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Meeting of Experts on Olive Oil
Production and Electroplating Industry

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MEETING OF EXPERTS ON OLIVE OIL PRODUCTION

PRESENTATIONS MADE BY THE SPEAKERS

Autonomous Government of Catalonia
Ministry of the Environment
Centre for Cleaner Production Iniciatives

UNEP

Ministry of the Environment
Spain

INTRODUCTION

Mr. Mohammed El Barraka
Production Manager
Lesieur Cristal
Morocco

LADIES AND GENTLEMEN,

It is an honour and a great pleasure for me to participate in this session organized by the Regional Activity Centre for Cleaner Production with a brief exposition on the oil-producing industry and the problems in Morocco.

GENERAL PRESENTATION

Morocco's industrial network is made up of about 6,200 factories of which 1,548 are agro-industries, or 25% of the industrial sector.

49% of industrial activities are concentrated principally around Casablanca.

The industry, all activities included, consumes 1,088 billion m3 of water, 81% of which is made up of seawater, 14% comes from surface water, 4% from drinking water and 1% from underground water.

Agro- industries consume almost 24 million m3 of water consisting of 1.6 million m3 of seawater, 4.8 million m3 of surface water, 3.4 million m3 o drilled water and 14.2 million m3 of drinking water.

THE OLIVE OIL PRODUCING INDUSTRIES IN MOROCCO

The olive-oil industry in Morocco is on the one hand made up of a seed oil crushing and refining sector consisting of about ten mills in the cities of Casablanca, Kénitra, Fez, Meknes, Marrakech and Agadir; and on the other of the olive crushing sector consisting of 179 modern industrial mills and about 16,000 small traditional mills.

The olive processing mills are very unequally distributed throughout the country. The province of Fez, and more especially the city of Fez has the greatest concentration of processing mills, with 72 modern ones and 2,879 traditional ones, followed by the province of Marrakech with 25 modern mills and 1,760 traditional ones, and the province of Meknes with 29 modern mills and 183 traditional ones. About 50% of olives are crushed in the cities of Fez, Meknes and their regions.

Olive growing is an age-old tradition that has an important socio-economic role and is very important for the national economy of almost all the Mediterranean countries.

In yield, Morocco is in seventh position behind Italy, Spain, Greece, Turkey, Tunisia and Syria. The first five countries produce more than 80% of the world production.

AGRO- INDUSTRY WASTES IN MOROCCO

In this paragraph I shall give an overview of industrial waste in Morocco.

Total liquid waste produced by industry as a whole is estimated to be 964 million m3, which is 89% of the total volume of used water.

Solid waste from factories amounts to 800,000 tons, 5% of which is disposed of in public dumps and 23% of which is reused in manufacturing processes such as sugar bagasse, olive pomace, wool surplus etc.

Farm-produce industries discharge 22 million m3, 32% of this waste is discharged directly into the surface water network, particularly Sebou (17%), L'OUM ER-RABIA (7%) and the TENSIFT (8%).

The COD and BOD_5 of these industries represent 80% and 66% of the COD and BOD5 discharged by the entire Moroccan industrial sector.

Solid waste is estimated to be almost 500,000 tons, 73% of which comes from sugar factories.

Liquid waste from oil mills is estimated to be 640,000 m3 made up of margarine from crushed olives and organic materials from vegetable oil refineries. The Atlantic ocean receives 420,000 m3, the Sebou and Tensift wadis the rest. This waste represents almost 50% of the COD and BOD from the farm-produce sector.

Solid waste is made up of 400 tons of bleaching earth in vegetable oil refineries and 100,000 tons of pomace of which 30% is reused in the oil mills and 70% is sold as a fuel, particularly in brickyards.

Though liquid waste from vegetable oil refineries, essentially composed of cleaning water and soapy paste acid-diluting water, can be assimilated into urban water with basic pre-treatment, waste from olive oil mills, consisting mainly of waste water, poses serious pollution problems.

Vegetation water, the undesirable waste left after the olive crushing process is a viscous liquid whose colour ranges from dark purply brown to black and whose BOD and COD concentrations reach 100,000 and 250,000 mg/l.

Average annual production of vegetation water in Morocco is around 210,000 T. For the region of Fez it is around 78,000 T. In addition this production is seasonal.

Vegetation water is discharged into rivers in many countries causing very serious pollution problems. This is the case of vegetation water in Fez that is discharged into the Sebou wadi leading to a deterioration in water quality. Sometimes this reaches such high proportions that downstream water treatment plants in Sebou suffer long stoppages during the oil producing season with a resulting increase in exploitation costs of 1.4 DH/m3 at normal times, to 6.3 DH/m3 during periods when oil is being produced.

TREATMENT AND VEGETATION WATER ELIMINATION PROCESSES

In recent decades, much research has been done in the field of treatment and exploitation of vegetation water. Techniques that have been developed include biological treatment, natural evaporation, forced evaporation, ultrafiltration and reverse osmosis.

The application of a system depends on various factors such as the crushing technique used, the crushing capacity, staff training and the variety of olive. Conditions vary greatly from one country to another and are not comparable.

EXAMPLE OF SOLUTIONS FOR ELIMINATING VEGETATION WATER: EXAMPLE OF OIL MILLS IN FEZ

Given the extent of the polluting impact caused by vegetation water discharges in the waters of the Sebou wadi and the very large number of stoppages in the water purification plants that can no longer ensure the continuity of the drinking water supply to the population of the region, local authorities, together with the departments concerned, have made a considerable effort to start up a project for eliminating vegetation water from oil mills in the city of Fez. The processes the elimination of vegetation water contemplated within this project are:

Natural evaporation: this technique consists of collecting, transporting and storing vegetation water in tanks in which they naturally evaporate. The volume of vegetation water to be treated in this way represents approximately 50% of the total quantity of vegetation water produced in all oil mills in the city of Fez. This project is being carried out in the following manner:

1. Stocking the vegetation water in tanks within the oil mills.
2. Collecting and pumping the vegetation water on tanker lorries acquired with the help of a European Community grant.
3. Transporting the vegetation water to a site 15 km away from Fez for natural evaporation.
4. The running of this site has been entrusted to the RADEEF.

Forced evaporation: This is a procedure that consists of placing evaporation panels in the vegetation water storage tanks to facilitate evaporation. This method multiplies the amount of water that is evaporated per m2 of ground by 100 by increasing the exchange surface and height, which favours evaporation because wind speeds are higher. This project will be tested as a pilot scheme for one neighbourhood in Fez. It is planned to eliminate 2,000 m3/year of vegetation water through forced evaporation and will permit the study the efficiency and usefulness of the system for the future in order to avoid the transportation of large volumes of liquid.

ACTIONS FOR THE PROTECTION OF THE ENVIRONMENT

In order to confront all these problems new impetus has been given to environmental protection in Morocco.

I shall make do with pointing out the following actions:

- A pilot study of industrial decontamination in Mohammedia, Casablanca, a region in which almost 50% of all industry in Morocco is concentrated. This study has brought about a plan of action for audited companies. One part of these actions will be financed by own funds and the other part with the support of decontamination funds.

- Drawing up regulations and standards for waste in collaboration with industrialists.

- Creating funds for industrial decontamination.

- Carrying out more and more environmental audits, now considered as technical tools for prevention.

- Study on the impact of industrial waste on the quality of the water of the SEBOU, a river that takes in 17% of the waste and 50% of the vegetation water from oil mills.

- Building a sewage and drying works for vegetation water that works with natural evaporation. This would contribute to the improvement in drinking water in this region and a reduction in waste water.

- Study on the impact of industrial waste on the quality of the water of d' Oum Er Rabia and Tensift. These rivers each take in 7 and 8% respectively of the farm-produce industry' s industrial waste including the waster from 39 modern oil mills and 3,716 traditional oil mills.

LADIES AND GENTLEMEN

This brief overview of the environmental problems of the olive oil industry and the actions undertaken in collaboration with the appropriate Ministries and industrialists for the protection of the quality of the natural environment shows the veritable will to make progress in this field.

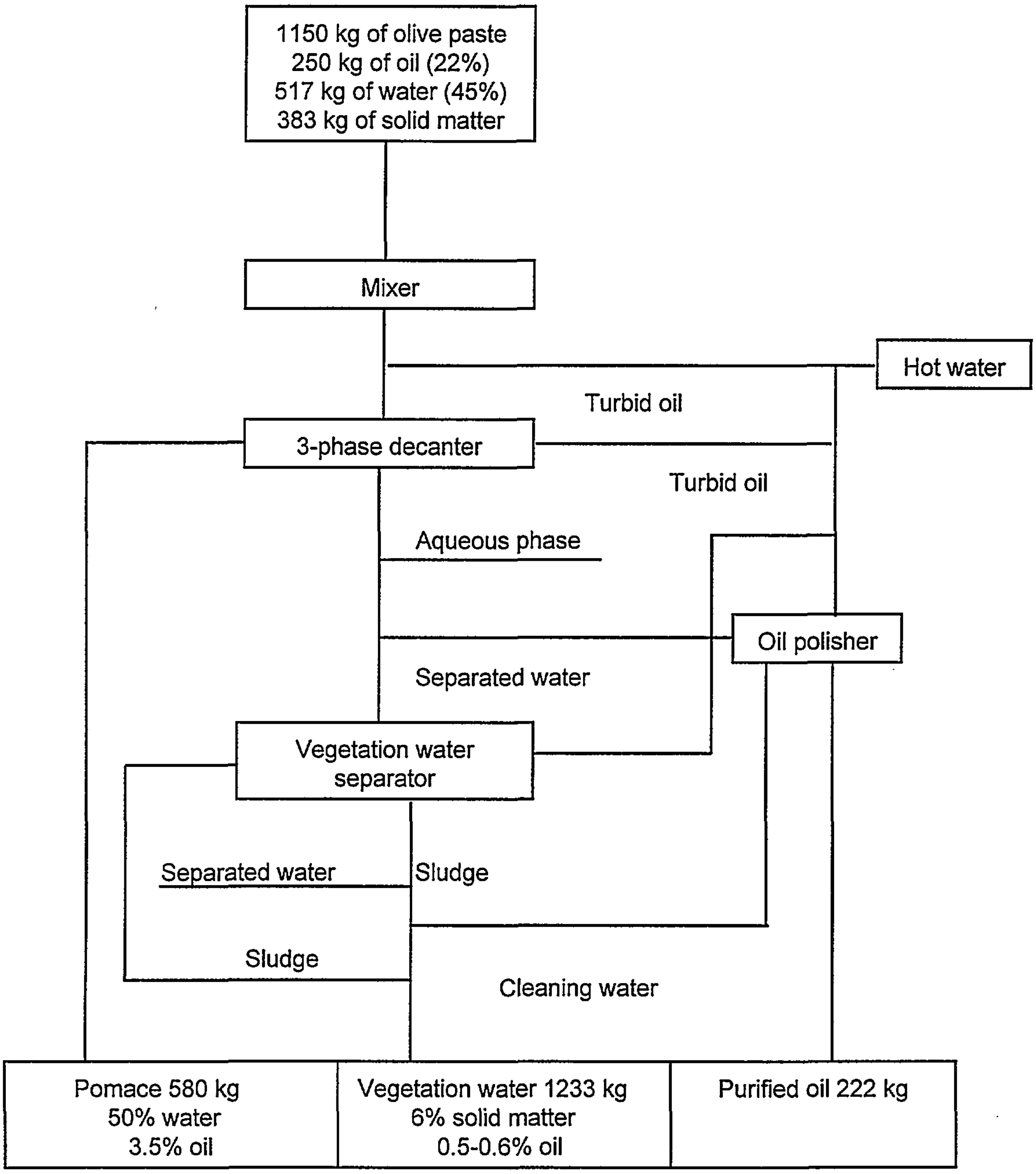
But, the way is still long and the efforts to be made enormous, particularly regarding financial resources and the mechanisms for funding decontamination.

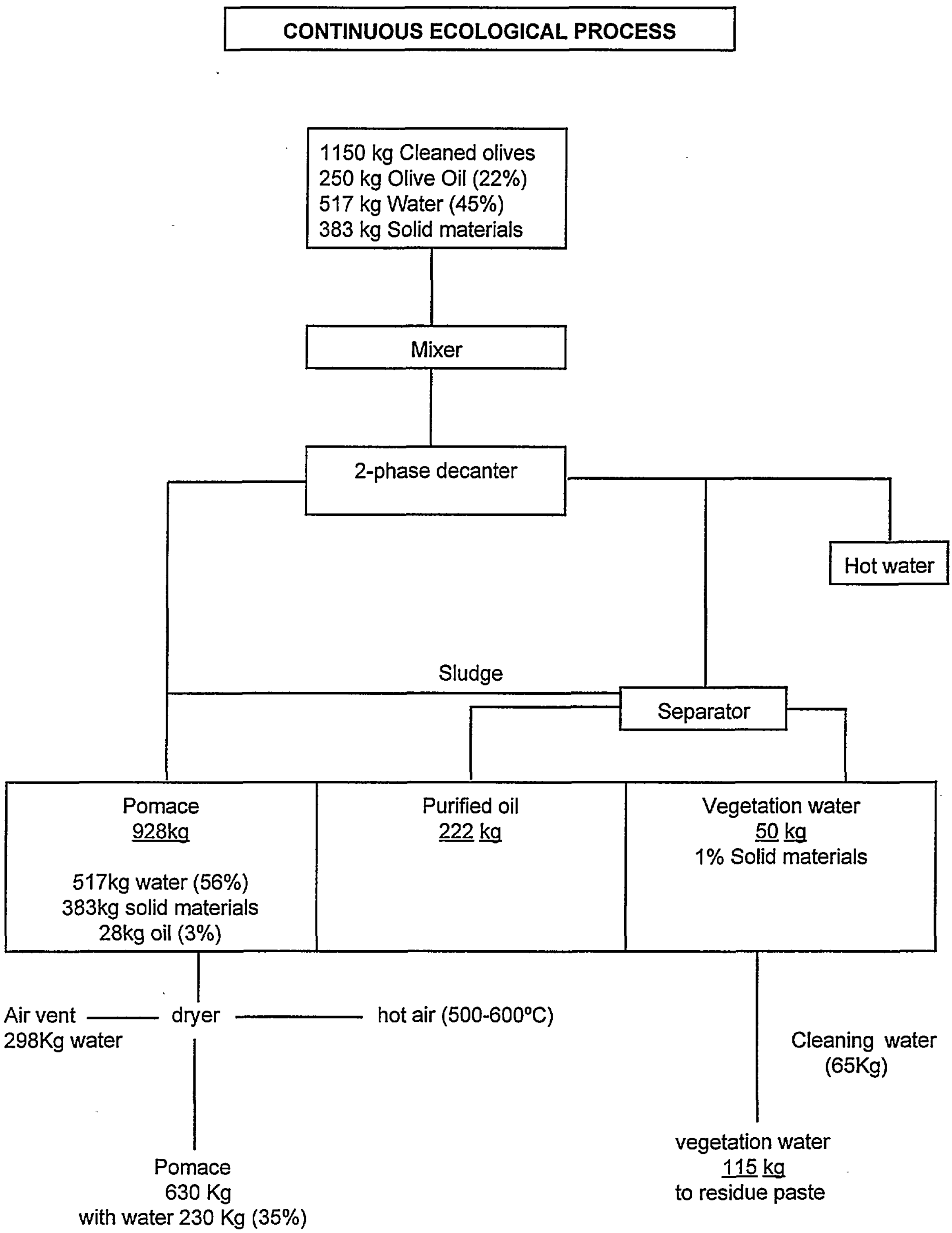
If we wish to keep our environment healthy and balanced for generations to come, we must progressively find solutions and apply them. This is a responsibility for us all.

I wish our work the greatest success

Thank you for your attention.

TRADITIONAL CONTINUOUS PROCESS




CONTINUOUS ECOLOGICAL PROCESS
1150 kg Cleaned olives
250 kg Olive Oil (22%)
517 kg Water (45%)
383 kg Solid materials
Mixer
2-phase decanter
Hot water
Sludge
Separator
Pomace
928kg
517kg water (56%)
383kg solid materials
28kg oil (3%)
Purified oil
222 kg
Vegetation water
50 kg
1% Solid materials
Air vent
298Kg water
dryer
hot air (500-600°C)
Cleaning water
(65Kg)
Pomace
630 Kg
with water 230 Kg (35%)
vegetation water
115 kg
to residue paste

PHYSICO-CHEMICAL CHARACTERISTICS OF THE VEGETATION WATER

Colour: Reddy brown
Appearance: cloudy
Origin: Olive for 40-50% + the water used for crushing

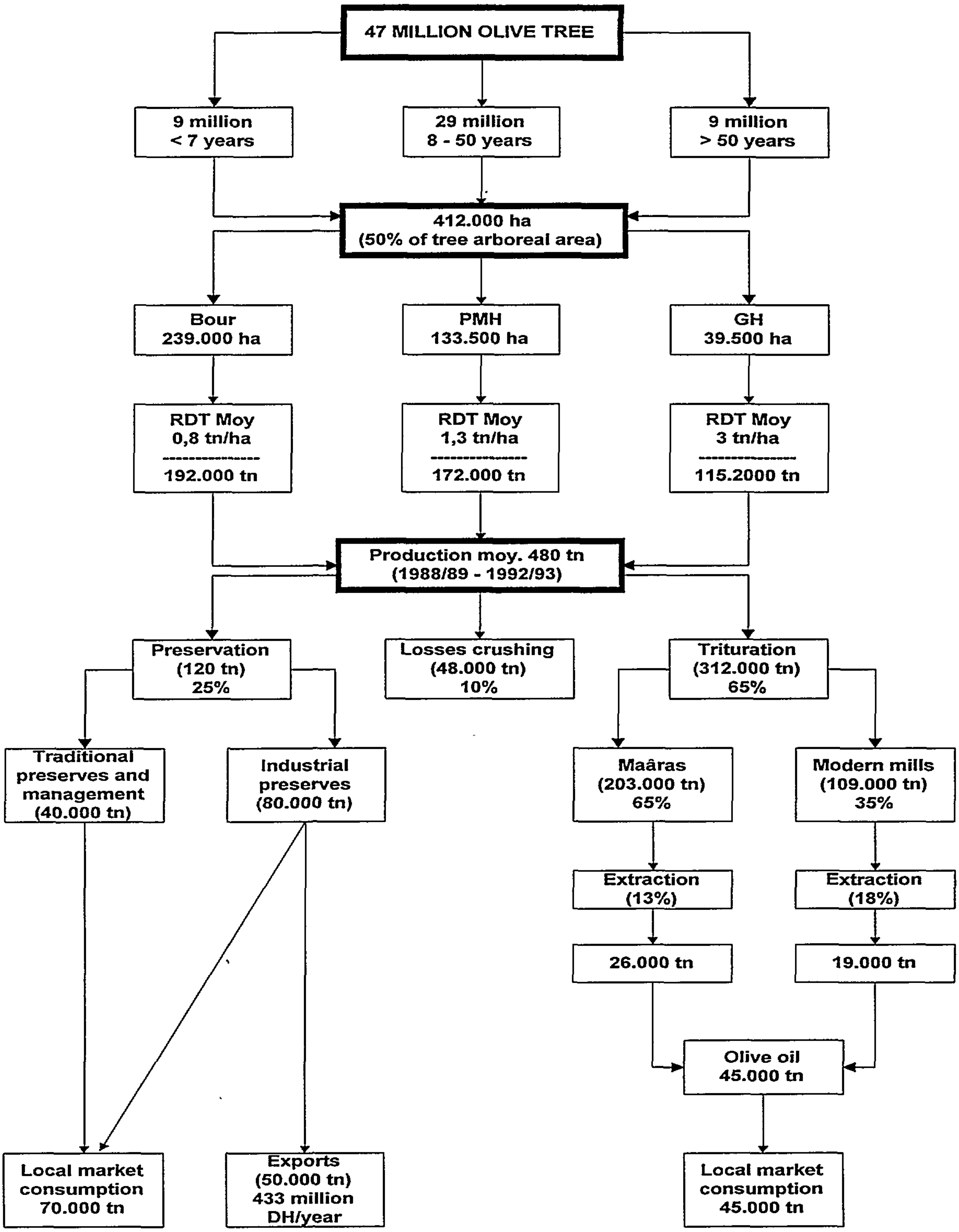
PARAMETERS	
pH	4,5 - 5,5 4,5 - 5 (press) 4,7 - 5,2 (centrifugation)
Dry material	170 Kg/m3 120 Kg/m3 (press) 60 Kg/m3 (centrifugation)
Organic material	150 Kg/m3 Sure : 50 Kg/m3 Oil : 0,3 -10 Kg /m3 0,5 - 1 Kg/m3 (press) 3 - 10 Kg/m3 (centrifugation) Tannins: 8 -16 Kg/m3 Phenols : > 10 Kg/m3
Mineral material	20 Kg/m3 15 Kg/m3 (press) 5 Kg/m3 (centrifugation) Potassium: 0,05 - 0,2 Kg/m3 Calcium: 0,3 - 0,6 Kg/m3
BOD5	45 - 55 Kg/tn treated olives
BOD5 max	100 Kg/m3 Vegetation water 90 - 100 Kg/m3 (press) 35 - 48 Kg/m3 (centrifugation)
COD max	220 Kg/m3 Vegetation water
COD	45 - 200 Kg/tn (centrifugation) 100 - 390 Kg/tn (press)
Particles in suspension	3 - 4 Kg/m3 1 Kg/m3 (press) 9 Kg/m3 (centrifugation)
Density	1,02 - 1,09 (press) 1,007 - 1,046 (centrifugation)
Conductivity	10 μS/cm
Inhibition index	48,10%
Polluting potential	2 L of vegetation water = 3 inhabitants

REGIONAL DISTRIBUTION OF MAIN MODERN AND TRADITIONAL INDUSTRIAL MILLS

PROVINCES	NUMBER OF INDUSTRIAL MILLS	
	MODERN	TRADITIONAL
FES-TAOUNATE	72	2879
TAZA	4	1815
MARRAKECH	25	1760
CHEFACHAOUEN	-	1528
AGADIR - TAROUDANT	6	1351
ESSAOUIRA	9	1109
AZILAL	2	1107
SIDI KACEM	8	778
BENI MELLAL	6	529
BOULMANE	-	500
ERRACHIDIA	3	382
OUARZAZATE	1	361
EL KELAA	6	320
OUJDA	4	304
MEKNES	29	183
NADOR	3	181
KHEMISSET	-	54
SAFI	1	30
AUTRES PROV	-	812
TOTAL	**179**	**15980**

AVERAGE ANNUAL PRODUCTION OF VEGETATION WATER

	CRUSHED OLIVES (TONS)	VEGETATION WATER PRODUCED (M3)
MAASRAS	203000	105000
U. MODERNES	109000	109000
MAROC	312000	210500
FES	115440	77885



PRESENT SITUATION OF MOROCCO OLIVE OIL INDUSTRIES

OLIVE OIL
PRODUCTION 194 / 1995 / 1996 (in 1000 Tn)

COUNTRY	PRODUCTION	
	1994/1995	1995/1996
ITALY	480	580
SPAIN	481,5	301
GREECE	387	330
TURKEY	160	45
TUNISIA	100	70
SYRIA	90	76
MOROCCO	45	40
PORTUGAL	32	38
ALGERIA	14	23
JORDAN	13,5	13
ARGENTINA	9,5	11
ISRAEL	5,5	6,5
LEBANON	5	5
LIBYA	6,5	4
CYPRUS	2,5	3
FRANCE	2,5	2
YUGOSLAVIA	2,5	1,5
USA	1	1
OTHER COUNTRIES	1	22
TOTAL	1857,5	1572

MOROCCAN INDUSTRIAL SECTOR PRESENTATION

INDUSTRIAL SECTOR	NUMBER	%
TEXTILE AND LEATHER INDUSTRIES	1862	30
CHEMICAL AND PARA-CHEMICAL INDUSTRIES	1790	29
AGRO-INDUSTRY	**1548**	**25**
MECHANICAL, METALLURGICAL AND ELECTRICAL INDUSTRIES	1002	16
TOTAL	6202	100

DISTRIBUTION OF WATER USE AMONG THE DIFFERENT SECTORS

SECTOR	SEA WATER		SURFACE WATER		DRILLED WATER		DRINKING WATER		TOTALS	
	1000 m3	%	1000 m3	%	1000 m3	%	1000 m3	%	1000 m3	%
TEXTILE AND LEATHER INDUSTRIES	0	0	0	0	1940	0,18	9130	0,84	11070	1,02
CHEMICAL AND PARA-CHEMICAL INDUSTRIES	875500	80,43	147600	13,56	5920	0,54	22390	2,06	1051410	96,59
AGRO-INDUSTRY	1600	0,15	4750	0,44	3400	0,31	14200	1,3	23960	2,2
MECHANICAL, METALLURGICAL AND ELECTRICAL INDUSTRIES	0	0	210	0,02	190	0,02	0,02	1690	2100	0,19
TOTALS	**877110**	**80,58**	**152570**	**14,02**	**11450**	**1,05**	**47410**	**4,36**	**1088540**	**100**

DISTRIBUTION OF INDUSTRIES BY TOWNS

WILAYA OR PROVINCE	NUMBER	PERCENTAGE
CASABLANCA	3018	49%
RABAT	440	7%
FES	397	6%
TANGER	340	5%
AGADIR	220	4%
MARRAKESH	224	4%
MEKNES	183	3%
KENITRA	161	3%
TETOUAN	158	3%
OUJDA	143	3%
NADOR	124	2%
EL JADIDA	114	2%
AUTRES	680	9%
TOTALS	6202	100%

INDUSTRIAL ACTIVITY WASTE

LIQUID WASTE	964 milions m3	89% of the water used
SOLID WASTE	800.000 tn	23% reused 5% evacuated to dump

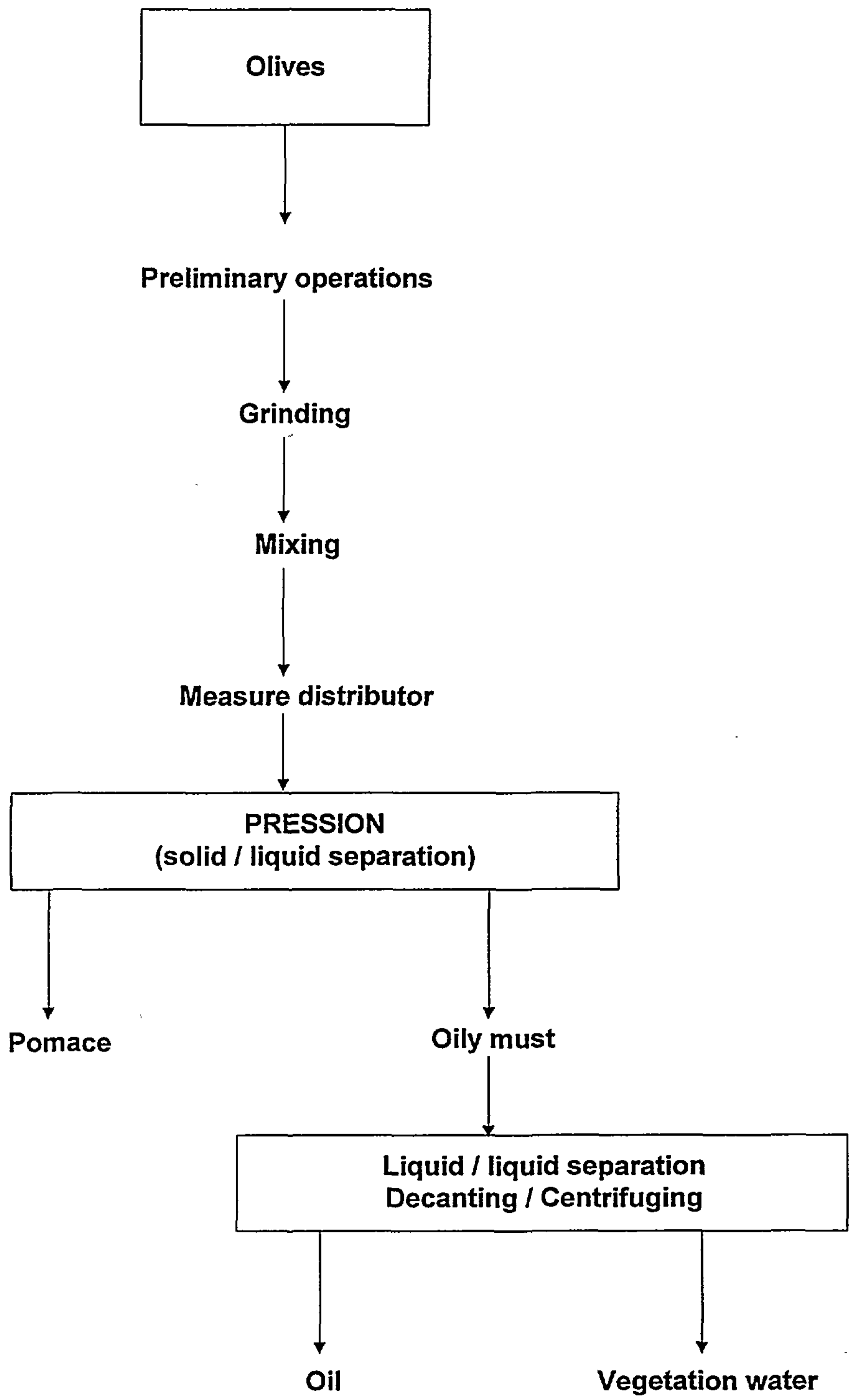
AGRO-INDUSTRY WASTE

LIQUID WASTE	22 milions m3	17% SEBOU 7% OUM ER_RABIA 8% TENSIFT
SOLID WASTE	500,000 t	of which 100,000 of pomace

MAIN POLLUTANTS OF INDUSTRIAL WASTE

POLLUTANT	CHEMICAL AND PARA-CHEMICAL INDUSTRIES		TEXTILE AND LEATHER INDUSTRIES		AGRO- INDUSTRIES	
	Tons/year	% all sectors	Tons/year	% all sectors	Tons/year	% all sectors
MES	6465500	99,6	7600	0,12	17400	0,3
COD	12600	12,6	-	-	80000	80
BOD	4300	18,8	15400	26,5	38100	66
TOTAL NITROGEN	1780	55,0	-	-	1500	45
TOTAL PHOSPHATE	11	6,0	-	-	190	94
FLUORS	37700	100	-	-	-	-
PHOSPHATES P205	54840	100	-	-	-	-
CHLORIDES	1900	100	-	-	-	-
MERCURY	0,015	100	-	-	-	-
TOTAL CHROME	-	-	111	100	-	-
SULPHURS	-	-	140	100	-	-

PRESS OLIVE OIL PRODUCTION SYSTEM



MOST POLLUTANT AGRO-INDUSTRY SECTORS

INDUSTRIAL SECTOR	Waste Million m3/year	MES	COD	BDO5	Population in equivalent-inhabitant
SUGAR	4,5	1200	8300	3200	400000
Fruit and vegetable preserves	3	500	3000	2000	145000
Manufacture of fatty substances (oil mills)	0,64	4936	12380	5975	595000
TOTAL	8,14	6636	23680	11175	1135000
% of pollution in the fatty substances manufacturing sector	7,9	74,4	52,3	53,5	52,4

VEGETATION WATER TREATMENT AND EXPLOITATION PROCESSES

A/ VALUATION	
Process	Application stage
1)Fertirrigation (strewing)	large scale
2)Cattle feed	large scale
3)Organic proteins	R&D
4)Enzyme production	R&D
5)Composting	large scale
B/ PURIFICATION	
Thermal concentrations A) Dumping vegetation water B) Vacuum Distillation C) Evaporation (simple and multiple effect) D) Lagooning and natural drying E) Incineration	 large scale large scale large scale large scale and pilot large scale
2) Physico-chemical:	large scale and pilot
3) Biological: a) Anaerobic treatment b) mixed treatments	 large scale and pilot R & D & pilot

EXAMPLE OF SOLUTIONS FOR THE ELIMINATION OF VEGETATION WATER EXAMPLE OIL MILLS IN FEZ

NATURAL EVAPORATION	Treatment of 50% of vegetation water in the city of Fez
FORCED EVAPORATION	Pilot project Treatment of 2,000 m3 of vegetation water

LESIEUR CRISTAL ACTION PLAN

Actions using own funds:

-Extension of the environmental quality control function

-Improvement of measuring orchestration and sensitizing of staff on economical use of water

-Establishment of a water-matter balance at the end of each month

-Partial recycling of condensates in the boilers and in the production line

-Distribution of storage areas for the placing of chemical products by class

-Building of detention reservoirs around the storage tanks in the next 5 years

-Recycling by direct sale of certain solid wastes (plastic, drums,...)

-Follow up of the efforts of upgrading the by- products

-Use of antinoise headsets by the staff working in noisy areas

Actions in need of financial support:

-Building of a pre-treatment unit for waste waters

THE PROBLEM OF OLIVE WASTE
POSSIBILITIES FOR ACTION

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Centre International de Technologie de l'Environnement de Tunis (CITET)
Tunisia

THE TUNISIAN EXPERIENCE IN THE STRUGGLE AGAINST POLLUTION CAUSED BY OLIVE OIL INDUSTRY RESIDUES

The olive growing industry with its oil mills is an integral part of a heritage to which many Tunisians feel very attached. This ancestral activity is economically very important for Tunisia. With its 60 million olive trees and 1.3 million hectares Tunisia is one of the four biggest olive oil producers in the world.

This sector provides 30 million days of work per year and thus ensures an income to almost 1 million Tunisians.

Furthermore, it should be pointed out that olive oil export receipts amount to 37% of agricultural and farm-produce export receipts and 4-5% of all Tunisian export receipts.

I. OLIVE OIL PRODUCTION:

90% of all Tunisian olive groves are for the production of olive oil. They constitute 31.5% of all cultivated land.

Olive oil production has always been characterised by its many fluctuations, due to intrinsic (real and potential) and extrinsic (environmental and farming) conditions. This fluctuation is even more acute in periods of drought or low rainfall.

Assessment of Tunisian production (in tons)

Season	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94
Olive oil production	101540	109699	115655	97873	65935	145542	171872	288306	146873	200000

Average production is 140,000 tons of olive oil per annum.

More than 80% of oil mills are concentrated in traditional olive oil producing regions in the centre and south of the country.

Currently 1,300 oil mills have a capacity for crushing 1.3 million tons of olives, thus easily providing the potential to respond to exceptional yields in one season.

II. EXTRACTION TECHNIQUES USED IN TUNISIA:

In Tunisia extraction of oil from kneaded olive paste is done either by pressing or centrifugation (continuous process).

<u>1/ The pressing system</u>

This is the oldest system and, nowadays, the most widespread. Mills have evolved over the years.

Modern presses, with pistons with a diameter of 35 or 40 cm can press 250 to 320 kg of olive paste in 4 layers on 5 mats. Pressure can reach 400 kg/cm2. However, some oil mills also use a double cycle, which in the first cycle applies 100-200 kg of pressure. After washing, grinding and kneading, the oil is extracted with a vertical hydraulic press that is fed and emptied manually. The paste from the press is separated into oil and wastewater either in decanting basins or in plate centrifuges.

Every ton of crushed olives produces about 500 l of highly saturated vegetation water.

<u>2/ The centrifugation system – continuous system</u>

After washing, thinning-out and grinding, the olive paste goes to a churning machine. There it is mixed with water heated to a temperature of 35°C causing the oil cells in the pulp to burst continually. The components, pomace, oil and wastewater are separated by a tri-phasic decanter into which a large quantity of diluting hot water, between 40 and 70% of the quantity of olives to be crushed, depending on the ripeness of the fruit, is poured.

The amount of wastewater produced in mills of this kind can be as high as 1,000 l per ton of olives.

III. QUANTITY/QUALITY OF WASTEWATER (VEGETATION WATER) PRODUCED:

The amount of vegetation water produced does not just depend on weather conditions. It depends more on the type of crushing process used.

Process	Oil mill numbers		Vegetation water production (m^3/year)		Crushing capacity (ton/year)	
System-press	1114	85%	345000	49%	13251	69%
System-mixed	39	3%	64000	9%	1407	7%
System-continuous	147	12%	296000	42%	4592	24%
Total	1300	---	705000	---	19250	---

- Oil mill wastewater is an acid effluent with a high saline and organic content. Concentration and composition varies according to the variety of olive, their ripeness as well as the type of crushing process used.

Parameter	Press system	Continuous system
pH	4,5 - 5	4,5 - 5
COD (g/l)	90 - 200	50 - 90
BOD_5 (g/l)	60 - 100	35 - 50
MES (g/l)	20 - 30	10 - 15
M.S (g/l)	100 - 150	50 - 70
Reducing agent sugars (g/l)	30 - 40	10 - 20
Total phenols (g/l)	7	3

There are also high levels of mineral components

Ca^{++} (g/l)	Mg (g/l)	Na^+ (g/l)	K^+ (g/l)	Cl^- (g/l)	$SO_4^=$ (g/l)
0,5	6	0,2	7	2	0,7

IV. IMPACT OF WASTE ON THE ENVIRONMENT

Bearing in mind the composition and characteristics of the wastewater discharged by the oil mills, any environment where it is directly discharged is harmed for the following reasons:

* The strong coloration

* The acidity

* It is a mineral and organic substance very prone to ferment

* There is a substance that inhibits natural regeneration

As a comparison, it is important to stress that crushing 1 kg of olives generates approximately the same amount of pollution as one person does per day.

In Tunisia, theoretically, the pollution produced by 700,000 m3 of vegetation water is equivalent to 7 million inhabitant units of waste per season day.

It must be pointed out that if the vegetation water were to be discharged into the public sewerage system it would quickly become corrosive because of its acidity and the particles in suspension. This could provoke sedimentation and anaerobiosis as well as dangerous gas emissions (H_2S).

The discharge of vegetation water in treatment plants very negatively affects the functioning of primary and oxidising processes. Indeed, even with small amounts of vegetation water, compared to domestic wastewater, large accumulated quantities of particles in suspension are produced. This leads to:

* An increase in sludge volume

* Unstable sludge

* A higher oxygen requirement

* Colour in treated water (due to tannins)

If the vegetation water is discharged into the earth, its toxicity is attributable to the presence of certain organic compounds, particularly carbolic acids, flavonoids and tannins that are not assimilated by plants and whose decomposition is often slow. These elements inhibit the activity and growth of the microorganisms that provoke mineralization.

V. TREATMENT – EXPLOITATION OF BY-PRODUCTS

Many ideas for exploiting the value of the "olive oil extraction" industry's by-products have been explored.

1. *Using pomace as cattle feed*

An intake made up of 1/3 pomace, 1/3 bran and 1/3 cactus was used with ovine animals. Experiments demonstrated that pomace, in 40% proportions with other by-products, lead to weight gain in bovine animals, even in difficult periods.

Worn and sifted pomace is easy to store and can be used in periods of shortage.

2. *Using pomace as a fuel*

Home heating in rural and olive oil producing areas has for ages been done by burning pomace. This was also done in brickyards and for traditional potters' kilns.

Soap factories, before using pomace as a fuel, use up the hexane in the pomace's remaining fat.

3. *Using vegetation water to stabilise embankments and farm tracks*

Simple and cheap systems have been developed using tanker lorries, a motorgrader or a scarifier and a tyre counter. With this equipment any farming community can do this work itself.

4. *Value of vegetation water as biogas and biomass*

Since vegetation water is rich in organic matter, biological treatment processes are presumably appropriate for obtaining valuable products for the production of protein-rich biogas and biomass.

It should be pointed out that several tests have been done. Here are some examples:

* Distillation: tried since 1977 but not continued because of operational problems (corrosion, sophisticated technique, etc.)

* Chemical treatment: weak performance (50%) and expensive reagents

* Forced evaporation

* Aerobic biological treatment: good performance (50%)

* Anaerobic treatment (20% performance)

All the tests carried out confirm the difficulties in treating raw vegetation water with its high acidity and complex organic make up. Research work has been done to combine several bio-technological processes in order to try and find a way to overcome these difficulties.

This work has been done thanks to the sponsorship of the Environment and National and Regional Development Ministry together with other institutions under its charge, particularly the ONAS and the CITET on the one hand and the Tunis National School for Engineers and German collaboration (GTZ) on the other.

This work led to the identification of a treatment process that enhances the value of vegetation water. It has been tested at a pilot plant, currently located at the Centre International des Technologies de l'Environement de Tunis (CITET), with a capacity of 100 to 1,000 l/j.

The new process consists of the following three stages:

* _Activated sludge with a very strong charge:_ This process produces a biomass that can be easily separated by decanting and then used as animal feed (25% protein). Additionally, with this bioconversion the substances that inhibit the biological process (phenols) are destroyed. Performance is around 50% of the DCO.

* _Biomethanisation_: this process breaks down organic molecules transforming them into carbonic anhydride and methane. For every kilogram of DCO that is eliminated, one can obtain 0.6 m3 of biogas at 70% in Ch4. This can then be used as a source of energy.

* _Activated sludge with a medium charge_: Normally the effluents from the biomethaniser have more than the permitted amount of DCO for discharging into public networks. This end biological treatment is able to eliminate residual organic components and help the plant's performance.

The pilot plant, with the above processes, at once reduces pollution by 95%, obtains methane-rich biogas as well as protein-rich biomass.

VI. THE TUNISIAN APPROACH IN THE FIGHT AGAINST VEGETATION WATER POLLUTION

1.The global approach

The Tunisian strategy with regard to industrial policy insists on the need to produce in the most ecological way possible, not only to conserve natural resources and reduce pollution, but also to ensure the competitiveness of Tunisian industry in the national market and for exports.

Protection of the environment is at the heart of any such development. A legislative and institutional framework has been developed for the creation of the following institutions under the Environment and National and Regional Development Ministry:

* The National Department of Decontamination
* The National Agency for Protection of the Environment
* The Coastal Development Agency
* The Tunis International Centre for Environmental Technologies

The strategy is based on prevention, control and treatment of existing problems.

1.1 Regulatory framework

The main documents that govern this industrial activity are the following:

Law n°66-27 of 30th April 1966 (labour regulations)

Decree n°68-88 of 28th March 1968 (opening and operation of listed mills)

Law 75-16 of 31st March 1975 (water regulations)

Decree 85-56 of 2nd January 1985 (discharges into the environment)

Law n°88-91 of 2nd August 1988 (creation of ANPE)

Decree n°91-362 of 13th March 1991(impact study)

Law n°96-41 of 10th June 1996 (waste)

Law n°94-122 of 28th November 1994 (town and country planning regulations etc.)

1.2 Advantages and financial incentives

The provisions of the new code for investment incentives (law 93-120) and the application documents constitute a system of assistance to investors for matters regarding the environment.

Apart from public incentives, investors in environmental technologies will benefit from:

Exemption from customs duties

Prorogation of VAT on equipment

Tax rebates

Subsidies in the form of grants (FODEP)

Funds for decontamination (FODEP):

The funds for decontamination (FODEP) under finance law 93 aim to help industrialists to invest in facilities that reduce or eliminate pollution and to encourage them to create waste collection and disposal units.

The FODEP provides industrialists with the possibility of a grant that would cover 20% of the cost of the facilities if they present a financing plan in which they contribute 30% of their own legitimate funds. The remaining 50% required can be funded through a bank loan obtained via special credit facilities for the environment and managed by government regulated banks.

2. The specific approach

The Tunisian government, together with the competent authorities, is carefully examining the problem of pollution caused by vegetation water. Several specific measures have been taken to this effect.

2.1 With olive oil-mills

Oil producers are being made to stop all vegetation water discharges into the natural environment. Oil-mills in urban areas must disengage from any sewerage networks they may be connected to.

Olive oil producers should build storage tanks capable of containing a week's effluent waste.

This practice has been applied for the entire country. These tanks would also serve to recover the (5%) oily residues still in the vegetation water.

2.2 At a regional level

Given that the construction of small storage tanks does not in itself solve the problem, the idea was to build larger regional storage tanks. Hydro-geological studies have been carried out to study regional storage tank locations where the adopted treatment technique is natural evaporation favoured by meteorological conditions.

At the same time as the storage tanks were built, transport companies were created in the region. These companies have cistern trucks equipped with vacuum pumps. In this manner the olive oil producers pay for the transport and unloading into the regional storage tanks. A great step forward has been made with regard to the principle of "the polluter pays".

3. Prospects

Bearing in mind the special requirements of the Tunisian olive oil industry, the various oil extraction techniques used, crushing capacities, oil-mill situation and availability of suitable land, the plan of action set up by Tunisia for progressively resolving environmental problems is based on:

3.1 Short term measures

For large crushing capacity oil-mills (of about 2,000 m3 of vegetation water per year) the quantities discharged may justify separate made-to-measure solutions for treatment and exploitation of the wastewater by means of bio-technological treatment processes.

For small capacity units, collective treatment facilities in keeping with current practices are envisaged. The Environment Ministry has, as part of this strategy, launched a project for building a regional vegetation water treatment plant for the region o Sousse. This plant would be situated next to the storage tanks built there in 1985. The planned plant will have a capacity of 30,000 m3/year coming from 50 oil-mills in the region.

3.2 Medium and long term measures

The Environment and National and Regional Development Ministry's strategy for pollution prevention, contemplates medium and long term measures aiming to develop cleaner olive-crushing technologies that use less water and produce less residue. So, current production facilities that work with presses or three-phase centrifugation must evolve towards cleaner more "ecological" processes by modifying some of their equipment. Incentives and financial support, already begun, will play a role in this plan.

OLIVE OIL INDUSTRY SITUATION IN LEBANON

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OLIVE OIL INDUSTRY SITUATION IN LEBANON

1- What is olive oil?

Olive Oil is a natural product that, when extracted by physical procedures from high quality and adequate mature olives, has exceptional properties making it ideal for seasoning and frying food.

It is marketed in accordance with the following designations and definitions:

* Virgin olive oil: it is the oil obtained from the fruit of the olive tree solely by mechanical or other physical means under conditions, particularly thermal conditons, that do not lead to alterations in the oil, and which has not undergone any treatment other than washing, decantation, centrifugation and filtration.

- Virgin olive oil fit for consumption as it includes:

    ♦Extra virgin olive oil: virgin olive oil has an organoleptic rating of 6.5 or more and free acidity, expressed as oleic acid, of not more than 1 gram per 100 grams.

    ♦Virgin olive oil: virgin olive oil has an organoleptic rating of 5.5 or more and free acidity, expressed as oleic acid, of not more than 2 gram per 100 grams.

    ♦Ordinary virgin olive oil: virgin olive oil has an organoleptic rating of or more and free acidity, expressed as oleic acid, of not more than 3.3 gram per 100 grams.

- Virgin olive oil not fit for consumption as it is, designated lampanate virgin olive oil, virgin olive oil that has an organoleptic rating of less than 3.5 and/ or a free acidity, expressed as oleic acid. It is intended for refining or for technical purposes.

* Refined olive oil is the olive obtained from virgin olive oils by refining methods which do not lead to alterations in the initial glyceridic structure.

* Olive oil is the oil consisting of a blend of refined olive oil and virgin olive oil fit for consumption as it is.

2- Lebanon's situation

Lebanon was considered as one of the most important countries that plant olives.

This culture constitutes the principal agricultural resource for many regions including Akkar, Koura, Zgharta, Batroun, Nabatieh, Jbeil....

36.000 ha are planted by more than 6 million of olive trees.

The olive tree is very ancient in the North of Lebanon, it is more dynamic and well treated in the south, where we see young trees.

All of the trees are situated on the hills and slopes of small hights.

Near the sea, between few meters and 100 meters height, they are found in an optimal climatic zone where the average winter rainfull varies from North to South from 600 to 900.

The average production per year is of 60000 tons, where 12000 tons are consumed for table, the rest is designated for olive oil production.

With respect to the Ministry of Agriculture, 650 presses of olives are found :

- 300 in the North Lebanon,
- 200 in the South,
- 150 in the Mount Lebanon and Bekaa.

and with 3 refining industries for olive oil.

The pressing of 1 tonne of olives gives between 20 and 30% of oil, depending on the type of olives, amount of water received by the plant, on the fertilizing, on the harvesting system and above all on the extraction technique.

3- The production of olive oil.

Oil production is a seasonal production , it takes place between September and November.

The process is as follows:

1- Harvesting and Cleaning of the olives.
2- Crushing of the olives by stone or mechanical pestle.
3- Formation of the olive paste.

4- Cold mechanical pressing of the paste to obtain the olive juice, the juice being composed of oil and vege.

5- Separation of oil from the vegetable water, the oil then is called extra virgin oil, first cold presser.

<u>1- Preliminary exterior operations in the olive press:</u>

a- Harvesting

The olives are harvested by hand or by stick beat (darb bel assaye) between September (after the first rain) and the first of October.

b- Cleaning

Before the transportation the impurities are removed from olives (leaves, stones....) this can be done by hand or using simple machines.

The presence of leaves gives sour oil of green color.

c- Transportation

The olives are transported either by bags or by boxes (it's more preferable by boxes)

<u>2- Interior operations:</u>

a- Reception

Each olive press has a stocking place.

b- Quality control of the olive

None of the olive presses has a laboratory to determine the quantity of grass material in the fruit.

c- Washing

The olives are washed by water in order to eliminate all the impurities to avoid the augmentation of the acidity of oil and the changement of organoleptic qualities (Odor, taste).

3- Preparation of the paste

a- Crushing

Olives are crushed by circular millstones (made up from granite) or mechanical crushers, most industries use millstones in crushing step.

a-1- The old technique:

The olives are fed betwwen the mills that rotate around a fixed base at a speed of 10 to 14 revolutions per minute and crush them to a thick paste.

Cooling water flowing in jacket surroundng the millstones maitains the paste at an optimal temperature for extraction of the oil (between 15°C and 25°C). Excessive heat can compromise the quality of the oil (high acidity).

The paste is then transported by hand and spread evenly onto round mats.

Three full mats are stacked like pizzas on a cart and covered with an empty mat and a steel. when a sufficient number of these units are assembled , usually about 30, they are rolled into the hydrolic press .

The press squeezes this sandwich with a force about 350 Kg per square centimeter for 40 minutes or so. The oil is removed and run into a container at the base of the cart.

a-2- The new technique:

The olives are fed between steel cylinders that turn against each other at a speed of more than 1800 revolutions per minute and crush them to a thick paste.

Cooling water flowing in a jacket surrownding the cylinder housing maintains the paste at an optimal temperature for extraction of the oil.

4- Oil production clarification

The oil extracted from the paste still contains emulsified water, fruit particles and mucilage in suspension.

These substances compromise the quality of the oil in as much as they promote oxidation, hydrolysis and fermentation.

They are removed by clarification.

a- The old technique:

In this technique, the clarification is achieved by sedimentation, allowing the oil to settle for a long time, free of sudden changes in temperature.

The sediment was then collected with decanting ladles. The last drops of oil floating on the vegetation water or on the dregs were collected with a broad, flat spoon with a handle.

b- The new technique:

The technique is based on the principles of centrifugation.

This process exploits the specific weight differences between water and oil. The water- thinned paste is churned at very high speed in a horizental centrifuge. This results in the separation of the three components of the paste: oil, vegetation and the pit and pulp residue (pomace).

4- The storage of Olive Oil

Stainless steel tanks are used for the storage of olive oil, they afford protection from light and easily sanitized, thus offering highest guarantee of correct conservation.

If correctly stored, olive oil can be consumed even more than two years after it was produced because it contains antioxidants that protect it from becoming rancid.

The containers must be of dark glass or tinplate, to protect the contents from light, and must be stored in a dark, cool place.

5- Utilisation and valorisation of sub-products of olive oil

After extraction of oil, contained in olives, by pressure or by centrifugation, we, essentially, dispose off the sub- products, vegetation water and the pomace.

a- Pomace

Because of the oil contained in the pomace , it presents an interesting commercial value.

In Lebanon the extraction of oil from the pomace is done by using the circulation of the HEXANE solvant into the pomace, distillation of the mixture oil-hexane and injection of vapor pressure to eliminate the hexane by condensation.

So, oil is used to fabricate the soap and a part of disoiled-pomace is used as a source of energyfor the enterprise, and the other part of the disoiled -pomace is used to fabricate fertilizers.

b- Vegetation water

All the presses use to get rid of the vegetation water, without any treatment, in sewer tanks.

THE CRAFT PRESS SYSTEM AND THE THREE-PHASE SYSTEM

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THE CRAFT PRESS SYSTEM AND THE THREE-PHASE SYSTEM

The process for obtaining olive oil consists of crushing olives.

Varying amounts of water (depending on the extraction technique used) are added to the resulting paste, which then goes through a separation process (using a press in the craft system or centrifugation in the three-phase system) leaving a liquid and a solid residue (pomace).

The vegetation water is the water that is left after separating the oil from the above liquid.

The pomace and the vegetation water are produced in varying quantities and can have different compositions depending on the process used.

There is now a new technique, called the two-phase system, which does not produce vegetation water. The pomace that was obtained in the other two processes contains the vegetation water and a semisolid product known as thick paste is obtained.

This technology is the subject of another presentation in this Experts Meeting.

* The craft press system

This is the oldest process and it is typical in small communities that grind their own harvest. It is also known as the traditional or classical system and it is a discontinuous type system.

The process for this system is as follows:

- The olive is washed
- Crushed
- Churned
- Pressed

* The three-phase system

This is characteristic of large mills that centralise the harvest of an entire region and can be considered as true industry.

This is a continuous process, with a much larger consumption of water (approximately 100-120 litres of water per 100 kg of olives)

The process for this system is as follows:

- The olive is washed
- Crushed
- Churned
- Centrifuged in a horizontal centrifuge or Decanter

The amount of oil that is extracted is very similar in both systems at about 20-22% although this also depends on certain other factors such as: the time of year the olives are harvested, how ripe it is, the type of fruit, etc.

The flow chart for the two systems can be seen in diagram 1.

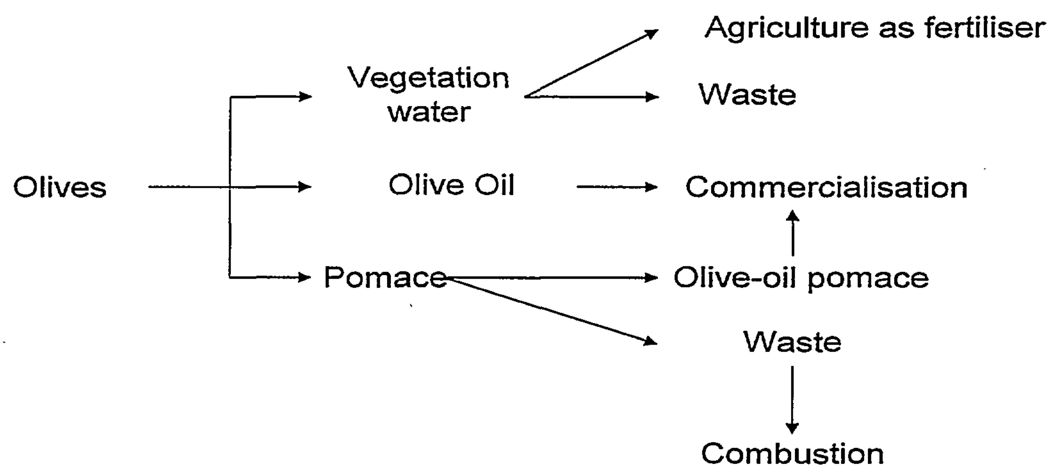

Diagram 1

The three products obtained in the press system as well as in the three-phase system are used for the following purposes:

- The oil is marketed

- The pomace has a closed circuit and the extracting industry obtains olive-pomace oil which is marketed and has a solid by-product (orujillo) that is used for combustion, as a source of heat in the pomace drying process.

- The vegetation water is environmentally problematic since its recycling capacity, traditionally at the mill (small mills used it as an agricultural fertiliser) is extremely antiquated.

Vegetation water, when discharged, is damaging to the environment and causes malfunctions in sewerage systems connected to water-treatment plants because of its very nature.

Tables I and II respectively show the characteristics of vegetation water and the mixture of solid residues obtained from the oil production process, depending on the production system used.

Table I. Average composition of the vegetation water according to the production system

Parameter	press system	three-phase system
pH	4,5 - 5	4,7 - 5,2
COD (mg/l)	120.000/130.000	45.000 - 60.000
BOD_5 (mg/l)	80.000/90.000	30.000 - 40.000
Particles in suspension (mg/l)	1.000	9.000
Total sugars (mg/l)	20.000/80.000	5.000/26.000
Nitrogenous substances (mg/l)	5.000/20.000	4.000/17.000
Organic acids (mg/l)	5.000/10.000	2.000/4.000
Polyalcohols (mg/l)	10.000/15.000	3.000/5.000
Polifenols (mg/l)	10.000/24.000	3.000/8.000
Lipids (mg/l)	300/10.000	3.000/23.000

Table II. Mixture of solid residues according to the production system

Production system	Olives added	H_2O added	Kg. Pomace	Kg. Vegetation water	Kg. Oil	Pomace moisture	% Pomace oil
Press	100	30	30-35	65-75	20-21	25-30	7-8
3-phases	100	100-120	45-60	110-140	20-21	40-50	4-5
2-phases	100	10-20			21-22		

In the two-phase system, 90-110 kg of thick paste (a mixture of pomace and vegetation water) is obtained, with 60-65% moisture and 3-4% oil.

THE TECHNOLOGY AND FEASIBILITY OF A TWO-PHASE GRINDING SYSTEM

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1. THE FEASIBILITY OF A CENTRIFUGATION SYSTEM THAT DOES NOT PRODUCE VEGETATION WATER.

Commercially used continuous olive oil extracting systems with three outlets (experimentally, two-phase systems were also tried out) made their appearance in Spain in the early sixties and became widespread in the olive oil industry. They had, however, two drawbacks:

* They produce large quantities of, potentially highly contaminant, vegetation water (1 to 1.21 per kg. of olives).

* They consume a large amount of water (required for paste fluidisation and washing oils): about 0.7-0.81 for every kg of olives.

With the basic aim of resolving these two disadvantages, during the 91/92 season, the so-called two-phase, two outlets or ecological continuous systems appeared. The main difference in these systems is the decanter, which eliminates the vegetation water outlets and increases the distance of the oil outlet from the shaft of the bowl.

A) The advantages of the 2-phase production system can be summarised as follows:

1. It saves water, since any water added to the decanter is almost completely eliminated. An initial estimate of the saving might be 0.51 l of water per kg of olives.

2. Less investment is needed, since the need for vertical centrifuges for vegetation water is greatly reduced. Furthermore, the heating boiler need not be as powerful.

3. There are energy savings since the water injected into the decanter need not be heated, electrical energy is not needed to operate the vegetation water vat, etc. We estimate a basic saving of 0.20 pts/kg of ground olives.

4. Hardly any vegetation water is produced and so there is very little potential pollution. This is, without doubt, the main advantage of the system. It essentially does not produce any vegetation water and instead there is an outflow of cleaning water. Effluent, in the two-phase system, is reduced by 80% and so there is a 90% reduction in polluting strength (D.Q.O.). Cleaning this new waste therefore becomes more viable. These figures to a great extent match those obtained by the Instituto de la Grasa (SIO de Reus 1994).

B) The disadvantages of the two-phase system can be summarised as follows:

5. Handling and using the pit and pulp residue or pomace. The pomace obtained in the two-phase system is distinctly different to that obtained in the three-phase system.

We should point out certain important aspects:

a) The production of pomace in the two-phase system is 60% greater than in the three-phase system. This is due to its higher degree of moisture (60% compared to 48%) and the fact that all the dry matter that goes into the vegetation water in the three-phase system, goes into the pomace in the two-phase system.

b) Twice as much (reducing agent) sugar is used as in the three-phase system. This added to the fact that "fine" and soluble solids that go into the vegetation water in the three-phase system go into the pomace in the two-phase system, means that the consistency of this pomace is totally different.

6. Visual checking when operating the oil mill is limited, since some points of reference that were essential in the three-phase system are eliminated (i.e. vegetation water sieves and vegetation water vat outlets).

7.Adapting machine handling to fruits with varying characteristics, since an important control element (i.e. injection water) is left out.Effectively, since the paste is not fluidised in the two-phase system, the thickness of the vegetable water phase is notably less than in the three-phase system. When the olives are not very moist, the thickness in this phase may be significantly less and there is a risk of part of the oil being dragged along with the pomace.

This is one aspect in which there are important differences between the two systems.

In the three-phase system, as revealed by some authors (Ranalli, Giovacchino) and almost all experienced mill owners, very moist olives are more difficult to work with, because there are, overall, more losses of oil in by-products. The use of technological aids (such as talc or enzymes) can give good results in the production of these fruits.

In the two-phase system, there are fewer problems in the production of very moist olives except when there are difficult pastes. The use of technological aids also gives good results. However, oil losses in by-products can be greater with less moist fruits. Here the fatty/dry R. of the two-phase system pomace rises as the moisture of the olive diminishes and consequently also that of the pomace (which means that the vegetation water phase is reduced).

This is something to be borne in mind when operating the continuous two-phase system.

In this analysis of advantages and disadvantages, there are two vital points to consider industrial performance and the quality of the oil obtained.

C) Industrial performance

Does one obtain more or less oil with the two-phase system? Are there any differences in oil losses in the by-products? To answer this question we must analyse oil losses that occur in the three-phase system. In a standard olive, of the Picual variety for example, as long as one works

with a certain amount of care, the characteristics and production of by-products can be deemed to be as follows:

Pomace:

Production: 49-51 kg per 100 kg of olives

Moisture: 47-50%

Fatty/moist R: 2.9-3,3%

Fatty/dry R: 5.47-6-60%

Vegetation water:

Production: 100-110 kg per 100 kg of olives

Moisture: 90-92%

Fatty/moist R: 0.25-0.45%

Vertical centrifuge discharges (oil and vegetation water)

Fat: 0.25-0.30 kg of oil per 100 kg of olives

That would give us fat losses of 1.90 to 2.45 kg of oil per 100 kg of olives (other losses from cleaning or garnering olives etc. are not taken into consideration).

In the two-phase system there is only one important by-product and almost all oil losses occur there. The fatty content of the pomace, therefore, expressed relative to dry matter (Fat/dry R) is a good parameter to quantify losses in the process. Yield and other features of the remaining outflows in the two-phase system are as follows:

Olive cleaning water:

Yield: 20-25 kg. per 100 kg. of olives

Moisture: 99-99.8%

Fat Rg. relative to moisture: 0.02-0.1%

The sum of these two items would give us fat losses of 0.15 to 0.25 kg of oil per 100 kg of olives.

Consequently, so that the two-phase system can be neutral compared to the three-phase system, possible losses in the pomace should be limited to 1.75 and 2.20 kg of oil per 100 kg of olives, which as regards the dry material of the pomace would give us a 5.60-7.10% point-pair.

This interval of 5,6-7,10% of Fat/dry Rg of pomace is what must serve as a reference point for the correct functioning of the 2-phase system.

During the 93/94 season, 25 oil mills operating the two-phase system with Picual olives were monitored on a daily basis. Here are the most significant conclusions:

* The average Fat/dry R. of the pomace in the 25 oil mills was 6.69%, which is within the reference point-pair for good functioning.

* The Fat/dry R. in 14 oil mills (56%) was below 7% and only 4 oil mills (16%) were above 7.4%.

In conclusion, it can be stated that, with the Picual variety, there are no additional losses with two-phase system production when compared with the traditional three-phase system. The fact that 6 oil mills (25%) have a Fat/dry R. of pomace below 6% is an example of the system's potential with appropriate handling according to the type of olive.

The experience obtained by other authors, working with other varieties, corroborates what has been said here concerning industrial performance:

Di Giovacchino (Expoliva 93) obtained a satisfactory yield (86.1% extractability) by working with the two-phase system - even better than with the three-phase decanter system (85.5%).

Almirante y Col (Olivae, October 93), in a survey with the Ogliarola Salentina and Cellina di Nardo varieties, obtained a higher extraction yield with two-phases (86.1%) than with three-phases (85.7%).

Alba y Col (Expoliva 93), in a comparative survey with the Picual variety obtained a similar yield (Ubeda) or slightly higher one (Luque) with two-phases.

A similar yield was obtained with the Lechin variety. In this test only the Hojiblanca variety had a better yield in three-phases.

D) The quality of the oil

In the 92/93 and 93/94 seasons oil extraction from the Picual variety was done with both systems. It must be pointed out that in each season the type of olive as well as working conditions (temperature etc.) was similar for each extraction (2F and 3F).

The 92/93 season was characterised by its mild not very bitter oils with low polyphenol content and stability, whilst in the following, 93/94 season, they were more normal and can be considered characteristic of Picual.

In the results obtained there are no differences in the degree of acidity, I. Peroxides, K270 and K232. However, since water is not added, the polyphenol content is greater in two-phases, as are the former parameters: K225 (bitterness) and stability (resistance to going rancid).

These results agree with those obtained by other researchers. Di Giovaccino obtained a 39% increase in the total number of polyphenols, 58% more o-diphenols and 16% more stability with two-phases. Almirante y Col similarly obtained an increase of 44-69% in total polyphenols, 115-143% more o-diphenols and 25-32% more stability. Other parameters were not affected.

Alba y Col. also observed a significant increase in polyphenols and stability and hardly any variation in other parameters with these tests.

The organonoleptic rating obtained with the Panel Test method was significantly different in each year. Whilst in the 92/93 season oils from the two-phase system always had a higher rating and were preferred to those from a three-phase system, in the 93/94 season the ratings were very similar and there was no preference criterion for either oil.

This may be due to the fact that in the first season, there were significant differences in the intensity of the attributes, specially in the fruitiness and greenness whilst in the second season the differences of intensity of these attributes were very small. During both seasons a more intensely bitter or spicy flavour was maintained in oils made with the two-phase system, whilst oils made with the three-phase system were sweeter.

It should be stressed that, in both years, the late season oils achieve a higher score when produced in two-phases. As shown, the score is below 7, indicating small flaws (a taste of wine, impurities, etc.). In these circumstances it seems the intensity of the defects is palliated in the two-phase production system. A similar conclusion was reached by the Instituto de la Grasa in the 91/92 season.

2. TECHNIQUES FOR CENTRIFUGING WITHOUT OBTAINING VEGETATION WATER.

We have mentioned three disadvantages in using this system.

1. The characteristics of the pomace, which make this by-product's handling and extraction of the oil more difficult. So, there is a need to increase storage capacity, transport systems, etc.

However, the two-phase pomace extraction system, through solvents in traditional pomace separators, makes drying and the extraction itself more difficult.

That is why some oil mills or companies have introduced double centrifugation for this pomace.

There are lots of variants that determine the percentage of oil extracted and its quality.

2. Given the lack of visual checks, the possibility of continuously measuring the fatty content and moisture of the pomace, using the NIR technique in an "on line" analysis, is being examined.

3. Increasing thickness in the vegetation water stage.

In the two-phase system, adding small quantities of water can be an efficient way to facilitate olive oil extraction, especially when the moisture of the olive is low because adding water increases the difference in density between solid particles and the fluid.

One of the most important questions is where should one add the water.

Traditionally, in the press system as much as in the continuous three-phase system, when the olive paste is very "dry", water is either added to the mill (this helps the paste elevators to work better) or before churning, making the paste more fluid. Part of the water is absorbed by the hydrophilic elements of the olive and oil appears floating.

Another possibility is to add this water when injecting into the decanter, as in the 3-phase system.

A series of tests were carried out in which various percentages of water (relative to the weight of the fruit) were added at two points in the process: a) before churning and b) before injecting into the decanter (as in the three-phase system).

It can be deduced that:

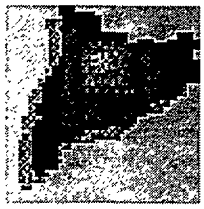
* Injecting water into the decanter is significantly more efficient than adding it before churning.

* When water is added to the churning, substantially more is required in order to reduce the Fat/dry R. of the pomace. Results are never as good as when it is injected directly into the decanter.

* Generally speaking, it is not advisable to inject more than 10% water even with oil with as little moisture as in the tests (35.5-36%).

* Logically the moisture of the pomace increases when water is injected.

* In the doses tested there were no apparent significant differences in the nature of the oils for the parameters analysed.



VEGETATION WATER MANAGEMENT

The Catalan experience

Speaker: Hernan Subirats i Videllet
Agricultural Engineer
Tarragona Territorial Delegate
Tarragona, December 1997

PRODUCTION

Situation prior to 1994

Olives

100.000 Tm

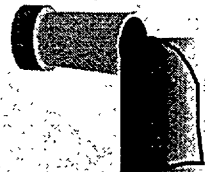
Oil

22.000 Tm

Pomace

45.000 Tm

Vegetation Water



120.000 Tm

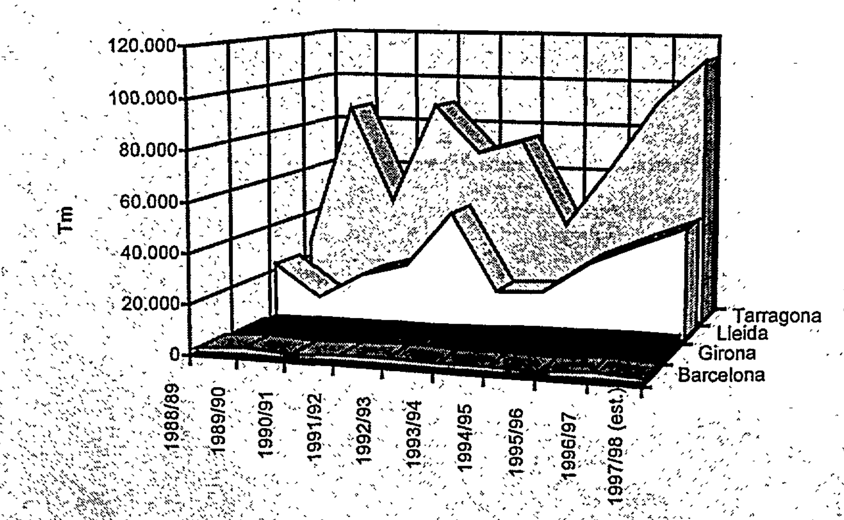
OLIVE OIL PRODUCTION

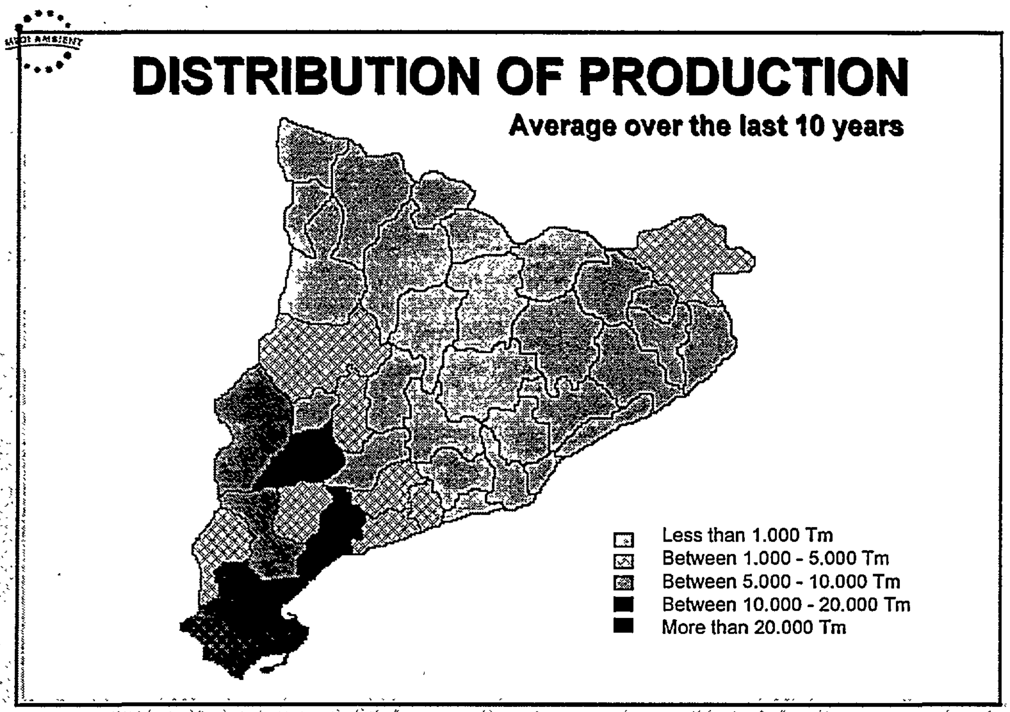
Evolution by provinces 1988-98

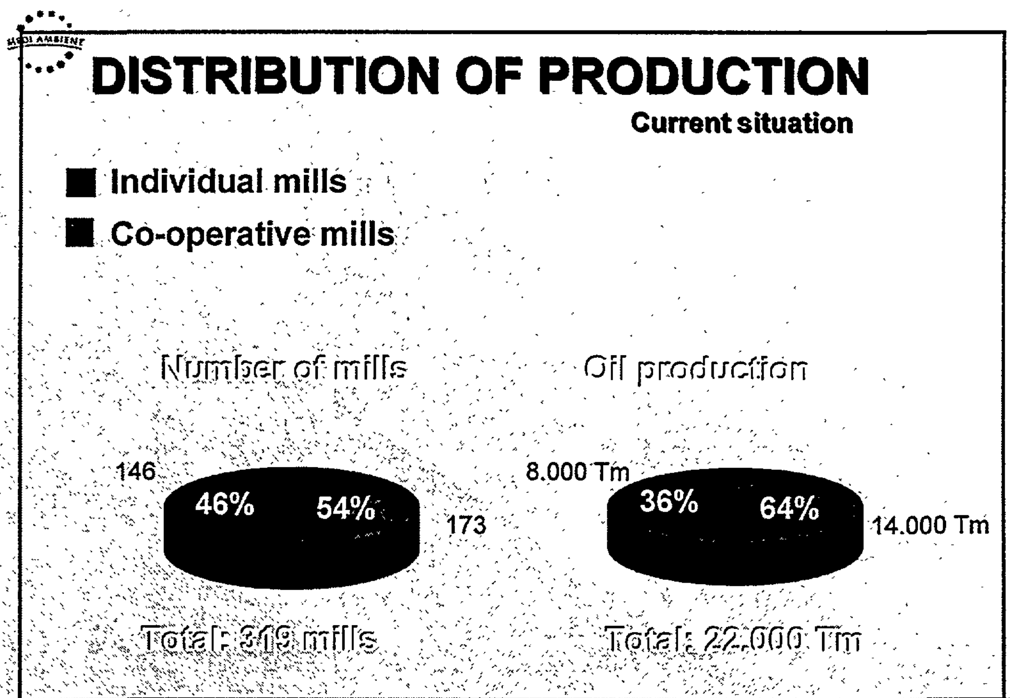
Season	Barcelona	Girona	Lleida	Tarragona	TOTAL
1988/89	1.782	900	22.509	26.667	51.858
1989/90	3.101	1.188	8.881	87.072	100.242
1990/91	1.574	1.158	19.500	46.376	68.608
1991/92	2.375	2.713	24.834	88.916	118.838
1992/93	2.600	2.625	47.880	69.077	122.182
1993/94	2.080	3.361	15.738	74.847	96.026
1994/95	2.151	4.409	16.614	39.229	62.403
1995/96	1.488	4.522	29.746	65.013	100.769
1996/97	2.825	4.725	38.003	93.241	138.794
1997/98 (estimate)	1.744	4.500	45.985	110.930	163.159
AVERAGE	2.172	3.010	26.969	70.137	102.288

OLIVE OIL PRODUCTION

Evolution by provinces 1988-98

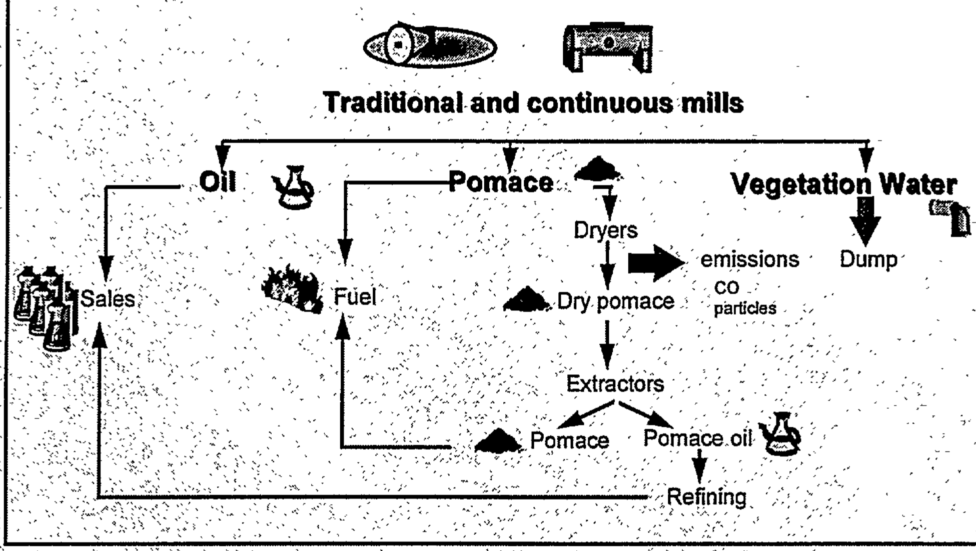



DISTRIBUTION OF PRODUCTION
Average over the last 10 years
Less than 1.000 Tm
Between 1.000 - 5.000 Tm
Between 5.000 - 10.000 Tm
Between 10.000 - 20.000 Tm
More than 20.000 Tm


DISTRIBUTION OF PRODUCTION
Current situation
Individual mills
Co-operative mills
Number of mills
Oil production
146
46%
54%
173
8.000 Tm
36%
64%
14.000 Tm
Total: 319 mills
Total: 22.000 Tm

FLOW OF PRODUCTS

Situation prior to 1994



CHARACTERISTICS OF THE VEGETATION WATER

Greases (mg/l)	3.000 - 5.000	
Organic material (%)	5 - 10	
N (kg/m^3)	1,5 - 1	0,5 - 1
K (kg/m^3)	7,2	2,7
P (kg/m^3)	1,1	0,3
$CO_3^{=}$ (kg/m^3)	3,7	1
Mg (kg/m^3)	0,1	
Water (%)	82,4 - 94,5	

VEGETATION WATER PROBLEM

	Traditional mills	Continuous mills	Table 3 (*) - RD 849/86
pH	4,5 - 5	4,7 - 6	5,5 - 9,5
Suspended solids(mg/l)	5.000-10.000		80
BOD_5 (mg/l)	10.000 - 110.000		40
COD (mg/l)	60.000 - 195.000	40.000 - 100.000	160
Oils and greases (mg/l)	3.000 - 5.000		20
Phenols (mg/l)	5.000-10.000		0,5

(*) Royal Decree 849/1986, 11th April, approving Public Water Regulations in APreliminar@ I, IV, V, VI and VII of Law 29/1985, 2nd August, BOE number 103 of 30.4.86.

ADMINISTRATIVE ACTION

- **Decree 290/94 on additional regulations concerning olive oil mill authorisations**
- **Order of 28.10.94 for the granting of subsidies for activities aimed at eliminating pollution from olive oil mills**

Decree 290/94

on additional olive oil mill authorisation regulations

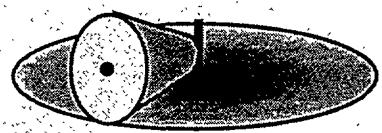
- Olive oil mills that act within the framework of community aid for the production of olive oil will have the status of being authorised
- This authorisation is conditioned to public water cleaning systems not being affected
- A minimum of 1 ha per 30 m^3 of vegetation water per year is deemed necessary. The storage facilities shall meet conditions for safety and waterproofing
- If vegetation water pomace is produced it is sent to the Waste Agency authorised extractor

Order of 28.10.94

for the concession of subventions for activities aimed at eliminating pollution originating in olive oil mills

- For owners of small and medium sized companies that grind olives to produce oil
- It shall be expressly stated that any subsidised activity waste that could affect public water and cleaning systems must be eliminated
- The subsidy could be as much as 30% of the real cost
- Upwards of 300,000 ptas the subsidy shall not exceed 2 ptas per kg of ground olives

PROPOSALS FOR ACTION

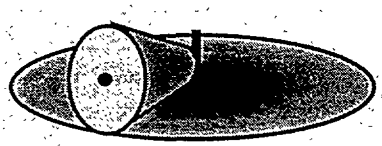


Traditional mills with an annual production of < 150 Tm

- Applied on agricultural land as fertiliser in quantities of 30 m^3/ha/year

Minimum farmed surface area required: 2.5 ha/mill
1 ha = 10,000 m2

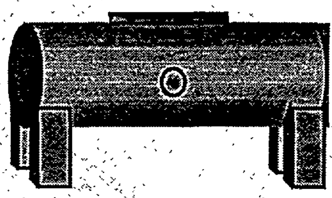
PROPOSALS FOR ACTION



Traditional mills with an annual production of < 150 Tm

- Storage of the entire season's vegetation water for gradual use in farming as fertiliser in quantities of 30 m^3/ha/year

PROPOSALS FOR ACTION

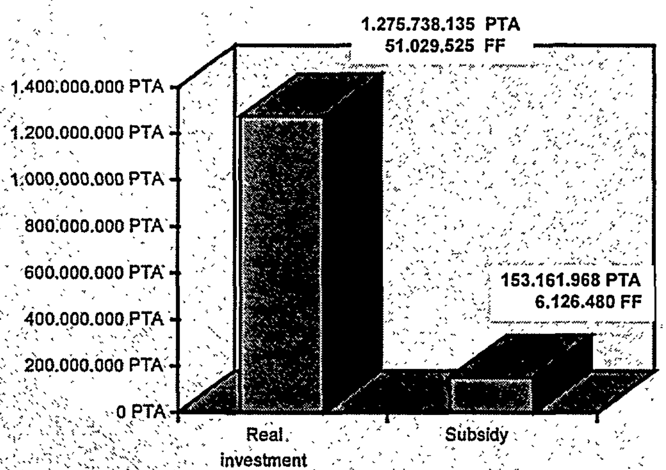


3-phase continuous system mills

- Storage of the entire season's vegetation water for gradual use as farm fertiliser in quantities of 30 m3/ha/year
- Implementation of the continuous 2-phase system

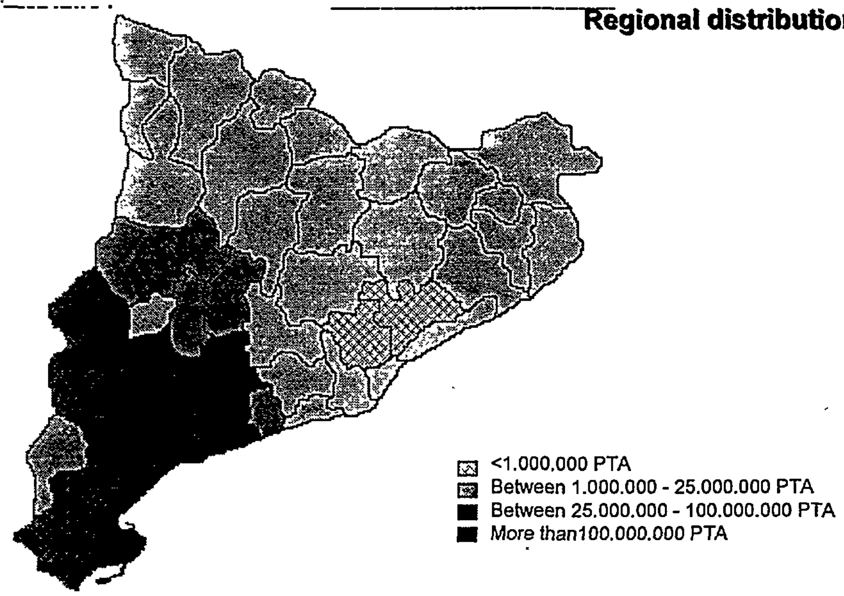
INVESTMENTS MADE

In comparison with the subsidy received



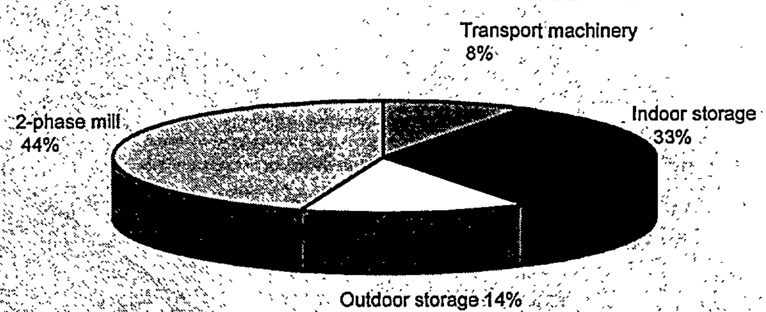
INVESTMENTS MADE

Regional distribution



ACTIONS TAKEN

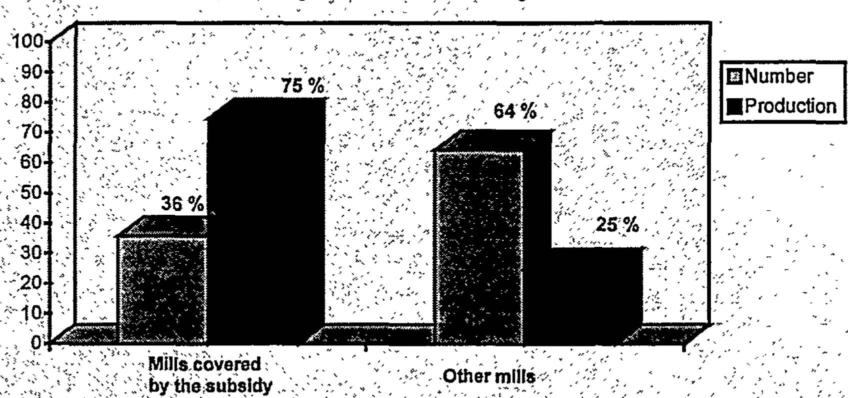
Actions taken	Number
Transport machinery	10
Indoor storage	39
Outdoor storage	16
2-phase mill	53



REPERCUSSIONS IN THE SECTOR

	Number	Production (Tm)
Mills covered by the subsidy	114	74.896
Other mills	205	25.104

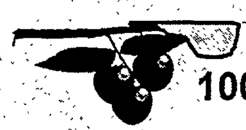
100% of working mills have been regularised



PRODUCTION

Current situation

Olives



100.000 Tm

Oil

22.000 Tm

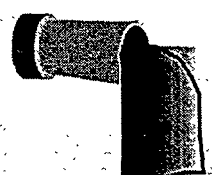
Vegetation water pomace

40.000 Tm

Pomace

25.000 Tm

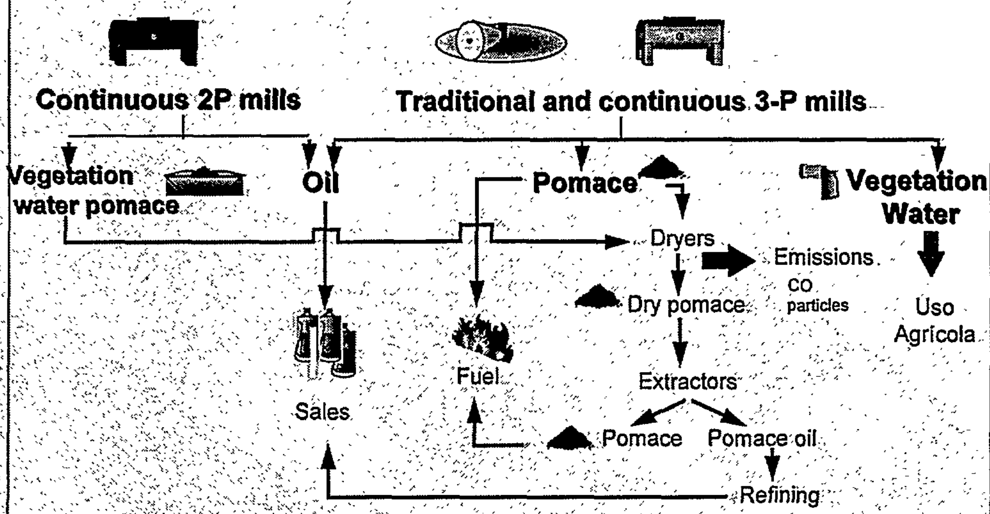
Vegetation Water



60.000 Tm

FLOW OF PRODUCTS

Current situation



AGRICULTURAL DEFINITION OF VEGETATION WATER

	Traditional mill		Continuous mill (3-phase)	
	%	30 m^3/ha (Kg/ha)	%	30 m^3/ha (Kg/ha)
Organic material	10,0	3000	2,5	750
N	0,2	60	0,06	18
P (P_2O_5)	0,1	30	0,02	6
K (K_2O)	0,4	120	0,15	45
Mg	0,02	6	0,05	15
pH	4,5 - 5,0	--	4,7 - 5,2	--
Poliphenols	0,5 - 1,0	300	0,5	150

RECOMMENDATIONS FOR THE USE OF VEGETATION WATER IN AGRICULTURE

- Preferably applied to adult arboreal cropland, avoiding crops that are sensitive to salinity
- To be applied 2-3 months before sowing, with herbaceous crops
- Respect the dose of 30 m^3/ha and year
- Avoid applying it onto acid land
- Spread uniformly and plough the surface after every application
- Apply the vegetation water in rotation and avoid reiterative applications in successive years on the same plot of land

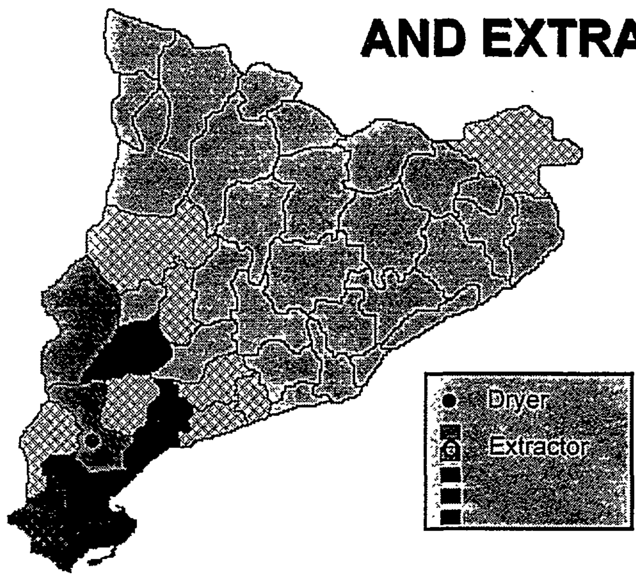
ECONOMIC VALUE OF VEGETATION WATER AS A FERTILISER

Example of a traditional olive farm

	N	P_2O_5	K_20	Economic cost
Plants need (UF/ha)	120	50	120	1.420 FF 35.450 PTA
Water vegetation (30m^3/ha)	60	30	120	1.020 FF 25.350 PTA
Necesity	60	20	0	

Characteristics of the plantation: 150 trees/dry land. Production: 35 kg/tree
Considered cost of fertilisers: N = 140 PTA, P_20_2= 85 PTA, K_2O = 70 PTA

LOCATION OF DRYING MILLS AND EXTRACTORS



DRYING AND EXTRACTING INDUSTRY SECTOR

Aid for increasing drying capacity