same section are not yet available for RECP

Environmental policies

Regulatory authorities tend to enforce a limited set of environmental discharge standards that do not include guidelines for reducing waste generation. Entrepreneurs therefore prefer to use conventional end-of-pipe control practices that satisfy the regulatory authorities, rather than adopt RECP practices which are not necessarily recognized by these authorities

Enabling measures

Governments can adopt the following measure to foster RECP:

- Financial incentives
- Are-wide volunteer RECP groups
- Enforcement of environmental legislation

Financial Incentives

Government could develop financial schemes that give priority to RECP proposals over end-of-pipe proposals. Such schemes, made easily accessible and procedurally simple, could have a huge impact on the capital cost and availability of RECP investments for SMEs. Governments could also institute fiscal incentives for RECP such as 100 percent depreciation allowance on private RECP investments, a government purchasing policy favorable to companies committed to RECP and concessional corporate tax for companies that perform automatic capacity enhancements.

Area-wide volunteer RECP groups

The government could set the stage for area-wide volunteer RECP groups and create conditions o exploit their achievements.

Enforcement for environmental legislation

If environmental laws are not enforced, entrepreneurs will not necessarily perceive the need to include environmental c concerns in their business activities.

7. APPENDICES

APPENDIX 1: RESOURCE EFFICIENT AND CLEANER PRODUCTION (RECP) ASSESSMENT CHECKLIST

Company profile:

Type of activity:

Worksheet 1: Data collection

Essential information	Available	Not available	Team nominated to collect information
Process flow diagrams			
Production schedule-total tonnage or volume produced per year			
Operating hours			
Major raw materials Inventory			
Product inventories			
Water supply invoices for previous years. Also consider pre-treatment costs and sources (e.g. mains, surface water, ground water)			
Energy supplies invoices for previous year (e.g. electricity, LPG, natural gas or fuel oil)			
Chemicals – costs and usage for previous year (e.g. detergents, sanitizers, wastewater treatment chemicals, oils and lubricants)			
Waste water discharge invoices for previous year — volume, quality, treatment and disposal costs			
Solid waste disposal invoices for previous year — include non-recyclables and recyclables (e.g. cardboard, plastics, glass)			
Useful additional information			
Site plan			
Factory layout			
Environmental audit reports			
Waste water and waste water licenses			

Worksheet 2: Annual resource and waste data

Inputs	Annual quantity	Unit charge	Annual cost (Kshs)
Raw material 1	tonnes or m^3	Kshs/unit	

Raw material 2	tonnes or m^3	Kshs/unit	
Raw material 3	tonnes or m^3	Kshs/unit	
Raw material 4	tonnes or m^3	Kshs/unit	
Raw material 5	tonnes or m^3	Kshs/unit	
Raw material 6	tonnes or m^3	Kshs/unit	
Raw material 7	tonnes or m^3	Kshs/unit	
Raw material 8	tonnes or m^3	Kshs/unit	
Water	m^3	Kshs/ m^3	
Packaging	Units	Kshs/unit	
Cleaning chemicals	L	Kshs/L	
Electricity	kW h	Kshs/Kwh	
Natural gas	MJ or Litres	Kshs/MJ	
Other			
Outputs	**Quality generated per year**	**Unit charge**	**Annual cost of disposal**
Waste water	m^3	Kshs/ m^3	
BOD	Kg	Kshs/kg BOD	
COD	Kg	Kshs/kg COD	
TN	Kg	Kshs/kg TN	
TP	Kg	Kshs/kg TP	
General waste	M^3	Kshs/m^3	
Recyclable waste	M^3	Kshs/m^3	

Worksheet 3: Current and target performance indicators

	Current performance (per unit of product)	Target performance (per unit of product)
Inputs		
Water	m^3/unit	m^3/unit
Electricity	kW h/unit	kW h/unit
Gas	MJ/unit	MJ/unit
Chemicals	kg/unit	kg/unit
Packaging	cartons/unit	cartons/unit
Other		
Outputs		
Solid waste (dumpsite)	m^3/unit	m^3/unit
Cardboard	m^3/unit	m^3/unit

Plastic	m^3/unit	m^3/unit
Glass	m^3/unit	m^3/unit
Other	kg/unit	kg/unit
Wastewater volume	m^3/unit	m^3/unit
Wastewater quality		
COD	mg/L waste	mg/L waste
BOD	mg/L waste	mg/L waste
TN	mg/L waste	mg/L waste
TP	mg/L waste	mg/L waste

Worksheet 4: True cost of water

	Heated water Kshs/M^3	Chilled water Kshs/M^3
Supply cost		
Heating/chilling cost		
Pumping cost		
Treatment cost		
Discharge cost		
True cost of water		

Worksheet 5: Water consumption for individual units of operation

Process area/unit of operation	Volume of water used weekly(m^3)	Volume of water used yearly(m^3)	% of total consumed
Process area			
Cleaning			
Services			
Boiler make-up			
Cooling tower make-up			
Domestic use			
Total			
Actual volume purchased			100
Variance/unaccounted			

Worksheet 6: Energy consumption

Form of energy	Annual usage	Annual usage (common unit)	Annual cost(Kshs)	% of total energy cost
Electricity	kW h	MJ		
Natural gas	m^3	MJ		
LPG	MJ	MJ		
Fuel oil	kg	MJ		
Coal				
Other				

Energy Type	Conversion Factor	
Electricity	3.6 MJ/kWh	
Natural gas	39.5	MJ/m^3
Fuel oil	43.1	MJ/kg
Coal	30.7	MJ/kg
Steam	2.8	MJ/kg

Worksheet 7: Electricity consumption

Process area	Equipment	No. of items	Rating (kW)	Capacity / load	Hours of use (h/day)	Estimated Consumption (kW h/year)	Subtotal (kW h/year)	% of total
e.g. Coldroom1	*Atlas Copco compressor*	*1*	*30*	*90%*	*24*			

Total								
Actual electricity consumed								

Worksheet 8: Solid waste audit

Waste steam	Source and cause of waste	Generation rate and pattern	Storage pre disposal	Service contractor and disposal location	Cost of Disposal (Kshs)	Comments
e.g. plastic packaging	*batch preparation*	*1.0 m^3 per day*	*15 m^3 skip*		*15/m^3*	*Investigate plastic recycling company*

Worksheet 9: Waste water charges

Component	Licence limit	Average load(mg/L)	Average daily load(kg)	Council charge	Actual cost of discharge(Kshs)
BOD	mg/L			Kshs/kg	
COD	mg/L			Kshs/kg	
TN	mg/L			Kshs/kg	
TP	mg/L			Kshs/kg	
Other	mg/L			Kshs/kg	
Volume	m^3			Kshs/m^3	
				Total cost	

Worksheet 10: Wastewater audit

Waste stream	Source and cause of waste	Generation rate and pattern	Mass load	Comments
e.g. product tank wastewater	*cleaning of product tanks*	*daily*	*500 mg/L BOD*	*Consider clean-in-place system*

Worksheet 11: Potential RECP opportunities

Opportunity Potential resource saving Passed								
	Water	Energy	Packaging	Chemical	Solid waste	Waste water	Other (e.g. labour, maintenance)	preliminary evaluation Yes/No
e.g. *Reduce timers on filling machine cleaning cycle*								

Worksheet 12: Economic evaluation of RECP opportunities

Costs of implementing the opportunity (a)Estimate the likely cost of equipment and installation and any other up-front costs associated with the change? (b)Estimate any on-going costs such as running costs, maintenance, materials, labour etc. (for a 12-month period). **Total costs (a + b)** **Savings from implementing the opportunity** (c)Determine the possible savings in terms of materials, water, energy, treatment, disposal etc. (for a 12-month period)? (d)Is the change likely to lead to increased sales of current or new products? What would be the likely range (for a 12-month period)? (e)Quantify any other associated costs or benefits. **Total savings (c + d + e)**	

Payback period		
ayback period in months =	Total cost	3 12 months
	Total savings	

RECP opportunity	Capital cost	Annual saving (resources)	Annual saving (Kshs)	Payback (months)	Implement (date)	Responsible person(s)
Water		m^3				

Energy		kWh/MJ				
Packaging		m^3				
Chemicals		L				
Solid waste		m^3				
Wastewater		m^3				

Worksheet 13: Summary of RECP opportunities

8.0 GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

BAT — Best available technology and best available techniques (from environmental viewpoint)

BAT — covers both equipment and operational practice.

Best practice — The practice of seeking out, emulating and measuring performance against the best standard identifiable

BOD — Biochemical oxygen demand: a measure of the quantity of dissolved oxygen consumed by micro-organisms as the result of the breakdown of biodegradable constituents in wastewater

Bloodwater — The general term for all liquid separated from fish prior to cooking

CFC — Chlorofluorocarbon. CFCs have very good technical properties as coolants; however, they are implicated in causing depletion of the ozone layer, which protects humans, animals and crops against ultraviolet radiation. CFCs and HCFCs (hydrogenated chlorofluorocarbons) are being phased out according to the Montreal Protocol. CFC-11 is commonly known as Freon.

CIP — Cleaning in place: circulation of a cleaning solution through or over the surface of production equipment

CO_2 — Carbon dioxide

COD — Chemical oxygen demand: a measure of the quantity of dissolved oxygen consumed during chemical oxidation of wastewater

CP — Cleaner Production

CPA — Cleaner Production assessment

Effluent — The liquid discharged from a process or treatment system

EMS — Environmental management system

Eutrophication — Excessive growth of algae, reducing penetration of liquid through water and consuming large amounts of oxygen, resulting in a high risk of fish death due to lack of oxygen

FP — Final (or finished) product. See also RM below.

HCFC — Hydrogenated chlorofluorocarbon; see CFC.

ISO 14001 — International Standard ISO 14001 Environmental Management Systems: specification with guidance for use. International Organization for Standardization

N	Nitrogen
NOx	Nitrogen oxides; covers both NO2 (nitrogen dioxide) and NO (nitrogen monoxide)
Nobbing	A process of cutting the head from a fish while simultaneously removing the entrails
P	Phosphorus
PAH	Polycyclic aromatic hydrocarbons: occur in flue gases from combustion of fuel. Some PAHs are carcinogenic
RM	Raw material, in this case fish arriving at a certain process. Most key statistics in the fish processing industry are based on RM or final product
SO_x^-	Sulphur oxides; covers the various forms of gaseous sulphur oxide compounds found in combustion gases
SS	Suspended solids
TS	Total solids
UN	United Nations
UNEP DTIE	United Nations Environment Programme Division of Technology, Industry and Economics
UNIDO	United Nations Industrial Development Organization
US$	US dollars
VOC	Volatile organic compounds, e.g. solvents with a low boiling point

Units

bar	unit for measuring pressure (1 bar = 0.987 atmosphere)
J	joule (1 W = 1 J/s)
kg	kilogram
kW.h	kilowatt hour (1 kW.h = 3.6 MJ)
L	litre
lb	pound (1 lb = 0.454 kg)

m	metre
m^2	square metre
m^3	cubic metre (= 1000 L)
MJ	1 million joules (1 MJ = 0.278 kW.h)
MW.h	megawatt hour (1 MW.h = 1000 kW.h)
Nm^3	Normal cubic metre
t/tonne	tonne (= 1000 kg)

ABOUT LAKE VICTORIA ENVIRONMENTAL MANAGEMENT II (LVEMPII)

1.0 LVEMP II BACKGROUND

LVEMP II aims at contributing to the East African Community's (EAC) Vision and Strategy Framework for Management and Development of the Lake Victoria basin of having a prosperous population living in a healthy and sustainably managed environment providing equitable opportunities and benefits. The phase I of the Project runs in the period 2009-2013 and the second phase may last possibly to 2017 and will contribute to broad-based poverty alleviation and improvement of shared natural resources of the Lake Victoria Basin (LVB).

1.1 LVEMP II Specific Objectives

a) Improve collaborative management of trans-boundary natural resources of LVB for the shared benefits of the EAC Partner States.

b) Reduce environmental stress in targeted pollution hot spots and selected degraded sub-catchments to improve the livelihoods of communities who depend on the natural resources of the LVB.

1.2 LVEMP II is regarded as an instrument to:

1. Achieve stress reduction outcomes in priority hotspots i.e. the project's interventions are expected to have measurable impact on the estuaries, bays, and gulfs due to point source pollution control.

2. Lay a foundation for the long-term program for sustainable improvement in the environmental status and water quality.

2.0 CLEANER PRODUCTION SUB-COMPONENT OF LVEMP II

The sub-component on Promotion of Cleaner Production Technologies seeks to reduce point sources of pollution from industry, by supporting the uptake of cleaner technologies and techniques in industry so as to rehabilitate priority degraded sub-catchments of Lake Victoria. The Cleaner Production project seeks to increase the competitiveness of the Lake Basin industries by reducing wastes, and negative impacts whilst enhancing raw material utilization efficiencies by deploying cleaner technologies and techniques.

The project targets at building the capacity of industry through education, training and a "learning-by-doing" cleaner production audits. This is in line with the region's Vision Strategy that is looking at shifting industrial transformation from regulatory intervention to promotion of voluntary initiatives. The vision strategy specifically aims at (i) building the capacity of enterprises to formulate and implement pollution prevention strategies and programmes that will improve their competitiveness and productivity (ii) building up the capacity of the region to formulate and manage an overall strategy for industrial development within the framework of an open economy (iii) strengthening the capability of both the private and public sector players to manage development resources within the region leading to a quality environment and employment creation for poverty reduction.

2.1 Long Term Impact

The Cleaner Production project is expected to contribute towards the long-term impact of sustainable industrial development in the Lake Victoria Basin. This shall be realized through increased industrial productivity as well as by reduced industrial pollution loadings into the lake.

2.2 Project Development Objective (PDO)

The PDO of this project is "to promote the Utilization of Cleaner Production Technologies by industries in the Lake Victoria Basin"

The success of this Project Development Objective shall be evaluated through the following:

- » Adoption of integrated environmental management by industries and switch to Cleaner Production technologies and techniques
- » Reduced point source pollution from industries and enhanced efficiency of resource utilization

The interventions of the Cleaner Production sub-component shall be on:

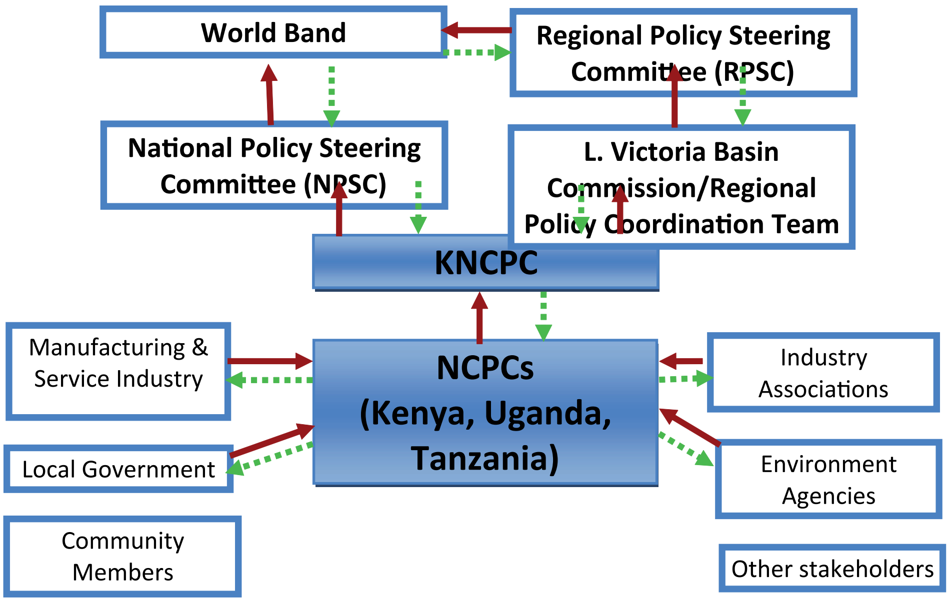
Component 1: The promotion of education, information dissemination, and training on resource efficient and cleaner production

Component 2: Promotion of cleaner production demonstration projects in enterprises through rapid and detailed in-plant assessments

3.0 INFORMATION FLOW

3.1: Information Flow Chart

Information flow and reporting hierarchy shall flow as below indicated.



KNCPC: Kenya National Cleaner Production Centre

NCPC: National Cleaner Production Centres

4.0 DATA COLLECTION

The sub-component shall collect both raw and historical data from industry pertaining to wastewater quantity and quality (BOD, COD, TN, and TP), solid waste volumes, production levels, energy and water consumption. These shall be used to determine the baseline performance levels before cleaner production intervention. Measurements of the same indicators shall be made after the CP intervention and improvement levels determined. All industries operating in the Lake Basin are expected to participate in the program.

5.0 THE MAIN INDICATORS FOR PROJECT PERFORMANCE

The principal indicator of the project success will be the enhanced readiness of industry and municipalities to develop and ultimately invest in cleaner production. It is recognized that the decision to invest will not depend exclusively on economic considerations, but will also consider company culture and social aspects. That is why awareness sessions to remove "myths" on cleaner production have been designed. In addition, the regional policy initiatives and of Governments will create a favourable working environment within which industry can implement cleaner production.

Specific indicators for success of the sub-component are:

i. Number of industries and technical staff trained in Cleaner Production from industry

ii. Number of industries implementing Cleaner Production Programs

iii. Number of Cleaner Production options identified and being implement

iv. The quantities of pollution reduced in tons per year and wastewater quality released

v. The efficiencies realized by industry in material, water and energy consumption per ton of product

vi. Public and industry awareness levels of the benefits of pollution prevention and waste minimisation and are involved with the project

vii. Indicators of formulated and implemented Cleaner Production strategies

viii. Development and implementation of national and regional Cleaner Production action plans

6.0 DATA ANALYSIS & REPORTING

Data collected from industry shall be written in a uniform report comprising the following:

- Rapid assessment: Short analysis, which assesses the quality of the crucial processes, pollution intensities, material and energy flows in order to identify the potentials for resource efficiency and cleaner production (RECP).
- Detailed assessment: Systematic modeling of production processes, identification of RECP options for waste reduction, technical and financial evaluation and implementation.
- EST transfer: Identification and evaluation of both front-and end-of-pipe technology transfer and development including support for the preparation of technology investment projects.

This shall enable the implementing partners to provide technical assistance to industry to develop effluent discharge management plans and environmental management systems to enable industry clusters/sectors comply with regulations & standards.

7.0 DISSEMINATION, FEED BACK AND REVIEW MECHANISM

The economic and environmental benefits realized from the Cleaner Production interventions in industry shall be disseminated in workshops, through newsletters, print media, the regional RECP network and websites. The regional communication strategy shall also guide on other appropriate channels for disseminating the information.