

# IENICA

Interactive European Network for Industrial Crops and  
their Applications

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## **REPORT FROM THE STATE OF FRANCE**

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## EXECUTIVE SUMMARY

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In 2002, France processed more than one million tonnes of industrial oilseed (336,000 ha). Since 1997, oilseed production has shown a growth of more than 65%. Highly promising possibilities are emerging for oilseed crops, a sector in which biolubricants, surfactants and various additives for plastics, paints, inks and plant protection products are already produced on a medium scale. For some applications like biolubricants it is considered markets are still limited, but they are expected to grow further within the next few years.

Starch from grains and potato also has a strong potential and since 1997 its use is increasing; the sector has shown a growth of 30%. In 2002, 1.3 million tonnes of starch was processed for non-food applications representing an area of 475,000 ha of cereals. There are many applications, such as in the pulp and paper industry and the chemical industry but the strongest growth is seen for the group of other applications including biodegradable plastics, biopolymers, detergents etc.

Fibre plants such as hemp, flax and also grain straw may find various applications in paper-making and the textile industry. French flax and hemp acreages represent 80% and 50% of the European acreage, with 9,700 ha for hemp and 68,000 ha for flax (2003). The flax area in 1999 was 49,000 ha; this growth is mainly due to a strong demand from the textile market. These applications are not expected to grow much more; development prospects for fibres depend on the creation of new products. Today fibres find new outlets in the building sector and in composite materials and these sectors are under development.

Medicinal, aromatic and perfume plants, traditionally processed for pharmaceuticals and cosmetics, are likely to find new outlets as a result of the search for new properties and as a response to consumer demand for so-called 'natural' products. Many efforts have been made to promote and regulate lavender and lavandin production which are the main speciality crops. Since 1995, the lavender area has been doubling and the lavandin area has shown a growth of 40%. Research programmes on dyes are currently ongoing with very promising results, but high prices are still a limiting factor.

The majority of bio-based products are processed from French crops, except of course when palm or coco oil are required. These oils are imported.

# OIL CROPS

## Crop Production

**Table 1 – Oil Crops: Area, Production and Yield**

Crops	1997						2002			
	Total			Non-food			Total		Non-food	
	Area (000 ha)	Oilseeds (000 t)	Yield (t/ha)	Area (000 ha)	Oilseeds (000 t)	Area (000 ha)	Oilseeds (000 t)	Yield (t/ha)	Area (000 ha)	Oilseeds (000 t)
Rapeseed	970	3,400	3.5	147	513	1,044	3,327	3.19	274 <sup>(2)</sup>	873
Erucic rapeseed	-	-	-	4	14	-	-	-	10	31.8
Sunflower <sup>(1)</sup>	895	1,940	2.17	40	87	613	1,490	2.43	51	124
Soy	97	280	2.9	-	-	75	204	2.72	-	-
Linseed	5	9	1.8	0.54	1	5	-	-	0.969	-
<b>Total</b>	<b>1,967</b>	<b>5,629</b>		<b>191</b>	<b>615</b>	<b>1,737</b>	<b>5,021</b>		<b>336</b>	<b>1,029</b>

Source: [14]

<sup>(1)</sup> high oleic included

<sup>(2)</sup> biofuel processing activity currently yields 350,000 tonnes of rapeseed methyl ester, from 260,000 ha of cropland [7], generating significant quantities of glycerine, around 35,000 tonnes of which find outlets in surfactant, solvent industries etc. plus a minor amount of non-saponifiable compounds like phytosterols and tocopherols, high added-value cosmetics or nutraceutical products.

## Industrial Applications and Generic Issues

### Lubricants/Drilling fluids

The French lubricants market is 850,000 tonnes a year and though today is still limited to a few thousand tonnes of oil-based lubricants [1], this sector is very promising. The adoption in 2003 of the French environmental quality label for lubricants for chainsaws ‘NF Environnement 375’ is a first step. Representative companies are Novance, Mobil and Fuchs.

### Surfactants

The French market is around 410,000 tonnes [6]. The largest amounts of surfactants are consumed by the household detergent industry. This sector has very strong market potential but European oil derivatives find competition difficulties facing tropical oils. Similar potential is expected for cosmetics and for the formulation of plastics and elastomers. Erucic oil derivatives, due to their specific properties, are marketed as a defoamer agent. 10,000-15,000 tonnes of oil are

dedicated to this production each year [2]. Representative companies are Atofina, Bio-Attitude (created in 2000) Cognis, Novance, Seppic, Soliance etc.

### Solvents

The paints and coatings sector uses several thousand tonnes of linseed, castor bean, sunflower and soy bean oils per year. The ink manufacture sector (Balavoid, Coates & Lorilleux) gains growing interest; the French market is 18,000 tonnes and could be largely substituted but today it is still limited [4]. Bitumen solvents from rapeseed oil have found recent outlets; 3,000 tonnes were produced in 2001 and a potential of 20,000 tonnes could be reached within the next few years [8]. The agrochemicals sector gives a strong potential for adjuvants, 5,000 tonnes is the present French market that could be largely substituted [4]. Vegetable oil methyl esters are of growing importance in the sector of surface cleaning; the French market is 14,500 tonnes per year. Vegetable-origin solvent has strong potential.

### Other

The soap industry uses more and more amounts of palm stearine; rapeseed oil derivatives do not fulfil technical requirements. The rubber manufacture sector could be a significant outlet for rapeseed oil. Atofina uses castor oil derivatives to produce nylon.

# FIBRE CROPS

## Crop Production

**Table 2: Fibre Crops – Grain Straw: Area, Production and Yield**

Crops	1997					2002				
	Total			Industry		Total			Industry	
	Area (Mha)	Straw (Mt)	yield (t/ha)	Area (Mha)	Straw (Mt)	Area (Mha)	Straw (Mt)	Yield (t/ha)	Area (Mha)	Straw (Mt)
Grain straw	<b>6.5</b>	<b>20</b>	<b>3.5</b>	-	<b>3-4</b>	<b>7.6</b>	<b>26.6</b>	<b>3.5</b>	-	<b>5-6 (2)</b>
wheat		<b>13.4</b>					<b>17.8</b>			
barley		<b>4.6</b>					<b>6.1</b>			
Other (1)		<b>2</b>					<b>2.7</b>			

Source: [15], [16]

(1) rye, triticale, bran...

(2) amount of straw that would be available for industry. This is a theoretical value but a large part is still used to regenerate the ground and there is strong competition with animal bedding.

**Table 3: Fibre Crops – Annual Lignocellulosic Plants: Area, Production and Yield**

Crops	1997			2002			
	Area (000ha)	Straw (000t)	Straw yield (t/ha)	Area (000ha)	Straw (000t)	Straw yield (t/ha)	Fibre yield (t/ha)
Hemp	<b>11</b>	<b>?</b>	<b>?</b>	<b>9.7 (2)</b>	<b>58</b>	<b>6</b>	<b>2.5-3</b>
Flax	<b>49 (1)</b>	<b>?</b>	<b>?</b>	<b>68</b>	<b>425</b>	<b>6.5</b>	<b>2</b>

Source: Hemp [18]; Flax [15]

(1) 1999 [11]    (2) 2003

French flax and hemp acreages represent respectively 80% [9] and 50% [10] of the European acreage. Since 1997 the EU has reduced hemp subsidies and the competitiveness of this crop has been threatened for a while, which explains the decrease of the French hemp acreage (< 7,000 ha in 2001) but in 2003, with 9,700 ha, an equilibrium is being found again.

Fibre sorghum has been produced at an experimental stage (20 ha planted in 1998). Today, a fibre sorghum programme is not ongoing due to a lack of competitiveness compared to wood material.

Perennial lignocellulosic plants: Short-rotation poplar and eucalyptus were planted on approximately 1,000 ha in France in 1996. No update data is available.

## **Industrial Applications and Generic Issues**

### Paper and Textile Industry: the two traditional applications

The paper industry is the main outlet for fibres. The quality of fibre determines the type of application; for example, 95% of hemp finds outlets in the paper industry. Whereas hemp is no longer used in the textile industry, flax finds great outlets, the maximum area could reach 72,000 ha. France is the second largest flax producer in the world and is the leader in terms of quality. Due to the strong demand of the textile market, flax production has been increasing for the past five years [11], but still remains a niche crop (1.5% of the whole textile industry). Textiles for clothing is the main outlet for this crop (61%) but it also finds other outlets in the household linen (tablecloths, cloths etc.) (18%), furnishing (wall linings, chair covers etc.) (9%) and technical uses (postal covers, bags, mulching) (12%) [9].

### Building Sector and Technical Materials

Today, new outlets in the building sector and in technical materials (composites) are expanding the field of fibres' applications. In France the hemp plantation in the Aube department (75% of the hemp market in France) has been particularly active in research and proof-of-concept work to define new outlets for hemp in buildings. Peeled hemp (the broken fibres, by-products etc.) is sold as a construction material and an insulating product. 20% of hemp is dedicated to the production of these materials [18].

Natural fibres (flax or hemp) are increasingly used as reinforcing fibres in plastics. Their characteristics: very low density, non-abrasiveness and innocuousness, renewability and recyclability, and an absence of noxious waste when incinerated, make them of interest for car manufacturers in particular.

For three years, flax tows have begun to be used as insulation material. The company *Techni-Lin* processes composite materials for the car industry, and in particular for C5, Twingo and Opel Astra. This represents 4,000 t/year and 8,000 to 10,000 pieces per year (2001) [16], [19].

In January 2001, AFT (Agro Fibres Technologies) Plasturgies was created jointly with La Chanvrière de l'Aube and the cooperative Interval. Since March 2002, the company has been able

to produce hybrid reinforced fibre polymers with 15-70% natural fibres (hemp, flax, kenaf, sisal) with a capacity of 6,000 t/year. At the end of 2002, a new capacity of 4,000 t/year was installed. Targeted markets are the car industry, buildings and packaging. [16]

# CARBOHYDRATE CROPS

## Crop Production

**Table 3 – Carbohydrate Crops: Area, Production and Yield**

	1997					2002				
	Total		Starch industry			Total		Starch industry		
Crop	Area (Mha)	Grain (Mt)	yield (t/ha)	Area (Mha)	Grain (Mt)	Area (Mha)	Grain (Mt)	yield (t/ha)	Area (Mha)	Grain (Mt)
Barley	1.5	10.8	7.2	-	-	1.6	11	6.9	-	-
Maize	1.7	16.7	9.8	0.179	1.76	1.8	16	8.9	0.2	1.79
Wheat	5	33.8	6.8	0.151	1.02	5.2	39	7.5	0.275	1.96
Other*	0.4	2.3	-	-	-	0.5	3.2	-	-	-
<b>Total cereal</b>	8.6	63.6		0.3	2.78	9.1	68.5		0.475	3.75

Source: [15]

\* *oats, rye, sorgho, triticale etc.*

## Starch Processing

2.45 million tonnes in 2002 (1.9 in 1997), 46% out of maize, 44% out of wheat, 10% out of potato, among with 1.3 million tonnes for non-food applications (53%) [17].

## Starch Processing Companies

Amylum, Avebe, Cerestar, Chamtor, Roquette, Staryl/Styral.

## **Industrial Applications and Generic Issues**

### Paper Making

Raw or modified starch is used as a viscosity enhancer and binder in paper making. In 2000-2001 565,000 tonnes of starch were used to make paper pulp. Due to increased consumption of paper and paperboard these applications have been expanding and since 1997/1998 a growth of 34% of starch consumption in the paper and pulp industry can be seen [17].

The adhesive qualities of starch are used to make corrugated paperboard which represents 184,000 tonnes of starch in 2000/2001 versus 193,800 tonnes in 1997/1998 [17].

## Chemical Industry

Via fermentation, starch hydrolysates are used to produce many active principles used in pharmacy and healthcare (antibiotics, vitamins, hormones, biopolymers). In 2000/2001 it represented 416,500 tonnes versus 444,600 tonnes in 1997/1998.

## Other Applications

Starch derivatives are also used in biodegradable plastics, biopolymers, detergents, paints, adhesives etc. In 2000/2001, together all these joint sectors processed 130,000 tonnes of starch; since 1997/1998 it has represented a growth of 63% [17].

### *Biodegradable Plastics*

In France, 16,000 tonnes of starch-based plastics are produced each year [9]. Despite a cost price that is not yet competitive with petroleum products, these products have started to find uses as certain kinds of packaging, recipient for cosmetics, compost bag or films for agriculture etc. The AGRIPACK company produces packing material from maize starch. A 20% share of this market could be supplied with industrial crops on 2,000 ha of set-aside land. Strong potential is given for films for agriculture. In France every year, 185,000 tonnes of plastics are used in agriculture; one third could be replaced [13].

### *Biopolymers*

These are produced by fermentation; the most common compounds are polyhydroxyalcanolate (PHA), polylactic and polyglycolic acid (PLA), polylactones, and chitosan. In France these compounds are only produced at pilot scale and are not widely marketed either. Their high price limits their application in uses such as surgical materials that are biodegradable, or 'green' packaging for cosmetics. But lower production costs would allow industrialists to increase their production capacity and branch into new markets. The products on the market are MATER-BI, NOVON, BIOPOL, ECO-PLA, produced in Italy, the UK and the USA [5].

### *Surfactants and Lubricants*

Starch supplies the hydrophilic part of surfactants like in alkylpolyglycoside (APG's) or sucroesters that can be used in the formulation of dishwashing liquids, liquid soaps and various other cleaning agents. The European market of APG's and sucroesters is around 60,000 tonnes [6]. Representative companies in France are COGNIS, SEPPIC and

Soliance (for cosmetic applications only). Starch is also used in association with basic vegetable oils for the manufacture of biolubricants.

Starch offers many properties and finds outlets in many different sectors: flocculent, binding or gelling characteristics used in metallurgy, pollution clean-up and paints; super-absorbents properties for disposal nappies or talc substitute; excipient, binder, coating properties used in chemical and agrochemical industry (e.g. encapsulation like cyclodextrine); binder, retarding agent in buildings and construction etc. For example, the BIODECAP company has instituted a new use: a vegetable polymer obtained from the extrusion of a special wheat grain is used to strip painted surfaces.

## SPECIALITY CROPS

### Crop Production

**Table 4 – Speciality Crops: Area (ha)**

	1995	2000	2002
<b><u>Total Perfume Plants</u></b> <sup>(1)</sup>	-	<b>21,260</b>	-
Lavandin	13,300	16,274	19,000
Lavender	2,500	3,850	5,000
Clary	1,000	1,000	-
Other: May Rose, Jasmine, Iris, Violet, Bitter orange	-	136	-
<b><u>Total Medicinal Plants</u></b> <sup>(1)</sup>	-	<b>9,640</b>	-
Oil Poppy	5,000-6,000	7,400	8,000
Ginkgo Biloba	-	490	-
Melilot	-	164	-
Psyllium	-	128	-
Camomile	-	106	-
Other (>40 ha): Artichoke (leaf), St John's wort, Borage, Passiflora, Valerian, Echinacea)	-	367	-
<b><u>Total Aromatic Plants (25 species)</u></b> <sup>(1)</sup>	-	<b>2,060</b>	-
Thym, Tarragon, Parsley, Basil, Mint, Coriander, Wild Rose	-	>100 (each)	-
Other: Officinal Sage, Rosemary, Sweet Mint, Lemon Balm, Origanum, Shive, Savory, Chervil	-	> 40 (each)	-
<b><u>Total Dye Plants</u></b>	-	-	<b>&lt; 20</b>
(cosmos, madder, dyer's greenweed, bukthorn, woad, Chinese Indigo, weld, goldenrod)			

Source: [3], [9], [20], [21]

(1) Main application, plants could have 2 or 3 applications.

The above list is not complete, many medicinal, aromatic and perfume plants are not grown, but are picked in the wild. Here are some examples: Gentian, Meadowsweet, Mimosa, Labdaniferous cistus, Narcissus, Cypress, Blackcurrant buds, Tree mosses etc.

Lavandin and lavender cover 60% of the French planted acreage of medicinal, aromatic and perfume plants. France produces 70% of the world supply for these two crops [9]. Until 1992, lavender production was decreasing. In 1994, a stimulating plan was launched which consisted of incentives at the production level, support to research to select more productive species and it also focused on the promotion of lavender and its essential oil [11]. As a result, lavender essential oil volume, which reached 30 tonnes in 1992, has been increasing to 65 tonnes in 2000. Before the creation of the CIHEF [12], the French essential oils interprofessional corporation, lavandin was submitted to wide fluctuation of prices and each crisis led to underproduction and overproduction periods. This context required the setting up of a market regulation tool. In 1997 an interprofessional corporation was created, the CIHEF, allowing the professionals to work together in a legal framework and to maintain national productions of lavender and lavandin. In 2001, 1,350 tonnes of lavandin essential oil were produced [9].

## **Industrial Applications and Generic Issues**

### Perfumes:

A great number of plants, mass or speciality crops, picked or gathered, are used in perfumes for their olfactory properties.

*Industrial Scents* (household detergents, washing powder, functional perfume): The only usable substances are the are cost-competitive ones with imported or synthetic products and this is the case for lavandin [9].

*Alcohol-based Perfumes*: This sector uses essential oils and other plant extracts, but must allow for competition from synthetic products. A steady drop in producer prices has been induced by international competitors but the French industry has performed well in export markets.

### Medicinal sectors:

*Conventional allopathic remedies*: exploitation of molecules containing highly complex active principles, or ones that cannot be made synthetically. These molecules are subject to the regulatory constraints governing medicines. Poppy, ergot, digitalus (foxglove), or picked in the wild (colchicum, holly etc.) are grown in France, but 70% must be imported.

*Herbal medicine*: use of medicinal properties of plants without isolating any one molecule, exploiting the synergy of multiple plant characteristics. This sector is maintained by the persistence of traditional herbal remedies and the revival of plant therapeutics.

*Aromatherapy*: this is a form of treatment that makes use of essential oils. Aromatherapy is defined in France as the ingestion of essential oils or their use in external applications (the definition is broader in Anglo-Saxon countries).

#### Aromatics:

Many industrial applications for aromatic plants are intended for foodstuffs (spices, savoury plants, herb teas). There are, however, also many non-food applications: tobaccos, toothpastes containing essences of mint, cloves or sage, etc. Aromatic plants are attractive for a range of industrial sectors, by virtue of four basic properties: as antioxidants, dyes, insecticides and active molecules for fine chemicals. This sector has strong potential to develop towards non-food uses.

#### Dyes:

Many industrial applications for vegetable dyes can be mentioned: make-up and cosmetics, clothes, the textile industry, decorative paintings etc. Some research programs are going on in France to optimise the agronomic stage, the extraction process, the dye properties (light and temperature resistance etc.). The results are very promising in terms of environmental impact and scientific advances but the cost (from 10 to 100 times more expensive than mineral pigment depending on the colour) is still a limiting factor. The representative French research teams are the CRITT Horticole and the CATAR.

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