PRIDE Project in Development and the Environment

Pollution Prevention in the Moroccan Agroprocessing Industry

July 1994

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The objective of the Project in Development and the Environment (PRIDE) is to help the U.S. Agency for International Development (AID) design and implement programs that foster the agency's environmental and natural resources strategy for sustainable economic growth in the Near East and Eastern Europe.

PRIDE provides AID and participating countries with advisory assistance, training, and information services in four program areas: (1) strategic planning, (2) environmental policy analysis, (3) private sector initiatives, and (4) environmental information, education, communication, and institutional strengthening.

The project is being implemented by a consortium selected through open competition in 1991. Chemonics International is the prime contractor; subcontractors include RCG/Hagler, Bailly, Inc.; Science Applications International Corporation; Capital Systems Group, Inc.; Environomics, Inc.; Industrial Economics, Inc.; Lincoln University; and Resource Management International, Inc. In addition, AID has entered into a cooperative agreement with the World Environment Center to support implementation of PRIDE.

Pollution Prevention in the Moroccan Agroprocessing Industry

by
Christine Léger
Jean Tilly

July 1994

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INTRODUCTION

The Project in Development and the Environment (PRIDE) is funded by the United States Agency for International Development (USAID). The purpose of the PRIDE project is to help USAID develop and implement programs that aim to promote the Agency's strategy for the environment and natural and resources for sustainable economic growth in the Near East. PRIDE provides USAID and participating countries with technical assistance, training, and information services.

PRIDE hired two consultants, Christine Léger of RCG/Hagler, Bailly and Jean Tilly of Capital Systems Group, to assess the potential of the Moroccan agroprocessing industry to develop and implement pollution prevention strategies. The consultants carried out their mission from April 25 to May 19, 1994. Their work was based on meetings with officials of the Government of Morocco who are in charge of protecting the environment, manufacturers in the agroprocessing industry (see Annex B for list of persons contacted) and domestic and international studies in this field (see Annex A for the bibliography).

Ms. Léger and Mr. Tilly presented the findings of the study at a seminar on the development of agribusiness as part of private sector development. This seminar, organized by the World Bank and the Ministry of Agriculture and Agricultural Development, was held in Rabat on May 17 and 18, 1994.

The report is divided into six sections, as indicated in the table of contents:

1. The agroprocessing industry in Morocco
2. Pollution and the agroprocessing industry
3. The impacts of pollution
4. Morocco's reaction to pollution
5. Pollution prevention
6. Strategy for accelerating pollution prevention in Morocco

EXECUTIVE SUMMARY

Moroccan agribusiness (representing 5 percent of GDP and more than 20 percent of the exports) is one of the country's most polluting industrial sectors. Units processing agricultural products, especially sugar (beet and cane) and olive oil processing plants and fruit and vegetable canneries, use large quantities of water and their effluents are loaded with biodegradable organic materials (almost three-quarters of all biodegradable organic materials generated by Moroccan industry).

This pollution, primarily liquid and seasonal, seriously affects the regions where the agribusiness industry is located. One of the hardest hit areas is the Sebou Watershed (especially the area around Fez), which produces more than 80 percent of Moroccan olive oil.

Water quality is worsening. Since 1988, two water purification plants located on the Sebou Watershed and supplying the city of Fez have had to shut down each year during the olive oil processing season because they can no longer purify the water polluted by effluents from the processing plants. Industrial (mostly agribusiness), urban, and agricultural effluents use all the oxygen required to keep the Sebou alive, effectively killing the river for 22 miles downstream from Fez.

In addition, the incidence of waterborne disease is high. The Sebou and Oum Er Rbia Wadis are the most important starting points and propagation zones for these diseases. The Public Health Ministry has described Fez as "cholera's hub."

Moroccan industry has significant potential for reducing its effluents. For example, Moroccan beet sugar plant effluents (on average 2 m^3/tonne of beet) are five times higher than good European and U.S. plants (e.g., 0.4 m^3/tonne[1] of beet in Belgium), and Moroccan cane sugar plant effluents are between two and 10 times higher than the typical plants in India or the United States.

Moroccan industry has tended to resist installing pollution control equipment because of its relatively high cost. However, in recent years a new approach, pollution prevention (or clean technology), offers opportunities to improve efficiency and product quality while reducing pollution. These technologies and practices focus on process changes, recycling, waste minimization, conservation, and material substitution to reduce pollutants, increase efficiency, and reduce overall production costs. They differ substantially from the traditional "end-of-pipe" treatments that try only to clean up pollutants after they have been generated in the process. The "end-of-pipe" approaches simply add to capital and operating costs without affecting plant output. Experience in the U.S. and some developing countries has shown

[1] One tonne = one metric ton or 2,200 pounds.

pollution prevention approaches can reduce plant emissions by 20 to 60 percent at little or no cost, or through investments that pay back in less than one year.

Some Moroccan industries, especially the sugar industry, have recently made noticeable efforts to reduce their pollution. They have reduced water consumption, increased the efficiency of their manufacturing processes, and partially stored their effluents. In the past 10 years, sugar plants have reduced their effluents by 30 to 70 percent and their polluting load by 30 percent. One of the largest olive oil processing plants has just implemented recycling techniques to reduce water consumption by 25 percent in 1995 and by more than 90 percent in 1996. Olive oil processing plants are trying to identify landfills outside of cities instead of disposing their margines (residues) directly into the wadis. Canneries currently seem less advanced in pollution prevention efforts but appear aware that they will have to make efforts soon.

How can Morocco speed up pollution prevention? The country should immediately develop a strategy of integrated pollution control and prevention. This strategy, adapted to the country's socio-economic conditions, would include regulations to control pollution without slowing down development. Several types of action are possible to decrease pollution and treat or dispose of effluents.

Economic and financial actions

- Increase the price of water to reflect its true marginal cost and generalize the sanitation tax already in place in Casablanca and Rabat. Financial advantages of pollution prevention in the agribusiness sector come primarily from conserving and recycling water, but as long as the government keeps water prices artificially low, these advantages do not materialize.

- Increase economic incentives (grants, loans) allowing industries to invest in order to comply with the new standards. The code of industrial investments already has a few financial incentives to encourage water and energy savings.

- Take advantage of the upcoming privatization of public companies, especially sugar companies, to reduce their effluents. The use of clean technologies and compliance with manufacturing standards protecting the environment increase a company's profits.

Awareness actions

- Work to make industries aware of pollution prevention (the U.S. government has done it for several years). An awareness campaign would be more effective if strict standards were in place and enforced, thus increasing downstream treatment costs and inviting companies to reduce these costs upstream.

- Encourage pollution prevention audits to identify potential savings. The GEM (Energy Management in Moroccan Companies and Clean Technologies) project

financed by USAID conducts such audits to encourage the development of clean technologies and inform industries of potential savings while protecting the environment.

- Inform financial decision makers (within the industry and the banks) about pollution prevention and show them the profitability of investment in pollution prevention equipment.

Training

- Prepare industries for upcoming regulations by strengthening trade associations such as the APS (Association des Producteurs de Sucre) and the FICOPAM (Fédération Interprofessionnelle des Conserveries de Produits Agricoles Marocains). An industrial sector capable of defining its pollution load and identifying possible remedies can be a key partner of the government in promulgating regulations to fight pollution.

- Include pollution prevention in the training of agribusiness engineers (future operators and decisionmakers) and in the ongoing training on manufacturing processes.

A major pollution prevention program for Moroccan industry will not completely eliminate the need to treat agribusiness wastewaters. However, it will reduce the amount of water that must be treated, reducing the capital and operating costs of these final treatment facilities. This in turn will help sustain economic development while protecting public health and welfare.

SECTION I

THE AGROPROCESSING INDUSTRY IN MOROCCO

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This section compares the economic influence of the agroprocessing industry with that of other industrial sectors in Morocco. It focuses on the sugar, olive oil, and fruit and vegetable canning industries, because they pollute the environment the most (see Section II).

A. Scope of the Agroprocessing Industry

Production from the agroprocessing industry in Morocco amounted to 110 billion dirhams in 1991. The agroprocessing, chemical, and parachemical (detergents and other chemical derivatives) industries are the largest in the country (Figure 1). The agroprocessing industry generated 35 billion dirhams[1] (32 percent of industrial production) and the chemical and parachemical industry generated 34 billion dirhams (31 percent of industrial production). With 1,500 production plants, the agroprocessing industry accounts for 26 percent of industrial plants.

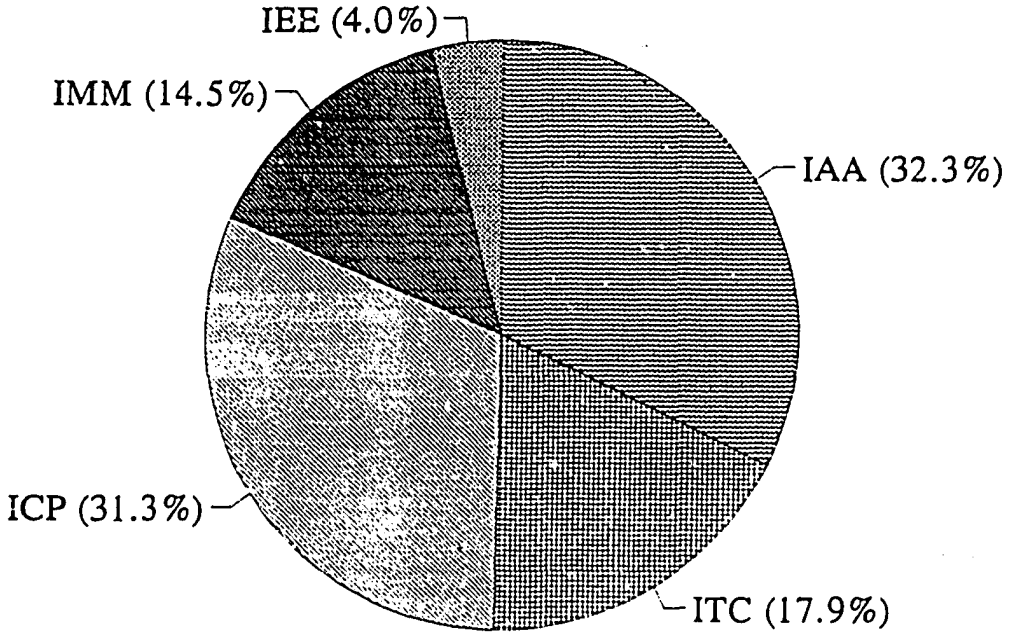
Domestic industrial production rose by 30 percent in current dirhams between 1988 and 1991 (Figure 2). The high-growth industries are electricity and electronics, where production rose by 70 percent. The agroprocessing industry increased production by 28 percent and contributed 30 percent to total growth between 1988 and 1991.

Added value in the industrial sector was 34 billion dirhams in 1991. The GDP in the industrial sector was 43 billion dirhams, or 18.6 percent of Morocco's GDP. With 11.6 billion dirhams or 35 percent of added value, the agroprocessing industry is ahead of the chemical and parachemical industry, which has 31 percent (Figure 3), and the agroprocessing industry amounts to 5 percent of GDP.

Industry exports amount to 28 billion dirhams or 25 percent of industrial production. In 1991, 230 of the 1,500 units exported products worth 5.5 billion dirhams or 20 percent of exports. The agroprocessing industry was slightly behind the chemical and parachemical industry and the textile and leather industry (Figure 4). Since 1988, exports have grown by 34 percent in current dirhams for the entire industrial sector. All sectors experienced strong growth in excess of 60 percent (63 percent for the agroprocessing industry), except the chemical and parachemical industry, where exports dropped 7 percent between 1988 and 1991.

[1] Nine dirhams = approximately one U.S. dollar.
$ 1 US = 9.3 dirhams (May, 1994)

FIGURE 1
INDUSTRIAL PRODUCTION IN MOROCCO



IAA Agroprocessing Industry
ITC Textile & Leather Industry
ICP Chemical & Parachemical Industry
IMM Mechanical & Metallurgic Industry
IEE Electricity & Electronics Industry

FIGURE 2 EVOLUTION OF INDUSTRIAL PRODUCTION IN MOROCCO (1988-1991)

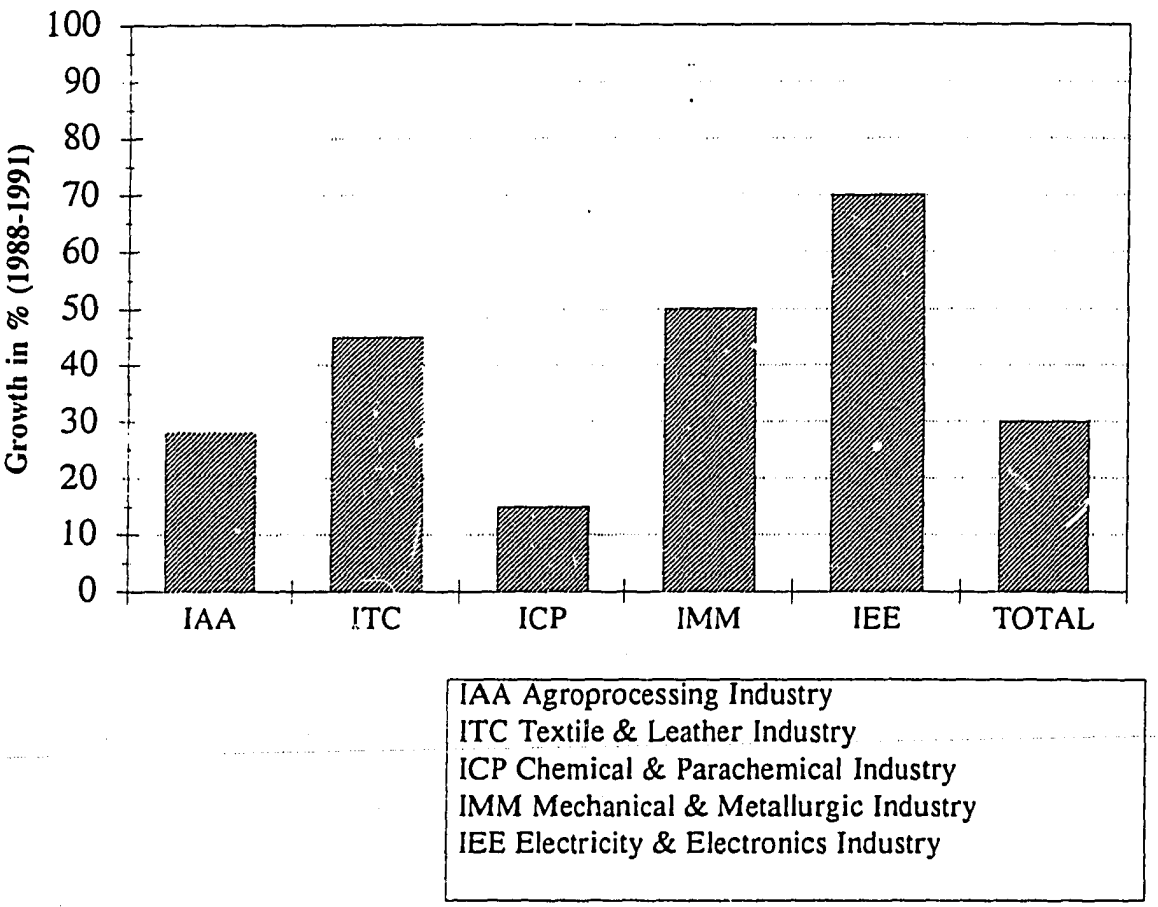
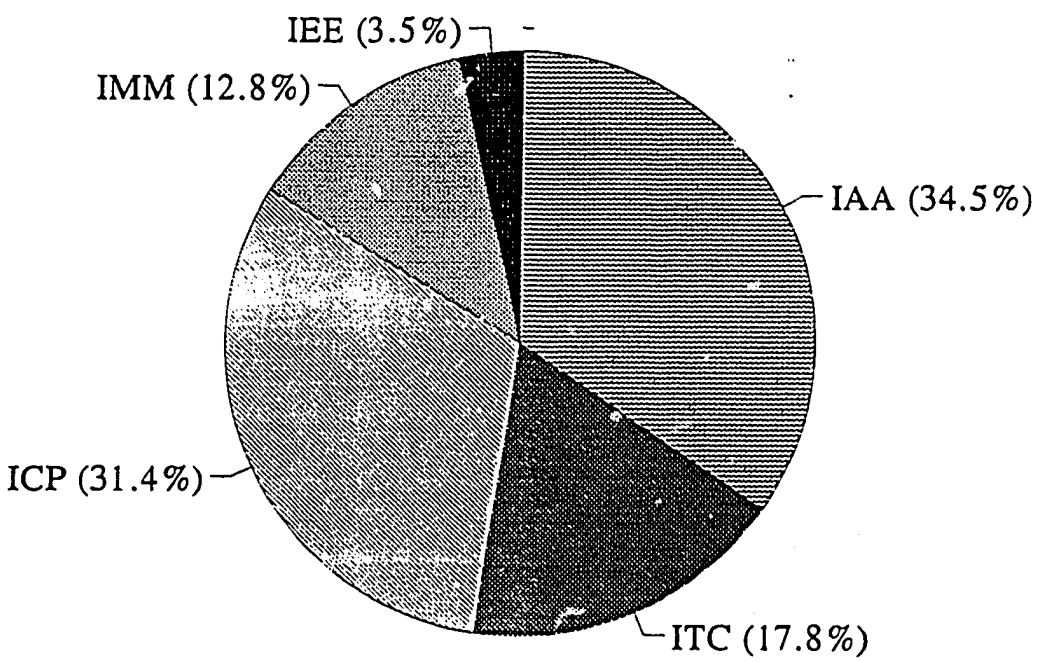


FIGURE 3 : INDUSTRIAL ADDED VALUE IN MOROCCO



IAA Agroprocessing Industry
ITC Textile & Leather Industry
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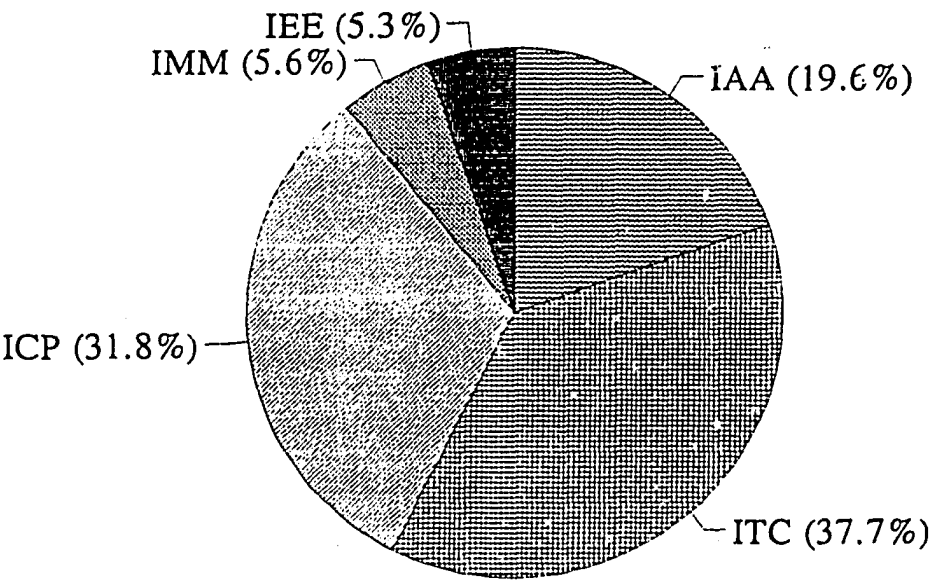
IMM Mechanical & Metallurgic Industry
IEE Electricity & Electronics Industry

FIGURE 4
INDUSTRIAL EXPORTS



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Investments in industry rose to 7.7 billion dirhams in 1991. Investments in the chemical and parachemical industry were the highest, with 38 percent of the total. Next came agroprocessing and the textile and leather industry, each with 25 percent of investments. Investments reflect the dynamics of an industry and interest in that industry at home and abroad. In 1991, investments in agroprocessing dropped by 6 percent from the 1990 level due to the drought of the last three years and the recession affecting the importing nations of Europe.

B. Main Agroprocessing Activities

The Ministry of Commerce and Industry (MCI) divides the agroprocessing industry into branches and sub-branches as listed in Annex C. The three largest branches are cereal and sugar processing, animal and vegetable canning factories, and the oil and fatty substance industries. These branches are further divided into sub-branches that include grain processing, the sugar industry, fruit and vegetable canning, seafood canning, and the fatty substance industry. The three branches account for 70 percent of agribusiness production and 94 percent of agribusiness exports (87 percent for canned vegetables and seafood and 40 percent of added value). (Figure 5).

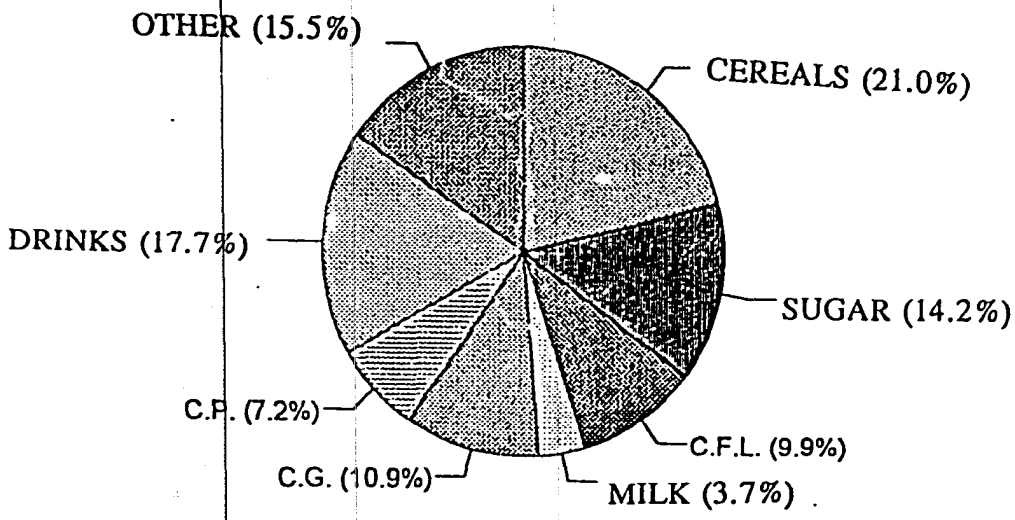
The following pages provide details about the sugar, olive oil, and fruit and vegetable canning industries, which generate the most pollution.

B1. Sugar

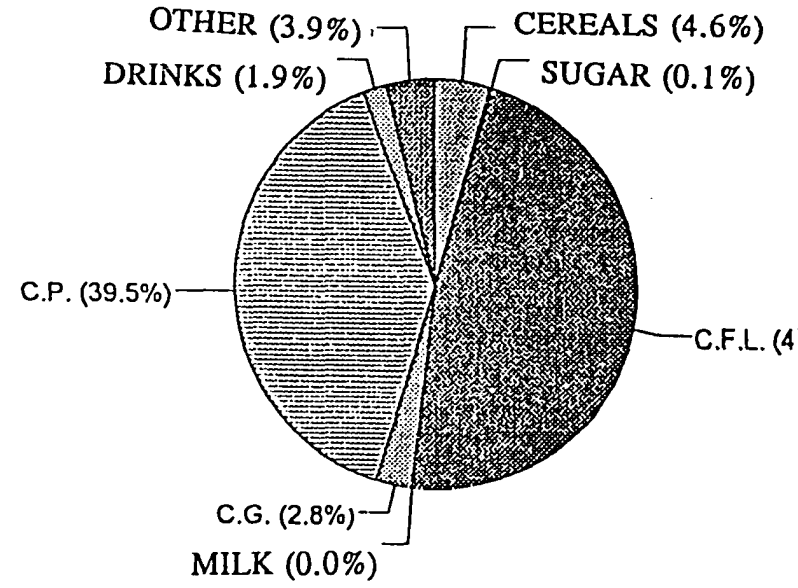
In 1991, sugar production amounted to over 5 billion dirhams and accounted for 14 percent of agroprocessing in the country, 6 percent of the country's industrial added value and 5.4 percent of industrial production. The sugar industry has the highest added value in the agroprocessing industry. Until 1992, this industry was a protected market. The government set prices for beets and sugar and controlled imports of unrefined sugar. The government still controls the price of sugar but has deregulated imports. Customs duties on imported sugar make it just as expensive as local sugar. Morocco's self-sufficiency in sugar, which was 70 percent at the end of the 1980s, fell to 50 percent in 1992, when consumption amounted to 810,000 tons and imports were 400,000 tons (STAT, 1993).

Morocco's sugar industry is composed of 15 plants, three of which are private and owned by Groupe ONA. The others are companies in which the government is the majority shareholder. Three of them, located in Tadla, are slated to be privatized by the end of 1994. The 15 sugar plants are in the Oum Er Rbia Watershed (Tadla units), Sebou Watershed (Gharb units), and Tensift Watershed (Doukkala units) (Figure 6). These units are located inside or close to irrigated sugar beet or sugar cane producing areas where the climate and availability of water for irrigation are conducive for these crops. The areas are Moulouya, Loukkos, Gharb, Tadla, and Doukkala. The Tadla, Doukkala, and Gharb plants produce 70 percent of the sugar (Doukkala produces 30 percent and the two others produce 20 percent each).

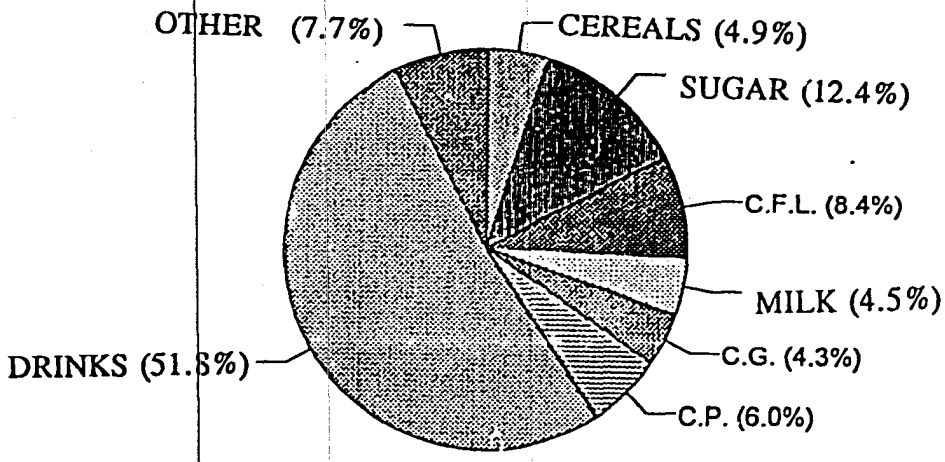
FIGURE 5: PRINCIPAL AGROPROCESSING SECTORS



PRODUCTION

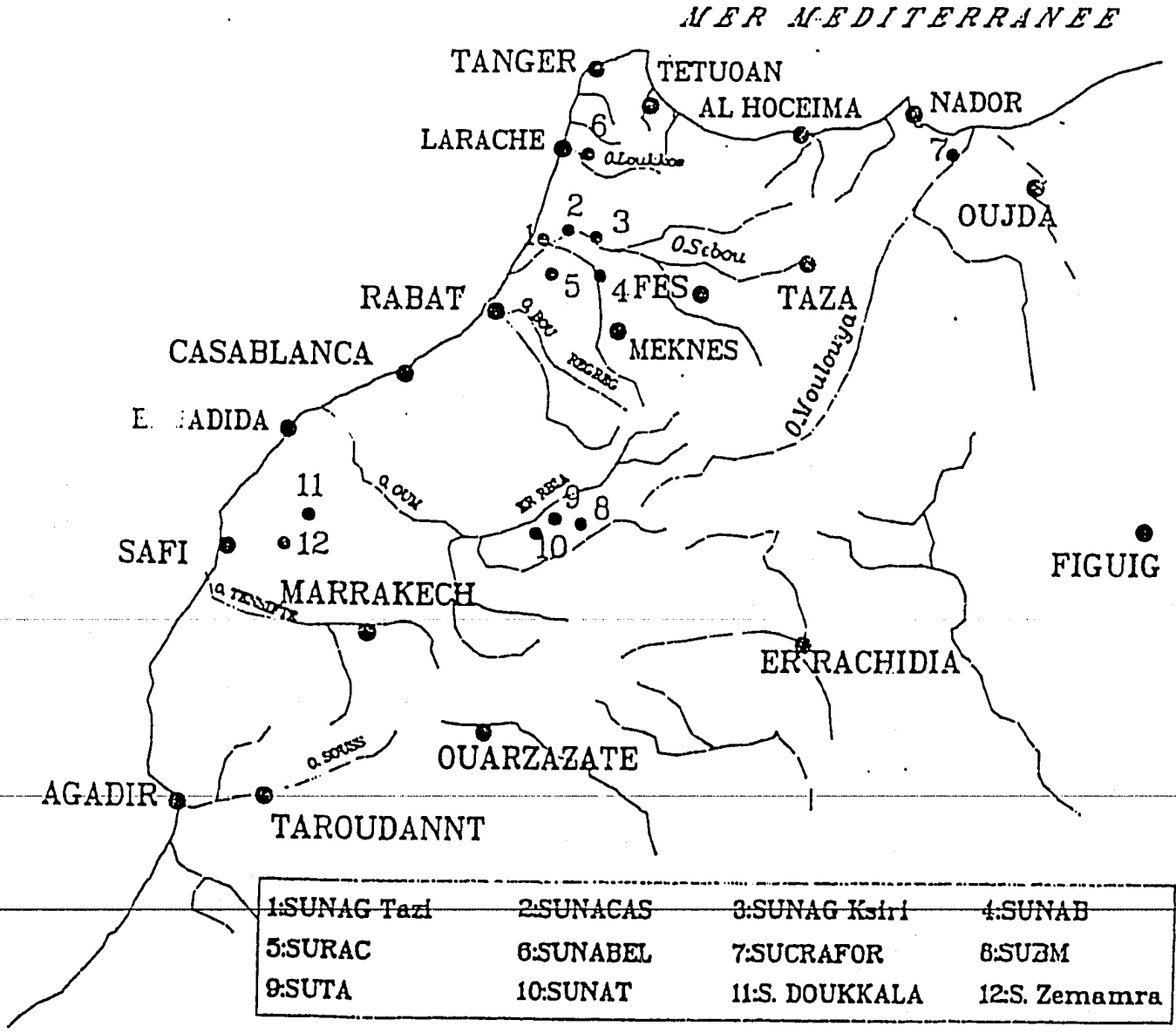


EXPORTATION



C.F.L. FRUIT AND VEGETABLE CANNING
C.G. FATTY SUBSTANCE
C.P. SEAFOOD CANNING

FIGURE 6: MAP OF SUGAR PRODUCTION SITES



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Seventy-five percent of sugar mill capacity is for beets and 25 percent for sugar cane, although only 20 percent of sugar actually comes from sugar cane. Among the units, three are only capable of processing unrefined sugar into white sugar, seven are capable of producing unrefined sugar and then refining it into white sugar, and five can only produce unrefined sugar (USAID, 1990) All the units produce white sugar sold as granulated sugar, sugar cubes, or loaves. The use of capacity for producing unrefined sugar varies from 55 to 95 percent.

Byproducts of the sugar industry include molasses, used in the animal feed industry as substrate for producing yeast and as an ingredient in the production of ethyl alcohol and citric acid; beet pulp and dry granulated beet pulp sold to cattle farmers; and bagasse used as a source of energy.

B2. Fatty Substances

Production in the fatty substances industry amounted to 4 billion dirhams in 1991. The olive oil industry produced 51,000 tons, representing 5 percent of the production value. Other oils are from the sunflower, colza, soy, and cotton. The olive oil industry is dominated by small traditional units known as "maasras" which produce 25,000 tons of oil per year, or 50 percent of Morocco's production. Alongside this traditional sector, industrial plants that process olive oil produced only 18,000 tons of olive oil in 1988 (FAO, 1988). These plants consist of small units (producing 8 to 10 tons of oil per year) and other more industrial units (producing 2,000 to 2,500 tons of oil per year). These oil mills (more than 110 units out of a total of 170) are concentrated in the North Central region (Fez and Meknes and in the Marrakech region to a lesser extent). The 170 industrial plants that manufacture olive oil use outmoded technologies. Only five are equipped to work on a continuous basis and can produce high-quality oil. The seed crushers-refiners-conditioners primarily process oil from seeds, but they also process 8,000 tons of olive oil each year.

Byproducts of the olive oil mills include margine that spills into the wadis or is sometimes stored before it evaporates; and olive grignon used as fuel after crushing, primarily in brick factories.

B3. Canning

In 1991, 146 fruit and vegetable canning factories generated 3.5 billion dirhams (10 percent of the agroprocessing industry) and exports amounted to 2.55 billion dirhams (47 percent of the industry's exports) broken down as indicated in Table 1.

Fruits and vegetables are canned in the vegetable growing areas along the Atlantic coast and the Agadir region, as well as in Casablanca and Tangier for export as indicated in Table 2. The basins involved are the Tensift and Loukkos. In Casablanca, a major industrial production region, discharges from the units find their way into the city's sanitation system.

Table 1: Canned Fruits and Vegetables

Type of product	Quantity (Tons per year)	Share of production value (%)
Condiments (pickles, olives, capers, onions)	99,813	37
Fruit juices (citrus)	21,661	18
Vegetables (tomatoes, green beans, peas, peppers)	35,608	16
Dehydrated, dried, evaporated, or crushed products	24,130	12
Frozen fruits and vegetables	9,752	6
Fruits (mainly apricots)	19,299	6
Jams and jellies	9,217	4

Source: MCIP, 1992

Canning and processing techniques are still rudimentary and unsophisticated, mainly sterilization (canning) and/or cooking. Dehydration and freezing are beginning to develop. These processes produce effluent rich in organic matter but it is not contaminated by chemicals or microbiological products. The effluent consists mainly of water from scrubbing and cooling. Few of the products are processed through cracking, mixing, chemical treatment, or microbiological action.

Table 2: Location of Canning Plants According to Product

Principal products	Predominate location
Olives	Marrakech
Pickles	Casablanca, Mohammedia
Capers	Fez, Marrakech
Green beans	Casablanca, Larache
Frozen fruits and vegetables	Casablanca, Rabat, Safi
Apricots	Marrakech
Tomatoes	Larache, Atlantic Coast.
Fruit juices (citrus)	Kénitra, Casablanca, Agadir

Source: World Bank, 1993

B4. Other Agroprocessing Activities

B4a. Milk

In 1991, 19 dairies produced 400 million liters of milk (4 percent of agroprocessing production, 5 percent of added value)

B4b. Fruit Juices (Citrus)

Citrus fruit juices represent 18 percent of canned fruits and vegetables (Table 1). This share has been declining since 1988/89. This industry produces large amounts of liquid and solid waste. The three plants (Kénitra, Casablanca, and Agadir) that belong to FRUMAT have modern equipment and produce excellent juice.

SECTION II

POLLUTION AND THE AGROPROCESSING INDUSTRY

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Agroprocessing is one of Morocco's most polluting industries. Plants that process farm products, particularly sugar mills (both beets and sugar cane), olive oil mills, and fruit and vegetable canning plants consume large volumes of water and discharge effluent high in organic and biodegradable matter, amounting to nearly three-quarters of all organic biodegradable effluent produced by Moroccan industry.

A. Water Consumption

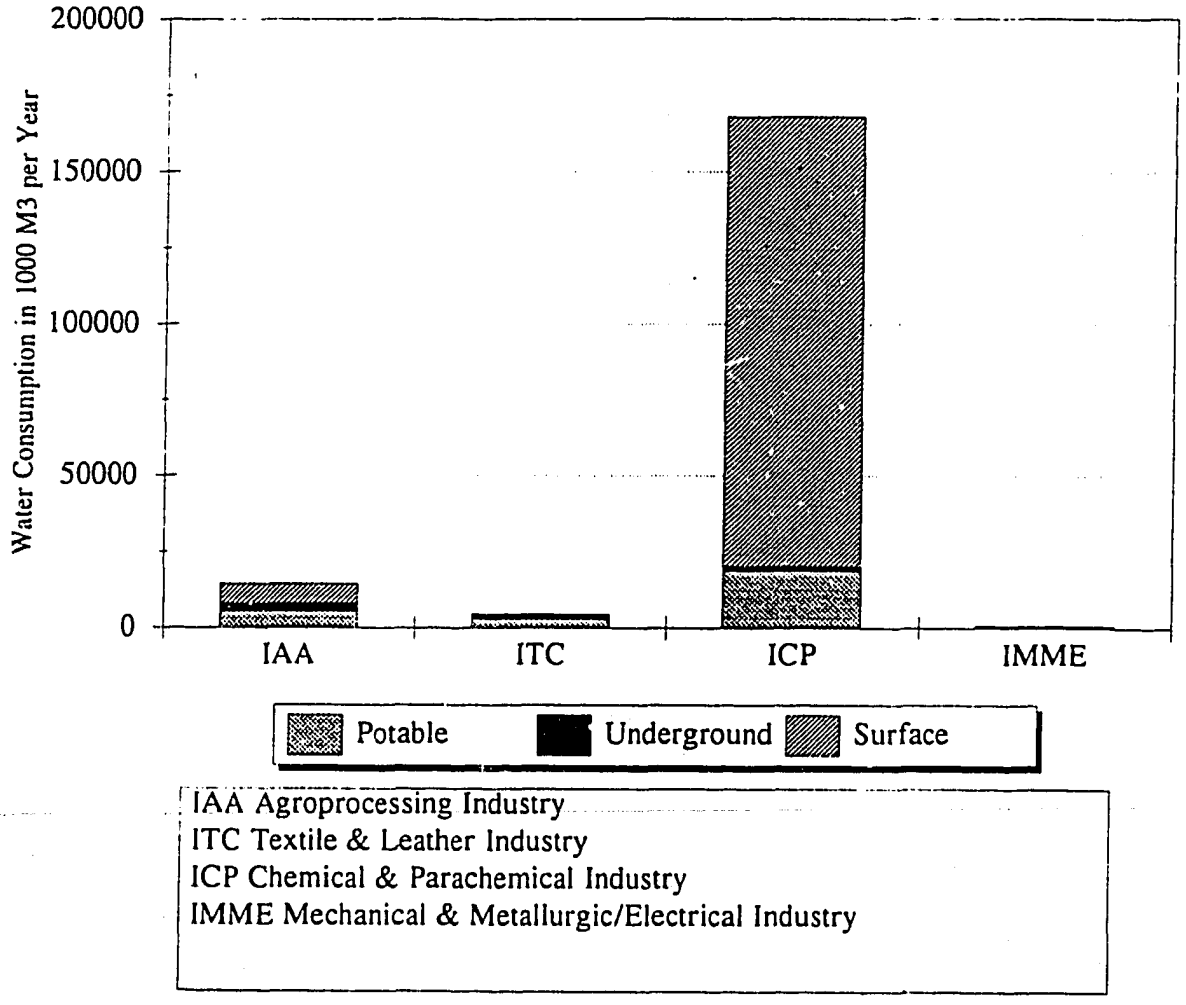
Agroprocessing consumes more underground water than any other industry and is the second largest user of drinking water after the chemical and parachemical industry (Table 3, Figure 7).

Table 3: Water Consumption of the Different Industries in Morocco

Industry	Water consumption (1,000 m^3 per year)			
	Drinking*	Underground	Surface	Sea
Agroprocessing	5,600	2,300	6,650	1,600
Textiles and leather	3,000	1,760	0	0
Chemical and parachemical	18,800	1,540	147,600	875,500
Mechanics, metallurgy and electricity	560	160	210	0
TOTAL	27,960	5,760	154,460	877,100

* Drinking water is water pumped over the existing system.
Source: MCIP, 1993a

FIGURE 7 : WATER CONSUMPTION PER INDUSTRIAL SECTOR



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The agroprocessing industries that pollute the most are sugar mills and refineries, oil mills, and fruit and vegetable canning factories (Table 5, Figure 9).

B. Types and Quantities of Pollutants

Pollution from agroprocessing is essentially biodegradable, organic, and non-toxic. There is liquid effluent, plus solid waste and gaseous discharges.

Three parameters characterize water pollution:

- Chemical oxygen demand (COD), or the amount of oxygen required to oxidize the harmful mineral and organic oxidizable matter in sewage;
- Biological oxygen demand (BOD_5), or the amount of oxygen that microorganisms in sewage need to breath and reproduce; and
- Suspended solids (SS), i.e., undissolved solids in water.

According to a preliminary study of industrial waste conducted in 1993 by the Ministry of Commerce, Industry and Privatization, discharges from the agroprocessing industries amount to 10 million m^3 with significant amounts of organic matter. The COD and BOD_5 discharged by these industries account for 76 percent and 72 percent of COD and BOD_5 discharged by all industries in Morocco (Table 4, Figure 8).

Table 4: Extent of Pollution Generated by the Agroprocessing Industry

Parameter	Quantity or volume discharged by the agroprocessing industry	% of discharge from all industries in Morocco
Liquid discharge	10 million m3	1
SS	7,980 tons per year	0.1
COD	26,460 tons per year	76
BOD5	12,600 tons per year	72
Solid waste	310,000 tons per year	51

Source: MCIP, 1993a

Agroprocessing industries generate vast amounts of solid waste, a total of 310,000 tons per year; this represents 51 percent of all waste generated by industry in Morocco (the chemical and parachemical industries produce 270,000 tons per year, or 45 percent of the total). The fuels these industries use also pollute the air.

FIGURE 8 : IAA INDUSTRIAL WASTE AS COMPARED TO ALL INDUSTRIES

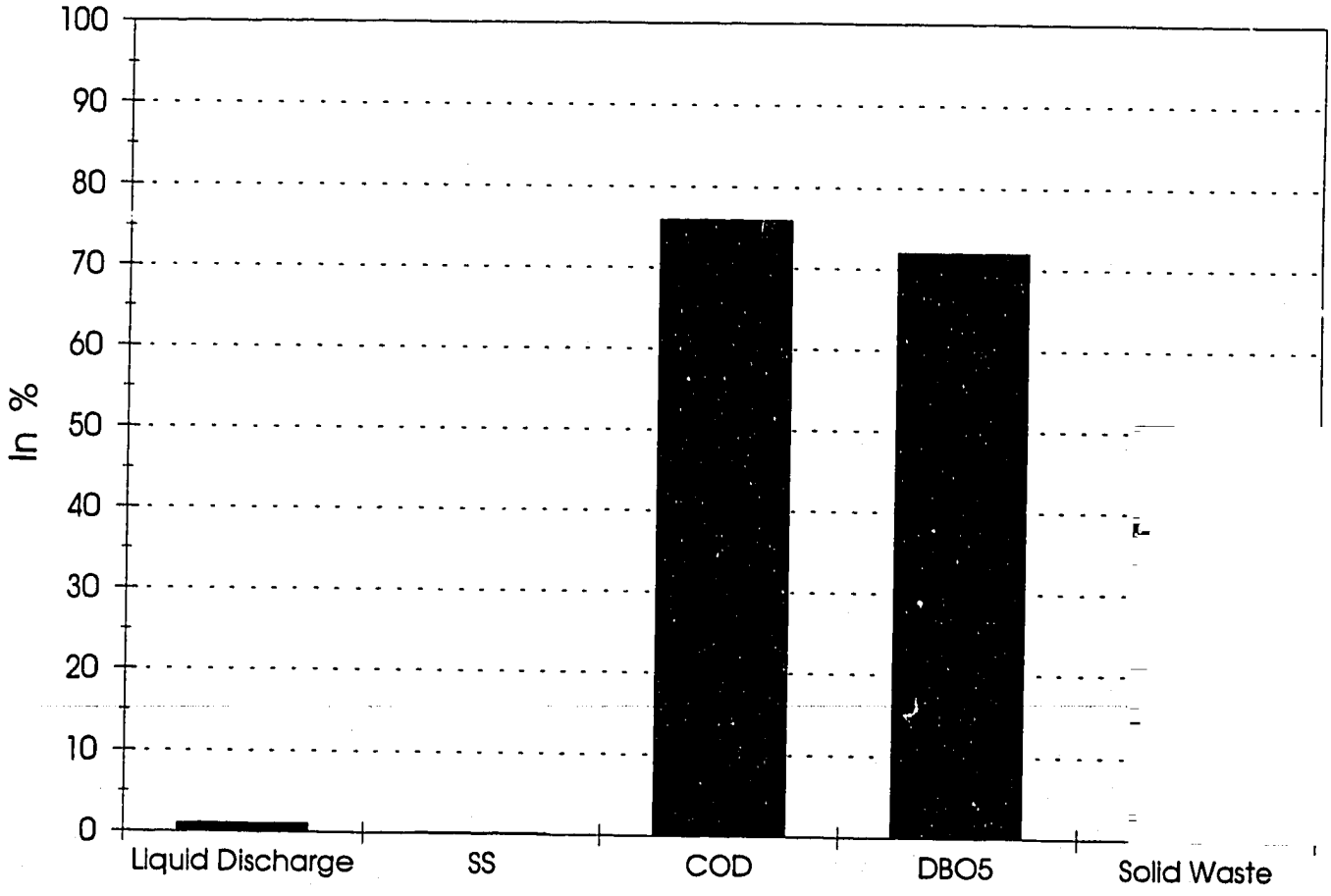

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Table 5: Most Heavily Polluting Agroprocessing Industries

Industrial sector*	Discharges (millions of m3 per year)	SS (tons per year)	COD (tons per year)	BOD_5 (tons per year)	Pollution in Inhabitant-Equivalent **
10.3 Sugar	4.5	1,200	8,300	3,200	400,000
11.1 Fruit and vegetable canning	3	500	3,000	2,000	145,000
11.5 Production of fatty substances (oil mills)	0.64	4,936	12.380	5,975	595,000
TOTAL	8.14	6,636	23.680	11.175	1,135,000
Pollution from the agroprocessing industry (Branches 10, 11 and 12)	10	7,980	26.460	12.500	1,270,000
Share of pollution from sugar mills, oil mills and canning factories relative to total pollution from the agroprocessing industry	81.4	83.2	89.5	88.7	89.4

* Ranking according to the Moroccan classification of economic activities (Annex 2)

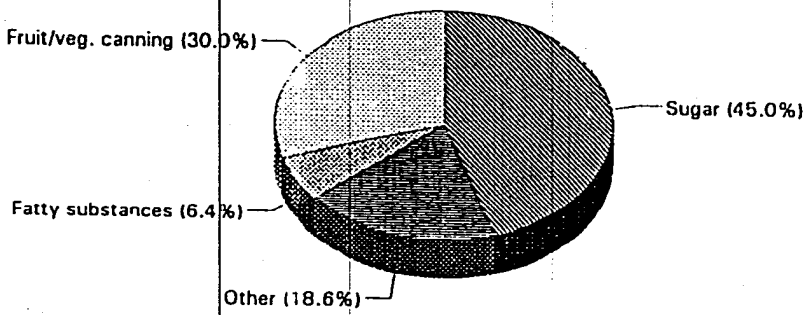
** To make it possible to compare sources of pollution, the inhabitant-equivalent was calculated assuming the following discharges per inhabitant per day: 57g of COD, 54g of BOD_5 and 90g of SS (source: MCIP, 1991). Pollution from sugar mills, oil mills and canning factories is distributed over 12 months instead of 3 (or 6) of a growing season. However, these equivalents suppress the "intensity" of pollution by distributing it over the year. For instance, during the growing season, the discharge from sugar mills is equivalent to the discharge from a city of 2.2 million inhabitants (Table 8) as opposed to 400,000 inhabitants.

Source: MCIP, 1993a

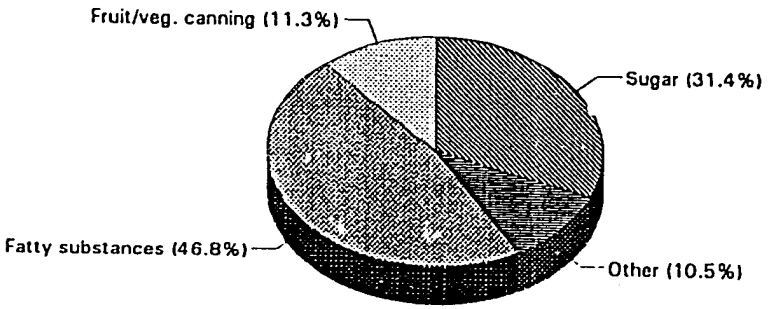
B1. Discharges from Sugar Mills and Refineries

Large sugar mills and refineries work on a seasonal basis, since the sugar cane season is from January to June and the beet season is from June to August. During these periods, sugar mills, which consume large amounts of water (80,000 m^3 per day, 60 to 165 days per year), discharge liquid organic matter that absorbs the oxygen in the waterways into which it pours. The water consumed by sugar beet factories (Table 6) is used for washing and carrying beets; cooling; diffusion for extracting the sugar; and washing the floors, tanks, and machines. Water used for washing and carrying amounts to 50 percent of organic matter pollution and 90 percent of suspended matter pollution. Specific discharges vary from 0.16 to 7.98 m^3 per ton of beets and from 1 to 1.2 m^3 per ton of sugar cane, while the national average is approximately 2 m^3 per ton of beets.

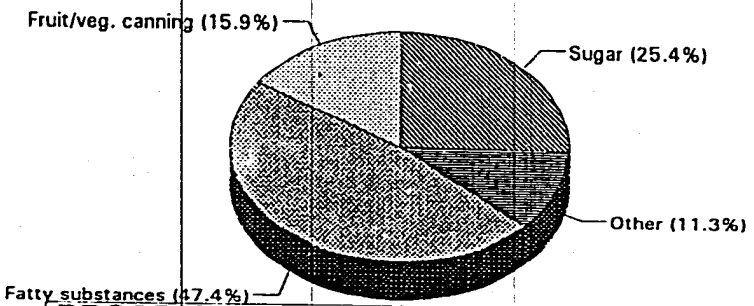
FIGURE 9 : AGROPROCESSING SECTORS THAT POLLUTE THE MOST



INDUSTRIAL WASTE DISTRIBUTION
(TOTAL INDUSTRIAL WASTE
10 MILLIONS OF M3/YEAR)



COD DISTRIBUTION
(COD TOTAL 26,460 T/YEAR)



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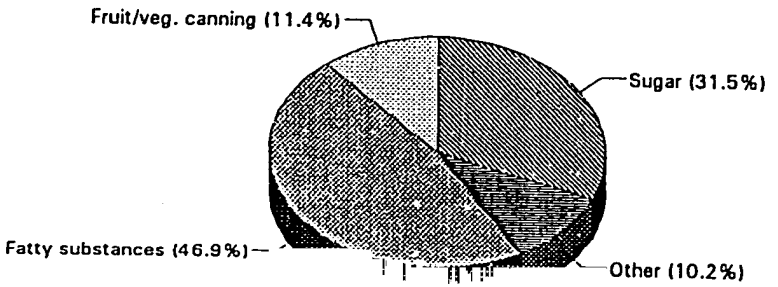

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Table 6: Characteristics of Effluents from Sugar Beet Factories

Effluent	Specific flow rate in kg per t of beets		
	SS	COD	BOD_5
Water for washing and carrying	93	5	2.5
Scum (residue from purification of juices)	0.1	2	1
Eluate from the demineralization of sweetened juices	–	8	4
Condensed water from the evaporation of sweetened juices	0.2	0.37	0.18

Source: MCIP, 1991

Two-thirds of this effluent flows into the Oum Er Rbia and Sebou Watersheds (Figure 6). The remaining third spreads over the fields (17 percent) and filters into ground water; evaporates due to the heat; or is stored in the vicinity of the factories (17 percent).

Nearly 200,000 tons of solid waste (sludge, scum, and sand) per year is deposited near factories. The mud from the beets is rich in lime and minerals, making it difficult to use, because Moroccan soil already has a high lime content. It needs to be mixed in with other materials to dilute the lime content.

About 112,000 tons of oil per year is used to generate energy for the sugar mills, emitting over 120,000 tons of carbon dioxide each year.

B2. Discharges from Fruit and Vegetable Canning Factories

Each year fruit and vegetable canning factories discharge the following:

- Three million m^3 of water, one million of which is sea water that was used to rinse raw materials. Almost 2.5 million m^3 of this waste water is discharged into the Atlantic Ocean. These discharges have less organic matter than those from the oil and sugar mills.
- 20,000 tons of solid waste, mainly peels, half of which are sold to breeders, while the other half are discarded.
- Gaseous discharges from burning 20,000 tons of oil.

B3. Discharges from Oil Mills

Each year oil mills discharge the following:

- 640,000 m^3 of margines from crushing olives and organic matter from vegetable oil refineries. The Atlantic Ocean receives 420,000 m^3, while the remainder finds its way into the Sebou and Tensift Wadis. These discharges represent almost 50 percent of the BOD and COD from the agroprocessing industry.

- 400 ons of bleaching earth used in vegetable oil refineries and 27,000 tons of olive residue, 30 percent of which is used again in oil mills, while 70 percent is sold as fuel, mainly in brick factories.

- Gaseous discharges from burning 15,000 tons of oil and 8,000 tons of olive residue.

The study of the impact of industrial discharges on water quality in the Sebou Watershed (MCIP, 1993b) classified discharges from oil mills as the top priority for action due to the high quantity of organic matter discharged over a short period of time.

B4. Discharges from Other Activities

Pollution from dairies is negligible (3 percent of BOD or COD from the agroprocessing industry; MCIP, 1993a). The liquid discharges from this industry flow into Casablanca's and Rabat's sewage systems (50 percent of capacity). Intensified recycling would help reduce the sewer fees that dairies pay to municipalities (World Bank, 1993).

The problems caused by discharges from the orange juice industry have been largely solved by installing "reheaters" to treat citrus peels and extract the water and essential oils. Certain local operational problems are now being resolved (World Bank, 1993).

SECTION III

THE IMPACTS OF POLLUTION

SECTION III
THE IMPACTS OF POLLUTION

Pollution seriously affects human health, water availability and quality, exports, and tourism in certain regions.

A. Public Health

Statistics from the Ministry of Public Health (MSP) on the major waterborne diseases, including typhoid, cholera, and viral and gastrointestinal hepatitis over the last 20 years (MSP, 1994) indicate two trends:

- Since the 1970s there have been three major cholera epidemics with a continuously growing incidence (Figure 10). The Sebou Watershed (Figure 11) is still the most affected area, particularly the Fez region, which has been called "cholera's hub." The Oum Er Rbia Watershed is also a highly susceptible region.

- Typhoid is clearly on the decline nationwide. However, many of the regions experiencing a heavy outbreak of typhoid are located in the Sebou and Oum Er Rbia Watersheds.

The Fez region produces 80 percent of Morocco's olive oil. Discharges during a production season are the equivalent of pollution from a city of 550,000 people, which is equal to half the population of the city of Fez. Similarly, the Oum Er Rbia Watershed, the second largest area for the spread of cholera, is heavily polluted by the sugar industries in Tadla.

Pollution from agroprocessing in the Sebou and Oum Er Rbia Watersheds is not the only source of waterborne diseases in these areas. Other factors, such as urban and agricultural pollution, as well as heavy population pressures in the Sebou area, promote the development and spread of these diseases.

B. Water

Pollution from agroprocessing decreases the availability of water and diminishes water quality.

B1. Water Availability

Due to demographic changes, water availability per inhabitant has been dropping continuously, a decline accelerated by the intermittent drought affecting the country (Figure 12). The agroprocessing industry is contributing to the decrease in the potential

FIGURE 10 : NATIONAL RATE OF INCIDENCE OF CHOLERA FROM 1970 TO 1990

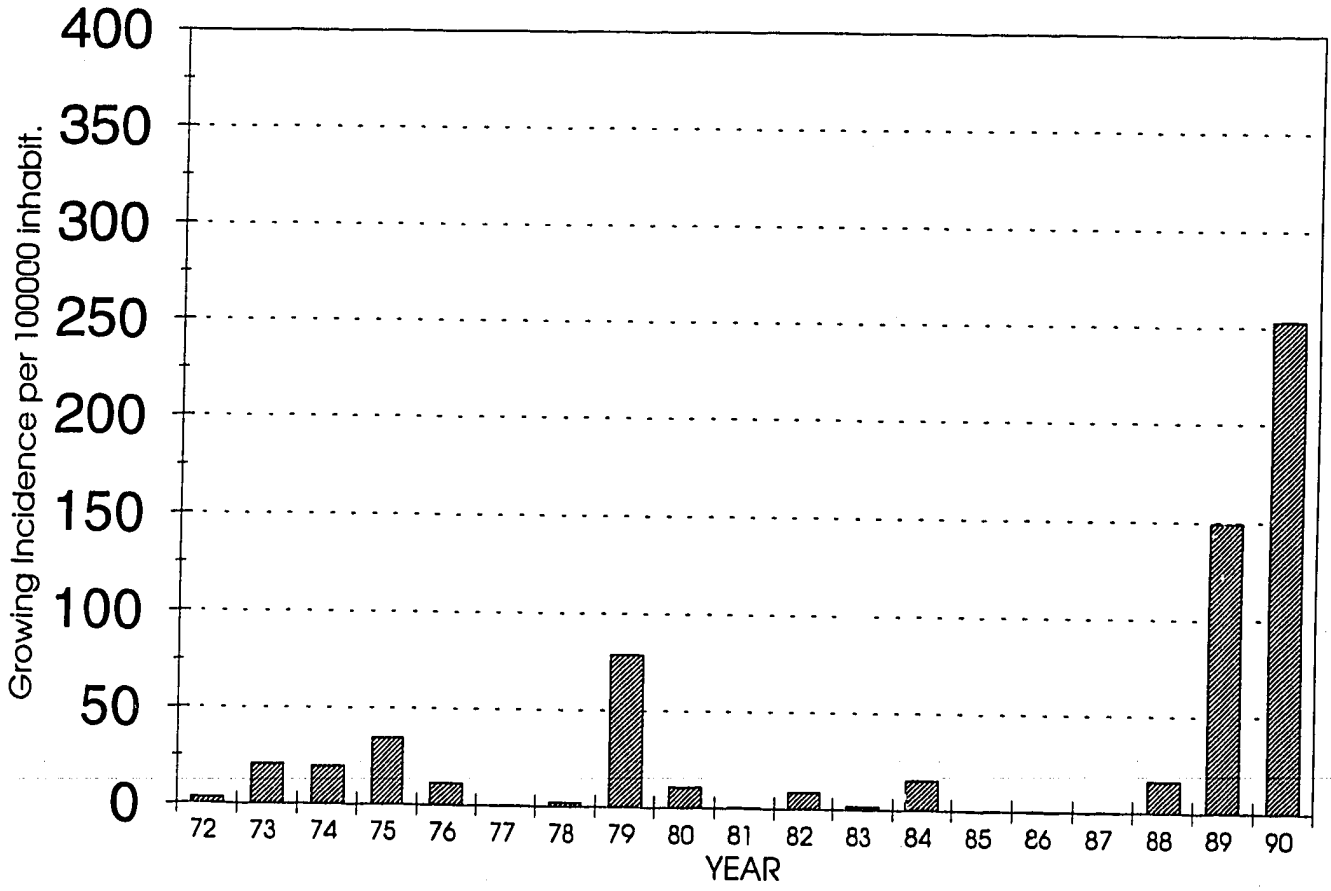

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FIGURE 11 : NUMBER OF CHOLERA CASES IN THE SEBOU WATERSHED (1972-1990)

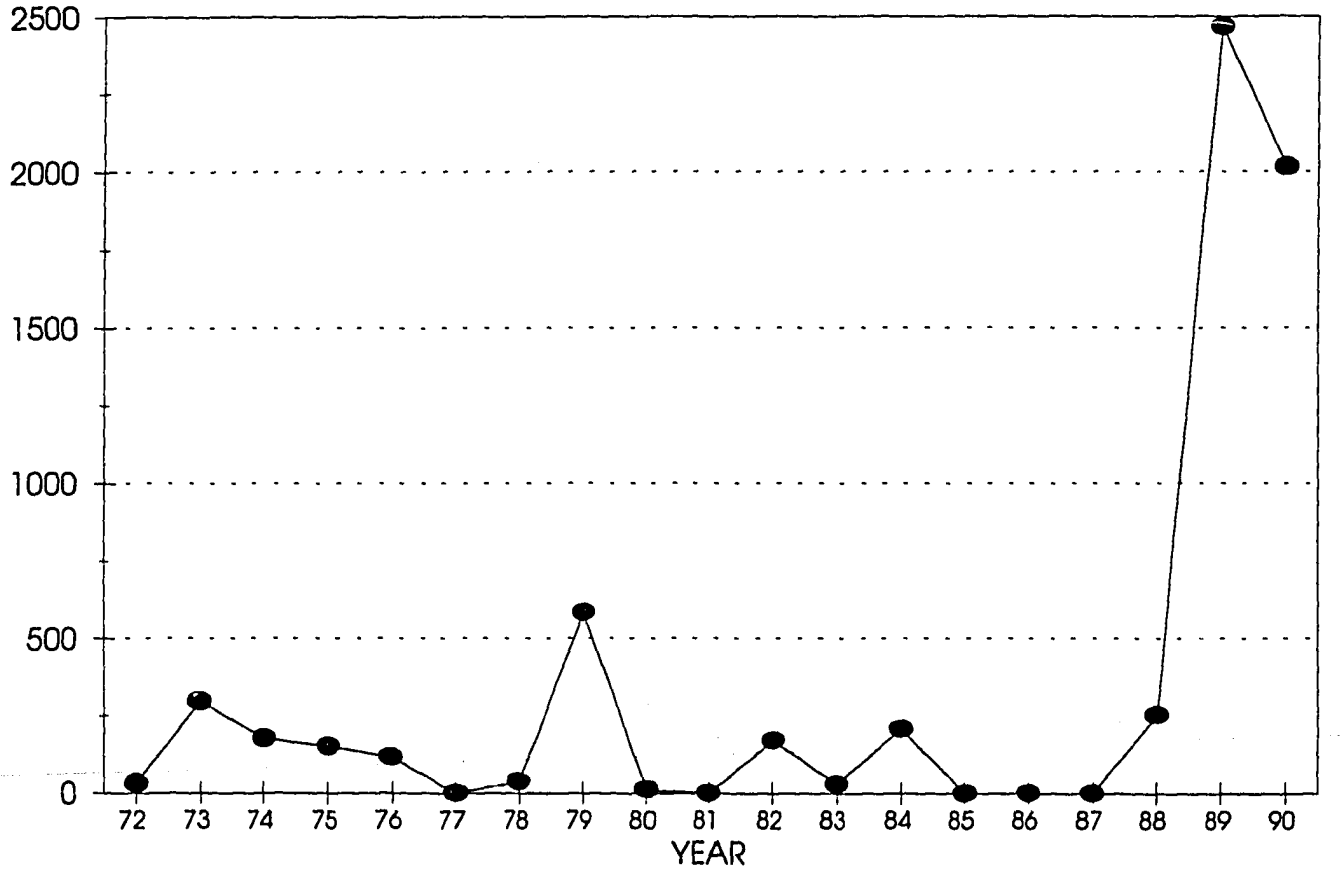
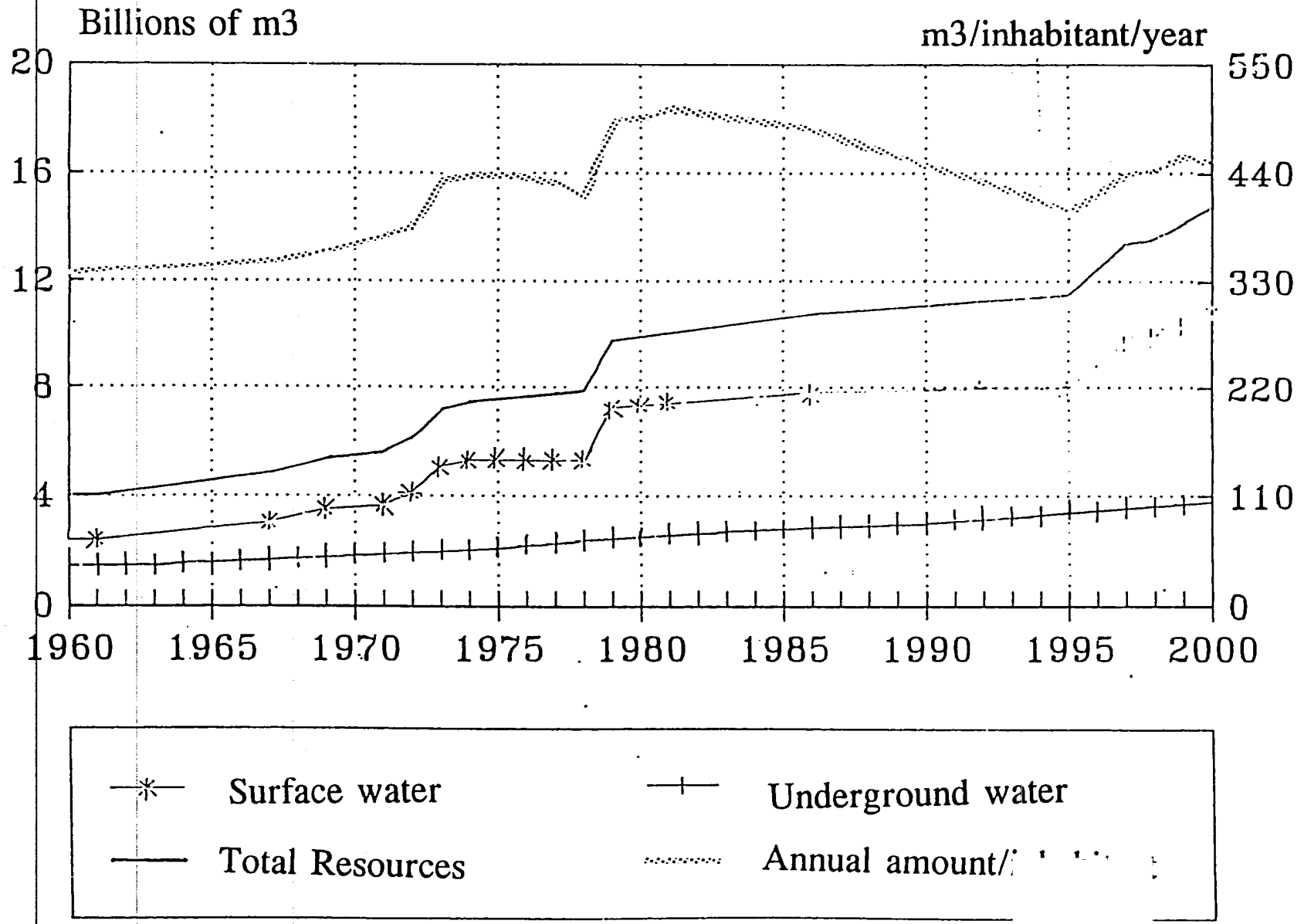


FIGURE 12: CHANGES IN AVAILABILITY OF WATER PER INHABITANT



Source: [illegible] 1993a

water that can be mobilized, which is estimated at 21 billion m^3 (16 billion from surface water and 5 billion from underground water); mobilized water has reached 56 percent of the potential water (MTP, 1993a). The Sebou, Bou-Regreg, and Oum-Er-Rbia Basins alone have more than two-thirds of the country's potential water. Furthermore, between 60 and 90 percent of the water in the country's waterways arrives during the rainy season and most waterways experience seriously low levels with no flow for over half the year (Morocco, 1993). In 1993, the drop in water supply due to dry wells and rivers, combined with the drought and excessive consumption in recent years, has interfered with the operation of some agroprocessing units.

B2. Water Quality

Water resources are subject to growing pressure from urban growth, the increase in industry and tourism, and the development of irrigated agriculture, not to mention a drop in quality caused by pollution from industry, tourism, mining, and farming. The treatment plants at Kariat Ba Mohammed and Mkansa on the Sebou Watershed have been shut down for long periods between December and March every year since 1988, because it is no longer possible to guarantee that the water from the Wadi can be made drinkable (MCIP, 1993b). Studies and analyses have shown that the drop in water quality from the Sebou Watershed has been caused by significant amounts of organic matter coming from the Fez Wadi at the same time as periodic discharges from oil mills (ONEP, 1991). Discharges from sugar mills when wadi water levels are low may create serious problems for fauna and flora. In August 1993, thousands of fish from the Sebou Watershed died near the Sebou protecting weir. The Sebou is a "dead" river for 35 km downstream after the city of Fez. Household and industrial waste, and waste from the olive oil mills in particular, consumes all oxygen in the river and destroys all life. The river can be regenerated only when new water flows in from the tributaries.

C. Exports

Export products will soon have to comply with international ISO 9000 standards that stipulate safety and quality standards. Originally developed by the pharmaceutical industry, ISO 9000 certification is issued to factories based on recommendations made as part of a Hazard Analysis Critical Control Point (HACCP). Hygiene control and inspection systems throughout the world, especially in the major importing countries, are all beginning to adopt the same HACCP approach, the purpose of which is to uncover all factors that could affect a product's quality and safety, including ventilation, air quality, brilliancy, waste storage, building soundness, and the quality of raw materials.

Environmental criteria such as the type and concentration of pollutants discharged by a factory are not among the factors considered in issuing ISO 9000 certification. However, it should be noted that measures to prevent pollution that reduce losses of raw materials and raise the quality of the final product will increase the chances of obtaining ISO 9000 certification. For example, any change in the process for producing sugar that increases the amount of sugar extracted and decreases the pollution discharged by the sugar mill will help increase the efficiency of the production process. However, in some cases, measures to

prevent pollution can undermine final product quality. Excessive recycling of rinse water, for example, can contaminate the final product. Therefore, caution is necessary to ensure that pollution measures do not undermine the quality of the final product.

Environmental issues were raised when the GATT (General Agreement on Tariff and Trade) was signed in April 1994. The Organization of Economic Cooperation and Development (OECD) countries emphasized the burden of complying with regulations and processing their waste, and the "unfair" competition from countries that do not yet follow these regulations. However, as far as we know, no OECD country has made a specific commitment.

D. Tourism

Domestic and particularly international tourism is a source of revenue for Morocco. Nauseating odors in the vicinity of hotels, uncontrolled waste, and used packaging materials polluting the beaches are impeding tourism development. Some hotel owners in northern Morocco have experienced a slowdown in their business over the last several years (World Bank, 1993).

It is very difficult to establish the direct impact of agroprocessing pollution on tourism. However, the substantial waste from the agroprocessing industry does contribute to pollution in general and to the deterioration of tourist sites.

SECTION IV

MOROCCO'S REACTION TO POLLUTION

SECTION IV
MOROCCO'S REACTION TO POLLUTION

Moroccan businesses, especially sugar processors, have made praiseworthy attempts to reduce pollution from their mills by cutting back their water consumption, increasing the efficiency of their production processes, and storing some of their waste. Most of the companies appear to be aware of pollution problems and the efforts they will soon have to make to control them. The Government of Morocco is developing regulations to control pollution.

A. Businesses

The drop in water availability and the continued rise in production costs have caused businesses to redouble their efforts to curb waste and protect the environment. The sugar mills have focused their efforts on water and energy conservation.

A1. Sugar Mills

Sugar manufacturers have reexamined their water circuits to find ways to increase recycling. They have installed settling tanks, built oxidation ponds for sewage, and scrubbed their gases. Overall, these investments have reduced polluting waste by over 50 percent and have made it possible to conserve substantial volumes of water (Table 7). Sugar mills have also conducted studies on purification techniques to treat their liquid discharge and conserve even more water. Between 1980 and 1992, Moroccan sugar mills reduced their effluent by 30 to 70 percent and their pollution burden by 30 percent (Tables 7 and 8).

The payback period in Table 7 shows that for significant conservation in water consumption (30 percent), the investments are high and "paid back" only after a long period of time. This outlook may discourage business people. Yet, the monetary benefits of pollution prevention in the agroprocessing industry are derived largely from water conservation and recycling. Businesses will not be able to enjoy these benefits as long as the government keeps the price of water low.

Sugar mills in Morocco have therefore begun to prevent pollution. Those sugar mills that have been most successful in this area are aware of how much remains to be done. The average discharge from a sugar beet factory in Morocco (2 m^3 per ton of beets) is five times higher than specific reference discharge in Belgium (0.4 m^3 per ton of beets) (MTP, 1993b). A comparison with international sugar cane factories indicates that a drop of at least 50 percent in the pollution burden is still possible (Table 9). The Oum Er Rbia sugar mills continue to consume more water than all the others in Morocco, despite reductions in consumption and in discharges that amount to 25 and 55 percent respectively. These sugar mills must therefore make in-house improvements to increase water recycling. Theoretically, the sugar mills should be able to operate in a closed circuit in view of the high water content

of beets. It should be possible to identify "cold points" in order to improve recycling (Benhnini, 1994). Technical audits of the processing process for each factory are needed to prepare a diagnosis, assess potential conservation, and suggest appropriate technical changes.

Table 7: Pollution Control as Conducted by Four Sugar Mills

Unit	Production capacity (Tons of Beets or Sugar Cane per day)	Water consumed (m^3 per hour) before reduction	Amount invested (10^6 Dh)	Water consumed after reduction (m^3per hour)	Reduction of water consumption (%)	Pay-back period (in months)
SUNAG Ksiri	4,000 tons of beets per day	800	1	250	70	6
SUNAG Tazi	4,000 tons of beets per day	800	0.66	250	70	4
SUNAB	3,000 tons of beets per day	460	2	200	60	26
SURAC	3,500 tons of sugar cane per day	200	5	146	30	108

Sources: ONEP, 1991, MCIP, 1991 and calculations made by the consultant for the payback period based on a price of 2.57 Dh per m^3 of water and a 60-day processing season for beets and 165 days for sugar cane.

Table 8: Decreases in Pollution from Sugar Mills

Sugar mill	Pollution in inhabitant-equivalent per day of sugar growing season	
	1980	1992
SUNAG Tazi	173,000	189,000
SUNACAS	318,000	268,000
SUNAB	170,000	86,000
SUNAG Ksiri	246,000	81,000
SUBM	242,000	207,000
SUNAT	268,000	362,000
SUTA	505,000	168,000
SUBTOTAL	1,922,000	1,361,000
SURAC		477,000
Sucrerie Zemamra		151,000
Sucrerie Doukkala		171,000
SUCRAFOR		33,000
SUNABEL		31,000
TOTAL		2,224,000

Source: ONEP, 1991 and calculations made by the consultant based on MTP, 1993b

Table 9: Comparison of Effluent From Sugar Cane Factories

Country	BOD_5 (mg per l)	COD (mg per l)
Morocco	3,500 to 12,100	4,750 to 14,400
India	667 to 1,660	890 to 2,.236
Puerto Rico, United States	112 to 225	385 to 978
Hawaii, United States	115 to 699	942 to 2,340
Philippines	130 to 1,220	--
Louisiana, United States	81 to 562	729 to 1,430

Source: UNEP, 1982 (for India, Puerto Rico, Hawaii, the Philippines and Louisiana) and MTP, 1993b (for Morocco)

A2. Oil Mills

Oil mills are also beginning to conserve water. This is particularly true for the Huileries de Meknès which will be recycling the dilution water from two of their eight production lines in 1994 and the remaining six in 1995, reducing their consumption by 25 percent in 1995 and more than 90 percent in 1996. Once recycling is fully implemented, approximately 15,000 to 20,000 m^3 per year will be conserved. It should also be noted that even before recycling, the Huileries de Meknès were using much less water (1.2 l per kg of olives processed) than average for oil mills in Morocco (1.9 l per kg of olives processed) (Table 10). Therefore, it appears possible to conserve significant amounts of water in this industry, approximately 200,000 m^3 per year. Oil mills are also trying to identify areas to discharge margines outside the cities instead of discharging them into the wadis. Since 1991, margines from the Sefrou oil mills have been collected and discharged outside the city, but without any controls unfortunately, resulting in nauseating odors and other problems (MTP, 1993c).

A3. Canning Factories

Fruit and vegetable canning requires substantial amounts of water. Fruits and vegetables must be rinsed and often blanched prior to canning or cooking. Some canning plants already seem to be highly advanced compared to those in the United States and to Morocco's national average (Table 11). However, there are few of these efficient factories; the industry as a whole has a long way to go but seems to be aware of the problem and what has to be done. Some solid waste is being sold as animal feed, but other factories still dispose of their solid wastes in garbage dumps.

Table 10: Water Consumption by Oil Mills

Oil mill	Quantity of olives processed (tons/year)	Production of olive oil (tons/year)	Water consumption (m3 per year)	Water consumption (liters of water per kg of olives processed)
Huileries de Meknès	16,750	3,350	20,000	1.2
73 crushing oil mills (including the Huileries de Meknès)	125,000	25,000	236,500	1.9

Source: MCIP, 1993 and Hassan, 1994

Table 11: Water Consumption in Fruit and Vegetable Canning Factories

Fruit and vegetable canning factories	Quantity of product processed (tons/year)	Water consumption in m^3/ton of product processed
Total for the industry in Morocco	220,000	19
A Unit in Casablanca	7,500	5
Green beans in the U.S.	--	8 to 16

Sources: Carawan, 1989; MCIP, 1993; MCIP, 1992

B. Government Programs

The government has environmental protection programs at the national, regional and local levels.

B1. National

At the national level, the governmental program has three types of features:

- Institutional
- Legislative and regulatory
- Economic incentives

B1a. Institutional Features

Aware of the economic and human merits of the environment as it relates to economic and industrial development in the country, the Government of Morocco recently institutionalized environmental protection by establishing an Undersecretariat of State for the Environment (SSE) under the Ministry of the Interior. The SSE's mission is to monitor environmental parameters and set up a legal and regulatory framework. It is also in charge of a program to raise the consciousness of the different players in the environmental area.

Besides this agency with its general responsibilities, the environment in Morocco is managed by the ministries concerned with various industries (Annex D). The Ministry of Commerce and Industry and the Ministry of Public Works monitor and conduct studies on pollution in the agroprocessing industry. The Industry Authority also set up an Environmental Protection Department which has responsibility for collecting and disseminating environmental data, raising the environmental awareness of businesses, enforcing the government's environmental policy in industry and, in conjunction with the different agencies involved, developing and implementing regulations for environmental protection.

With support from the World Bank, the SSE is preparing to implement the Environmental Management Project. The Government has selected four pilot projects for demonstrating pollution control. Three of these projects, located in the Sebou Basin, are for tanneries, the oil mills in Fez, and one sugar mill that also distills alcohol; the fourth processes household waste in Safi (Box 1). These projects aim to control effluent downstream. Steps to prevent pollution in these factories may reduce the amount and pollution burden of effluent, thereby reducing treatment plant capacity and the total cost for these pilot projects.

Moreover, the SSE has just launched two regional case studies (Centre Nord: Fez, Sebou—et Centre: Casablanca, Mohammedia, Rabat). The purpose of these case studies is to develop a strategy and action plan for the environment in the regions after assessing the environmental situation, including an evaluation of the costs of environmental deterioration. Pollution prevention will be a main component of these action plans. Finally, with assistance from UNDP and UNESCO, the SSE is preparing to develop a national environmental strategy and action plan in which pollution prevention will play a prominent role.

B1b. Legislative and Regulatory Features

Morocco's many pollution laws were enacted in the first half of the century. They are cumbersome and occasionally give rise to contradictory interpretations. Moreover, the institutional and legal study conducted by the Directorate General of Industry (MCIP, 1993b) found that these laws are not always enforced. Industries that discharge waste, regardless of the type and severity of the pollution, benefit from a legal vacuum and cannot be fined or sentenced. Similarly, there is no standardization system for industrial waste. The institutions that now conduct the inspections, such as ONEP (National Drinking Water Authority) or LPEE (Public Analysis and Testing Laboratory) use relevant European standards when they exist.

A growing desire to emphasize the environment resulted in the development of a framework law in 1985. This Bill for the Protection and Development of the Environment should be enacted soon. The law includes general principles for managing the environment. Subsequently, the regulations will have to be drawn up.

B1c. Economic Incentives

To protect the environment in the industrial sector (MCIP, 1991), the Industrial Investment Code of 1983 includes the following stipulations:

- Exemption from customs duties and the Value Added Tax (VAT) for all purchases of machinery and capital goods to be used to conserve water and/or protect the environment (article 32 of law 17-82 on industrial investments).

BOX 1
DESCRIPTION OF TWO PILOT PROJECTS (OIL AND SUGAR MILLS)

To promote the process of technology transfer, Morocco has selected four pilot projects, two of which are in the agroprocessing industry:

- **Processing margines from the olive pressing of a group of oil mills in Dakkarat.**

  The technology transfer will provide technical assistance to (1) develop and build drying basins 25 km from Fez (to avoid the nauseating odors); (2) safely eliminate the solid waste from the drying basins; (3) train the treatment plant employees in operations and maintenance; and (4) design a revenue generating system to be able to operate the processing factory at a reasonable cost.

  The secretariat of the Fez Wilaya has proposed that the demonstration project cover seven oil mills of different sizes during the first phase. The pre-feasibility study has shown that the project is economically feasible and that an investment of US$4.35 million will be required over a four-year period.

- **Treating waste water from a sugar refinery (SUNAG II) and from an adjacent alcohol distillery (SOTRAMEG), both located in Side Allal Tazi, to the north of Kénitra and along Sebou Wadi.**

  The technology transfer will make it possible to pretreat the high BOD/COD content from the liquid flows from SOTRAMEG before they are treated in the aerated lagoon along with the liquid flows from SUNAG II. Such an operation will make it possible to eliminate pollution from the underground water at the SOTRAMEG site, decrease the BOD from the two plants by 90%, use the treated water for irrigation, and generate electricity at SOTRAMEG's diesel-fired power plant using the methane produced by the anaerobic reactor.

  The pre-feasibility study has shown that this project is economically feasible and that an investment of US$5.5 million will be required over a four-year period.

- An equipment subsidy of 20 percent of the amount of the investment provided by the Government to any company that "continuously uses at least 30 percent less water over the last known yearly consumption volume, compared to the same volume of production" (article 19, 3rd section of decree n° 2.82.623 of 1-17-83 for implementation of law 17-82).

- A subsidy of "at least 10 and no more than 20 percent of the amount of the specific investment to protect the environment and that permits reducing pollution to continuously attain the accepted standards" (article 19, 4th section of the same decree).

- An agreement to be signed between the Government and the interested company prior to any industrial investments in the following provinces: Boulemane, Chefchaouen, Ifrane, Khénifra, Ouarzazate, and Taroudant. This agreement

obligates the company to take all steps necessary to protect the environment (law 17-82, article 6).

The program for industrial parks, a method of promoting existing industrial sites in cities, aims to reduce pollution and inconveniences in the vicinity of certain industrial facilities. To the extent possible, the sites for these parks are selected based on prevailing wind direction and there are disposal and sanitation systems that meet the relevant standards.

Since 1983, only about 20 applications to take advantage of these economic benefits have been submitted, and no subsidies have yet been awarded.

B2. Regional and Local

On the regional level, several organizations are contributing to the effort to protect the environment, including the regional, prefectoral, and provincial representative offices of the different ministries involved; local authorities (governors, *pachas* and *caïds*); the town councils; and Regional Councils for the Environment.

C. Non-governmental Organizations

Non-governmental organizations (NGOs) such as the Société Marocaine pour le Droit de l'Environnement (Moroccan Society for Environmental Law) and the Association Marocaine pour la Protection de l'Environnement (Moroccan Association for Environmental Protection) round out the institutional framework for pollution control.

SECTION V

POLLUTION PREVENTION

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POLLUTION PREVENTION

In the United States, environmental protection began in the 1970s when the Clean Air Act and Clean Water Act were enacted and when waste management began under the Resource Conservation and Recovery Act. To comply with the regulations and standards on waste developed by the government, businesses built waste treatment plants, which increased their production costs considerably. It took 20 years of control downstream in the industrial process for the U.S. to realize that waste treatment and the enormous amounts of money required would only partially solve the pollution problem. In 1990, the U.S. Congress enacted a framework law called the Pollution Prevention Act which involves a pollution prevention strategy.

A. Definition of Pollution Prevention

What exactly is meant by the phrase "pollution prevention"? Pollution prevention begins well before discharges occur—with manufacturing and the processing of raw materials (Box 2). Clean technologies and an uncompromising maintenance policy, make it possible to lower the amount and toxicity of industrial waste. This often makes it possible to avoid the costly construction of "downstream" control units or to at least substantially reduce their size. Therefore, pollution prevention is an efficient way to protect the environment without incurring heavy costs. For the last few years, businesses in the United States have increasingly made substantial reductions in their production costs through pollution prevention, mainly in effluent treatment costs.

B. Downstream Control Costs and Problems

Manufacturing any product invariably generates liquid, solid, or gaseous waste. Such waste causes serious environmental problems and costs a lot in terms of materials and energy. Major investments are required to control the pollution it creates. The traditional downstream or "back door" control approach requires costly human, energy, material, and financial resources. This approach entails cleaning up water, for instance, by treating sewage; or air, for instance, by scrubbing fumes, but polluting another area because the residue from the treatment has to be stored elsewhere, often at a garbage dump.

Confronted with new regulations, rising treatment and dumping costs, and increasingly severe penalties, business people and officials have begun to reexamine the usefulness of downstream control measures. Instead of concentrating solely on pollution control, businesses have realized that reducing waste production is worthwhile in a global context of environmental management. Waste reduction therefore enables businesses to lower their production costs while they improve the quality of the environment.

BOX 2
POLLUTION PREVENTION
Definitions

The 1990 United States law on pollution prevention defines pollution prevention as follows (AIPP, 1992):

- Prevent or reduce pollution at the source as much as possible.
- When this is not possible, recycle waste while protecting the environment.
- When it is not possible to recycle and reduce waste at the source, treat the waste while protecting the environment.
- Use landfill disposal or any other form of discharge into the environment only as a last resort.

According to the OECD, integrated pollution prevention and control are intended to prevent or reduce to the minimum the danger of damaging the overall environment (OECD, 1991). This approach recognizes the integrated nature of environmental issues, taking into account the effects of substances or activities on all environments, including the air, water, and soil, on organisms, including humans who live in these environments and culture and esthetics. Here are some important features of the integrated approach:

- Takes into account the entire life cycle of substances and products, from the time they are manufactured until they are completely eliminated.
- Projects the effects of substances and activities, both new and existing, on all facets of the environment, including the many methods of exposure and transfer of substances into the environment.
- Reduces the quantity of waste and its harmfulness to a minimum.
- Uses a common method, such as risk evaluation, to estimate and compare environmental problems.
- Additionally uses steps based on effects, such as environmental quality objectives and others based on sources, such as limits on emissions.

Any manufacturing process, from making a nail to assembling the space shuttle, can benefit from waste reduction techniques. These techniques range from simple changes in the manufacturing process to modern recycling equipment. All have at least one point in common: they reduce production costs.

C. Waste Reduction Techniques

Waste reduction techniques can be divided into four categories:

- Managing inventory
- Changing manufacturing processes
- Reducing volumes
- Recycling

C1. Inventory Management

The object of inventory management is to control raw materials, semi-finished products, finished products, and the ensuing waste. In many cases, waste is created from raw materials whose expiration date has passed, are not up to standards, are contaminated or unnecessary, or are residues from accidental spills or damaged finished products. The cost of dumping these materials has to be added to the cost of the loss of raw materials or product. Inventory management methods range from basic changes in ordering procedures to real-time manufacturing techniques. Many businesses could reduce the waste they generate by improving and expanding their existing inventory control programs, which would help reduce the two largest sources of waste: unnecessary and outdated raw materials.

C2. Changing Manufacturing Processes

Improvements in the efficiency of a production process can reduce the amount of waste generated at the source of production. Cost-effective techniques range from eliminating leaks from processes to the installing modern manufacturing equipment. Waste reduction techniques can be divided into three categories: improving operations and maintenance; changing raw materials; and modifying equipment.

A wide range of methods exists to operate a production process at maximum efficiency. These methods are not new or unknown and are usually affordable, because they require little investment. For instance, a producer of foods made with bread crumbs implemented certain process changes, such as cleaning by drying, installing recovery trays under the equipment and improving waste collection systems. These changes have enabled the producer to decrease water consumption by 30 percent, eliminate solid waste dumping, reduce the organic burden of waste water by nearly 80 percent, and sell 2,350 tons of solids per year to recycling outfits (North Carolina, 1989).

Once these new operating methods become established, they must be widely adopted and included in employee training programs. All efficient waste reduction programs are based on a comprehensive training program. For example, a dairy instituted a training program that helped it lower its waste by 14 percent (North Carolina, 1989). An effective program involves all employee categories, from assembly line workers to executives. The program should raise employee awareness of waste production, its impact on the company and the environment, and methods to reduce waste. Training must be ongoing and periodically updated.

A strict maintenance program—both preventive and curative—helps reduce the waste caused by equipment problems. This type of program makes it possible to identify potential sources of waste and to correct the problems. One company discovered that 25 to 50 percent of its waste was the result of poor maintenance (Shober, 1988).

Sometimes toxic raw materials used to manufacture a product can be replaced with less toxic or even non-toxic materials, thus reducing the amount of toxic waste produced as well as finished product toxicity. It also helps reduce the investments necessary to make the factory compliant with environmental standards.

Installing more efficient manufacturing equipment or upgrading existing equipment can help make more efficient use of raw materials, thereby decreasing waste. Moreover, these more efficient systems can help reduce the number of rejected products. For example, a manufacturer of electrical tools replaced a solvent-based painting system with a water-based electrostatic immersion system, lowering the costs of his raw materials by $600,000 per year and lowering garbage dumping costs by 97 percent, while productivity rose substantially (Huisingh, 1985).

C3. Reduction in Volumes

Waste volumes can be reduced by isolating the toxic and recyclable portions. These techniques help increase recycling and reduce waste volume and garbage dumping costs. A distinction is made between separation techniques at the source and concentration techniques.

Separation at the source involves collecting and storing rinse water and solvents used to clean machinery, such as tanks, hoses, pumps and presses, to reuse them in the manufacturing process.

Concentration techniques entail reducing waste volume by physically removing some of the waste, for example, water. These techniques may include vacuum or gravity filtration, evaporation, reverse osmosis, filter presses, drying, and compacting.

C4. Recycling

Recycling helps eliminate garbage dumping costs, lowers the cost of raw materials, and occasionally generates income through sale of the recycled waste. In many cases, recycling is done on site. Morocco's agroprocessing industry is already recycling solid waste; sugar cane factories, for example, use bagasse as their primary source of energy. In other cases, recycled wastes are sold elsewhere. For example, oil mills sell olive grignon to brick factories, which use it as fuel in their ovens.

Considering the importance and the diversity of farming activities located close to agroprocessing factories, the reuse of final effluent after treatment could be a worthwhile endeavor. Morocco is now studying this possibility, as shown by the latest report of the Senior Council for Water and Climate (CSEC, 1994). Such a solution would make it possible to eliminate practically all discharges into the water system, in turn preventing

damage to this environment. Some projects are already underway. Without any prior treatment, farmers are reusing the final waste from the Béni-Mellal sugar mill to irrigate olive and orange trees. Over one-third of the flow is diverted for irrigation to a site 800 meters away from the factory (MTP, 1993a).

BOX 3
POLLUTION PREVENTION AUDIT IN AN OLIVE OIL MILL IN TUNISIA

In Tunisia, the USAID Environmental Pollution Prevention Program (EP3), has just conducted a pollution prevention audit in an oil mill. The audit made it possible to discover methods to reduce:

- gaseous discharges of hexane;
- waste water and investments required to build and operate a sewage treatment plant;
- the danger of explosion and fire;
- the consumption of raw materials.

Using these methods will also improve process control, productivity and product quality, and will therefore help save money. More specifically, the audit made the following recommendations:

- Purchase and install control and testing instruments.
- Replace direct contact hexane vapor condensers with condensers that do not operate on the direct contact principle.
- Exchange the heat between raw materials at different points of the process to optimize production.
- Adjust the speed of assembly lines and certain process parameters to improve process control.

The audit recommended 10 steps to prevent pollution throughout the factory at a total cost of 3.7 million Tunisian dirhams (DT), for an annual gain of 3.8 million DT and payback periods ranging from three months to five years depending on the program, with an average of less than one year.

D. Results

Wherever practiced, pollution prevention helps reduce production costs at relatively little cost and makes it possible to quickly recoup the investments, usually in less than a year (Box 3). Sugar mill owners in Morocco who have been practicing pollution prevention in recent years are well aware of this fact (see Section IV A.).

Some agroprocessing factories in the state of North Carolina, U.S.A., have solved their waste problems through pollution prevention. These companies use volume reduction techniques, manufacturing process changes, recycling and reusage to lower their production costs. All of them have been saving thousands of dollars in raw materials and waste management each year. Through studies partially funded by the North Carolina Pollution Prevention Challenge Grants Program, five firms have lowered their processing costs and raised their profits (Table 12).

Table 12: Examples of Pollution Prevention in the Agroprocessing Industry In North Carolina, U.S.A.

Factory name and location	Business	Reduction in BOD (tons per year)	Investment ($)	Annual savings($)	Payback period time (in months)
Maola Milk New Bern	Milk and ice cream	136.4	54,000	300,000	2
Hunter Jersey Charlotte	Milk	102.9	116,922	406,244	3.5
Beaufort Fisheries Beaufort	Fish	113.6	300,000	900,000	4
Breeden Poultry & Egg, Morganton	Chicken	--	438,000	150,000	35
Randolph Packing Co., Ashboro	Meat	272.7	10,000	1,500	80

Source: Richardson, 1988

SECTION VI

STRATEGY FOR ACCELERATING POLLUTION PREVENTION IN MOROCCO

SECTION VI
STRATEGY FOR ACCELERATING POLLUTION PREVENTION IN MOROCCO

There is no need for Morocco to wait 20 years; at this point the country can develop an integrated pollution prevention and control strategy (Box 4) as many countries are doing. USAID is now working with the Government of the Philippines, for example, to develop an industrial environmental management program.

Such a strategy, suited to the country's socio-economic conditions, would include regulations to control pollution without hindering development. But pollution control and environmental production begin with pollution prevention. Therefore, pollution prevention should occupy a prominent place in the natural environmental strategy and the action plan that Morocco will begin to prepare soon. To prevent pollution and limit the amount of waste to be treated or dumped, several types of programs are possible, including economic and financial, consciousness-raising, and training.

Economic and financial programs

- Raise the price of water and extend the sanitation tax now paid in Casablanca and Rabat to the rest of the country. The monetary benefits of pollution prevention in the agroprocessing industry come primarily from water conservation and recycling. Businesses will not be able to enjoy these benefits as long as the government keeps the price of water low.

- Increase economic incentives, such as grants and low interest loans, that allow businesses to make the necessary investments so that their factories comply with the new standards.

- Take advantage of the upcoming privatization of nationalized companies, mainly the sugar mills, to reduce their waste. The use of clean technologies and production based on standards that protect the environment can only enhance a company's profits.

Consciousness-raising

- Raise business owners' awareness of pollution prevention, as the U.S. government has been doing for several years. Such consciousness-raising will be especially effective if discharge standards are strict, thereby increasing downstream treatment costs and giving businesses an incentive to reduce waste upstream.

BOX 4
INSTRUMENTS TO INTEGRATE
POLLUTION PREVENTION AND CONTROL

Pollution can be prevented and controlled by a full gamut of management instruments (OECD, 1991):

- Industrial research and development leading to a reduction in the consumption of materials and energy.
- Planning to develop strategies that result in overall improvement of environmental quality.
- Priorities to bring about a joint effort of all interested parties to address environmental issues.
- Audits so businesses can identify the issues and improve their own environmental practices.
- Prepare materials balances to stabilize material flows into and out of factories and to identify undesirable sources of waste.
- Environmental monitoring to provide information about chemical substances flowing into the environment.
- Basic research on the behavior of chemical substances and their life cycle in the environment.
- Evaluation of environmental impact to identify, prevent, or control all project's environmental outputs.
- Economic instruments such as taxes, user fees, grants and economic incentives.
- Notification programs to provide basic information about implementing an integrated approach.
- Specific standards to limit the total amount of any one chemical that may be discharged into the environment.
- Coordinated standards for quality and results to limit the discharge of a chemical into different parts of the environment.
- Single permits or authorizations having to do with the process or chemical substance.
- One consolidated program standard based on preventing excessive risks for health and the environment.
- Inspections to monitor compliance with regulations and standards.

BOX 5
PRESENTATION OF THE GEM PROJECT

The GEM Project (Energy and Natural Resources Management) is supervised by the Ministry of Energy and Mines (MEM), in conjunction with other ministries and is funded by USAID. Since 1989, the GEM Project has assisted businesses in Morocco in upgrading their energy efficiency. Since September 1993, the Project has added natural resource management in Moroccan companies to its objectives. This objective is part of an overall strategy to strengthen the competitiveness of companies confronted with international competition. Adopting measures to preserve natural resources helps reduce production costs incurred by recycling water, rational energy management and minimizing raw materials in waste. These measures also make it possible to address the root of the pollution problem in Morocco.

The GEM Project includes:

- technical support
- information and consciousness-raising
- training

Since 1989, the Project has conducted 35 energy audits for various businesses in the agroprocessing, hotel and construction industries. The audits were used to identify more than 260 projects to improve the energy efficiency of factories. For a total investment of approximately 85 million dirhams, these projects should help save 65 million dirhams per year, and 15 million of those would have a payback period of less than six months.

The results of the three pollution prevention audits conducted to date in a textile factory, a paper mill, and a cement factory, promise similar savings and payback periods.

- Encourage pollution prevention audits so that businesses learn about the savings they may realize. The GEM Project (Gestion de l'Energie dans les Entreprises Marocaines et Technologies Propres), a U.S.-Moroccan cooperative effort, is attempting to conduct these audits to foster the development of clean technologies (Box 5). Many technical and/or financial cooperation projects have a "technology transfer" component. Introducing new technologies should be one way to raise the awareness of business owners about the savings they may realize while they help protect the environment.

- Convince financial decision-makers in businesses and banks of the cost-effectiveness of investing in pollution prevention equipment through demonstrations.

Training

- Prepare businesses for future regulations by supporting the development of professional associations such as APS (Sugar Producers Association) and FICOPAM (Interprofessional Federation of Canneries of Moroccan Farm Products). An industry that can identify its level of pollution and the possible

solutions is an essential partner for the government in developing pollution control regulations.

- Include a pollution prevention component when engineers are trained in food technology, or when continuing education is provided in manufacturing processes.

Pollution prevention cannot completely eliminate sewage processing from the agroprocessing industry, particularly the biodegradable organic burden. However, any pollution prevention program that reduces the industrial pollution burden will help make possible a reduction in the size and cost of sewage and water treatment in terms of initial investment and operation, and facilitate plant operations

ANNEX A

BIBLIOGRAPHY

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BIBLIOGRAPHY

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ANNEX B

PERSONS CONTACTED

ANNEX B
PERSONS CONTACTED

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ANNEX C

CLASSIFICATION OF AGROPROCESSING INDUSTRIES ACCORDING TO THE MINISTRY OF COMMERCE AND INDUSTRY

ANNEX C
CLASSIFICATION OF AGROPROCESSING INDUSTRIES ACCORDING TO THE MINISTRY OF COMMERCE AND INDUSTRY

Branch 10: Food industry products

10-1	Grain work
10-2	Baked goods, pastry and crackers
10-3	Sugar industry
10-4	Chocolate and candy

Branch 11: Other agroprocessing industry products

11-1	Manufacturing of canned fruits and vegetables
11-2	Animal slaughter
11-3	Manufacturing of preserved meat
11-4	Dairy industry
11-5	Manufacturing of fatty substances of animal or vegetable origin
11-6	Canning of fish and other seafood
11-7	Other food products (starch, yeast, honey, coffee, tea, spices, etc.)
11-8	Animal feed

Branch 12: Beverages and tobacco

12-1	Manufacturing of beer and malt
12-2	Manufacturing of wines, ciders
12-3	Manufacturing of spirits
12-4	Manufacturing of non-alcoholic beverages
12-5	Manufacturing of tobacco.

ANNEX D

BREAKDOWN OF RESPONSIBILITIES FOR ENVIRONMENTAL ISSUES

ANNEX D
BREAKDOWN OF RESPONSIBILITIES FOR ENVIRONMENTAL ISSUES

Undersecretariat for Environmental Protection of the Ministry of the Interior monitors environmental parameters, establishes a legal and regulatory framework, and coordinates industry-wide programs.

Ministry of Public Works, Vocational Training and Manager Training addresses water pollution, controlling establishments that are unhealthful or dangerous.

The Ministry of Agriculture and Agricultural Development is concerned with forests, national parks, nature sanctuaries, game parks, river fisheries, land restoration and desertification control.

The Ministry of Public Health deals with environmental health.

The Ministry of Commerce and Industry is responsible for industrial pollution.

The Ministry of Energy and Mines is in charge of conservation in the areas of hydrocarbons and mines.

The Ministry of Maritime Fishing and the Merchant Marine is responsible for the management and conservation of the fishing stock.

The Ministry of Cultural Affairs deals with monuments, sites, and cultural heritage.

The Directorate of Local Governments under the Ministry of the Interior is involved in public health, sanitation, and household waste.

PRIDE **Project in Development and the Environment**

December 8, 1994

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USAID Contract No: ANE-0178-C-00-1046-00 & ANE-0178-Q-00-1047-00
Project No: 398-0365

Subject: Entry of ten PRIDE reports into CDIE

Dear Mrs. Swahn:

Enclosed please find two copies each of the following ten reports for entry into the Center for Development Information and Evaluation (CDIE):

- *PRIDE Third Annual Report: September 1993 - August 1994*
- *PRIDE Fourth Annual Report: September 1994 - August 1995*
- *Environmental Strategy for USAID/Morocco,* September 1994
- *Integrating Environmental Control Strategies in Morocco,* August 1994
- *Pollution Prevention in the Moroccan Agroprocessing Industry,* July 1994
- *Environmental Business Development Strategy for the Centre de l'Entreprise du Maroc,* July 1994
- *Environmental Benefits of USAID/Egypt Projects,* October 1994
- *USAID Mission to Slovakia Technical Assistance on Environmental Issues,* August 1994
- *Comparing Environmental Health Risks in Cairo, Egypt (Volume I),* September 1994
- *Comparing Environmental Health Risks in Cairo, Egypt (Volume II: Technical Annexes),* September 1994
- *Comparing Environmental Health Risks in Cairo, Egypt (Volume III: Technical Annexes - Reports by Egyptian Consultants),* Sept. 1994

If you have any questions, please feel free to contact me.

Sincerely,

Alaa Shoreibah
PRIDE Project Assistant

Enclosure: a/s

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