

IENICA

**Interactive European Network for Industrial Crops and their
Applications**

REPORT FROM THE STATE OF THE CZECH REPUBLIC

FORMING PART OF THE IENICA PROJECT

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METHODOLOGY

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Up until now, no public or private organisations have collected complete information about the so called “non-food” crops. This report has been prepared by using information obtained from various publications such as annual reports of specialised institutions, official national statistics and databases, WebPages, periodicals issued by agricultural organisations / industrial companies, and by interrogations of persons from institutions and organisations as listed in Annex 2. Contacts have been made with most of them via e-mail, phone, fax and/or interviews. For list of key contacts for Czech Republic see Annex 2.

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EXECUTIVE SUMMARY

In this national report presented by the Czech Republic both the aspects and the present and future role of agricultural crops used for non-food purposes are summarized and critically assessed. The report consists of four parts:

- i. Oil crops
- ii. Fibre crops
- iii. carbohydrates producing crops
- iv. other crops for special uses

Oilseed crops

Oilseed rape dominates (90% production) and is mainly used for the production of non-food products such as methyl esters-biofuels, crude glycerol, lubricants, detergents, soaps, etc. Other oilseed crops commercially grown in the Czech Republic and occasionally used for non-food purposes are sunflower, poppy and white mustard.

Fibre crops

Only bast flax and hemp have some importance in the country, but their uses are limited because of the cheaper production of domestic cellulose industry-using wood. The main fibre products based on bast flax and hemp are used for the textile industry: fabric for clothing purposes, home-textiles, technical uses, and linear textiles.

Carbohydrate crops

Potato tubers represent the main source of starch. At present annual production of industrial potato varieties is about 115,000 tonnes/year. A small amount of starch is also produced from wheat. Non-food uses of starch are in the paper industry (approximately 80%), the textile industry (approx. 5%), civil engineering (approx. 5%), the foundry industry (approx. 5%), lubricants (approx. 2%) and others (approx. 2%).

Sugar beet is the main source of saccharose. Aside from its use in the food industry, the main industrial application of this carbohydrate is in the production of bioethanol and it is also used in the pharmaceutical industry.

Speciality crops, herbs and medical plants

Limited amounts of plants used for the isolation of biologically active components and/or aromatic compounds are grown in the Czech Republic. Most of the raw materials/preparations are imported. LEROS s.r.o is the main Czech company supplying products to the food industry, the pharmaceutical industry and/or the producers of cosmetics.

AGRICULTURE IN THE CZECH REPUBLIC

The Czech Republic is situated in central Europe, between the 48th and 51st latitude bordering Poland, Germany, Austria and the Slovak Republic. The Czech Republic is a member of the EU associated states. The population of the Czech Republic is about 10.3 million with a population density of 131 inhabitants per square kilometer. Today only 3.41% of the labour force work in the agricultural sector, which is one third of that in the 1980's. Czech agriculture is based on agricultural cooperatives and private farms.

The total land area of the Czech Republic is 78,864 square km of which 33.4% is forest, 54.3% arable land (of which 11% pastures), 2% water and 10.3% others (built area). The Czech Republic is 493 km long in the west-east direction; 278 km from north to south and from 116 to 1602 metres above sea level. The climatic conditions in various parts of the country vary considerably. Precipitation during the year is usually 679 mm.

Research and development of non-food plant production started in the late 1980's. The paper industry uses starch which is the most important commercial non-food product. Also, the production of bioethanol is now on the way to being introduced commercially. The development of other non-food products is ongoing and the most promising species, like some herbal species, are now at the research or pilot stage. Further research is needed to make the production economically profitable.

More information about agriculture in the Czech Republic is available at: <http://www.mze.cz>
(Ministry of Agriculture)

OIL CROPS

1. Opportunities

1.1 Crop species and their production methodologies

In 2000 the production of oilseeds was generally lower than in 1999, or after, except for sunflower. Oilseeds were grown on 13% of total arable land, of which 89.5% was oilseed rape, 1.4% poppy, 1.6% white mustard, 6.9% sunflower and the rest were several minor crop species. In 2002 oilseeds were grown on 14.7% of total arable land, of which 76.4% was oilseed rape, 7.2% poppy, 8.6% white mustard and 5.9% sunflower.

Oilseed rape

The average yield in 2001 was 2.84 tonnes/hectare, which was the highest since 1995. Due to floods and weather in 2002 the harvested area dropped by 9% comparing to 2001, as shown in Table 1. In 1980 a variety was cultivated labeled as "0". This variety had a low content of erucic acid. Consequently, a subsequent variety introduced at the end of the decade labeled as "00" displayed not only a low content of erucic acid but also a low content of glucosinolates. For a long time the content of erucic acid has been below 0.5% of all fatty acids. The content of main unsaturated fatty acids is: 60% oleic acid (C18:1), 20% linoleic acid (C18:2) and 8-9% linolenic acid (C18:3). The utilisation of oilseed rape is documented in Table 2.

Table 1. Acreage, harvested area, yield and production of oilseed rape

Year	Acreage (ha)	Harvested area (ha)	Yield (t/ha)	Production (t)
1995/96	252 298	252 675	2.62	662 176
1996/97	228 775	226 533	2.30	520 572
1997/98	229 767	227 310	2.47	560 509
1998/99	265 560	264 310	2.57	680 216
1999/00	350 353	348 949	2.67	931 053
2000/01	325 338	323 842	2.61	844 428
2001/02	344 117	343 004	2.84	973 321
2002/03*	313 025	312 424	2.30	718 575

* Estimation of Czech Statistical Office

Table 2. Balance of production and utilisation of oilseed rape ('000 tonnes)

Index	1998/99	1999/00	2000/01	2001/02	2002/03*
Production	680.2	931.1	844.4	985.3	758.6
Import	1.1	26.8	5.0	12.3	10.0
Supply	560.7	681.3	957.9	985.3	758.6
Processing	490.4	477	494.6	578.3	500
From which MERO**	90	45	185	199.2	200
Seedling	2	2	2	2	2
Export	68.3	202.3	461.3	368	256.6

* Estimation of Ministry of Agriculture

** Estimation of Association for production of biofuel oil

Sunflower

Sunflowers are cultivated on approximately 30,000 hectares, mostly in the southern parts of the Czech Republic and more than half of production is usually exported (Germany, Austria, The Netherlands and Poland). For more information about production see Table 3.

Table 3. Acreage, harvested area, yield and production of sunflower seeds

Marketing year	Acreage (ha)	Harvested area (ha)	Yield (t/ha)	Production (t)
1995/96	19 476	19 387	1.66	32 180
1996/97	19 816	19 710	1.93	38 065
1997/98	11 055	10 885	2.09	22 801
1998/99	17 326	17 274	2.11	36 475
1999/00	28 500	28 450	2.22	63 228
2000/01	30 757	30 549	2.14	65 421
2001/02	28 583	28 528	1.99	56 717
2002/03	24 242	23 768	2.24	53 240

Poppy

Due to poor climatic conditions in 2000, poppy seed production was only 15,732 metric tonnes from 31,473 harvested hectares (as compared to 28,509 tonnes from 46,018 harvested hectares the preceding year). In the last few years acreage oscillates around 30,000 hectares which places the Czech Republic to foremost cultivators in the world. For more information about production and utilisation see Tables 4 and 5.

Table 4. Acreage, harvested area, yield and production of poppy seeds

Year	Acreage (ha)	Harvested area (ha)	Yield (t/ha)	Production (t)
1995/96	35 253	34 308	0.73	25 053
1996/97	14 677	14 271	0.68	9 654
1997/98	17 865	16 641	0.57	9 515
1998/99	28 513	27 881	0.74	20 524
1999/00	46 018	45 462	0.63	28 509
2000/01	31 473	31 473	0.5	15 732
2001/02	34 478	33 235	0.64	21 294
2002/03*	29 637	29 532	0.60	17 719

* Estimation of Czech Statistical Office

Table 5. Balance of production and utilisation of poppy seeds

Index	Unit	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03*
Supply	t	12,378.7	22,138.1	30,056.5	15,908.2	22,712.5	19,014.0
Food	t	3,300	3,500	3,700	3,500	2,700	3,000
Seedling	t	80	100	120	110	100	100
Export	t	8,127.7	17,988.1	25,390.7	11,955.2	19,617.5	15,000
Final storage	t	871	550	845.8	342.7	295.0	904.0

* Estimation of Ministry of Agriculture

White Mustard

Because of the great supply of mustard seeds from the previous years the area of white mustard was reduced in 2000 (see Table 6). In year 2002 acreage increased by about 90.4% compared to year 2001 and mostly all production is used as seedling.

Table 6. Acreage, harvested area, yield and production of white mustard

Marketing year	Acreage (ha)	Harvested area (ha)	Yield (t/ha)	Production (t)
1998/99	37 120	36 136	1.03	37 282
1999/00	39 927	39 423	1.14	44 930
2000/01	15 512	14 986	0.94	14 158
2001/02	21 009	19 720	0.95	18 800
2002/03*	35 798	35 255	1.00	35 255

* Estimation of Ministry of Agriculture

Linseed (Oil flax) and Soya-bean

Production of these two minor oil crops is show in Tables 7 and 8.

Linseed (oil flax and fibre flax) is known to be a very versatile crop, with fluctuating yields due to frequent difficulties related to early sowing, late ripening, difficult seed desiccation after rain as well as to the risk of sprouting before harvest.

The area grown has also fluctuated over the last 10-15 years, with a low of 312 ha harvested in 1997 and a high of 4,600 ha harvested in 1991. The current area is around 2,500 ha, which is the highest area since the early 1990's, with production of 3,300 tonnes of seed and an average yield of 1.35 t/ha. This increase is due to government support in cases where linseed is grown on fields, which will in the future be used for growing crops for energetic or technical use only. It is assumed that the linseed harvest area used for oil flax production will grow to approximately 4,500 ha in 2003. In the long term, the oil flax foreign trade is active. In 2002, 376 tonnes of oil flax were imported and 2,200 tonnes were exported, while almost 70% were exported to Poland. Linseed's seedlings grown in the Czech Republic for technical use are imported mainly from Germany, the Netherlands, the United Kingdom, Canada and Belgium.

Oil flax of the best quality is used for food production and in 2000 due to the high demand on the international market 3,421 tonnes of oil flax seed were exported. The main technical use of oil flax is as a drying oil used for the production of varnish or colours. The other technical use is as a main base material for floor-cloths.

Usually Canadian varieties of Soya-bean are grown in the Czech Republic (almost 92% of the area) and all the production is used for domestic consumption.

Table 7. Acreage, yield and production of linseed

Year	Acreage (ha)	Yield (t/ha)	Production (t)
1990	606	1.77	1,073
1991	4,600	1.47	6,762
1992	1,080	1.50	1,620
1993	780	1.58	1,232
1994	1,072	1.27	1,361
1995	752	1.30	978
1996	407	1.36	553
1997	312	1.21	377
1998	646	1.40	904
1999	2,251	1.57	3,535
2000	1,700	1.35	2,295

2001	3,045	0.85	2,603
2002	Tech. use: 2,048	1.30	2,662
	Food/feed: 500	1.35	675

Table 8. Acreage, harvested area, yield and production of soya-bean

Marketing year	Acreage (ha)	Harvested area (ha)	Yield (t/ha)	Production (t)
1997/98	281	249	1.36	340
1998/99	266	261	1.25	327
1999/00	397	143	1.53	219
2000/01	1,916	1,884	1.25	2,348
2001/02	2,743	2,706	1.59	4,301
2002/03*	3,002	2,955	1.95	5,762

1.2 Crop products - science, technology and industrial uses

Oils obtained from the crop species listed above display different compositions and technical characteristics, useful for several industrial applications such as biofuels, lubricants, inks, detergents, etc. For the main production of non-food products rape oil is used, thus in the next paragraphs attention will be devoted mainly to rape oil usage. The other oil crops mentioned are also used in the pharmaceutical industry (above all, stabilised sunflower oil or flax oil).

Oil flax

In addition to the traditional processing of oil flax, to drying oils for the production of varnishes and dyes, it is also used in the food industry and imperceptible amount in pharmaceuticals. Its cultivation will be encouraged by utilising the plant varieties which can be grown on the converted arable land (e.g. without growing foods and feeds).

Oilseed Rape

Two main industrial companies, Setuza a.s. and Unilever CR, produce non-food rape oils in the Czech Republic. The processing procedures in the two companies are somewhat different, depending on the end of uses of the oil.

Setuza, incorporated in 2000, is the main producer of food oils (company Lukana a.s.), and is also the dominant producer of methyl esters (about 30% of their capacity), fatty acids (alone producer), processing of crude glycerol and production of pure glycerol (alone producer) with a total capacity 450,000 t/year of oil seeds.

Unilever CR is the main producer of soaps (imported to central and eastern Europe).

Rape oil is used for the production of:

- ***Methyl esters*** of rape oil for the production of biofuel. In the Czech Republic biofuel has to contain a minimum of 70% hydrocarbons and a maximum of 30% methyl esters. The total capacity in the CR is about 150,000 tonnes and real production in 2001 was only 60,000 tonnes. As a raw material, crude pressed oil (residue of oil in cakes used for feeding is 9-10%) is, after a deep degumming, put through methanolysis catalyzed by KOH, which allows processing at 20-30°C. Only the main producer (35 kt/year) is using technology for pressing and then extraction (residue of oils in gristle 1.5%).
- ***Crude glycerol*** is a step product of the production of methyl esters (from 75 kt of methyl esters 7kt of crude glycerol is obtained). When methanol is split off, and the organic (lipid) part and salts are separated, its concentration reaches 80%. Part of production is processed in the CR (only Setuza has available complete technology).
- ***Lubricants*** - for their production, rape oil without erucic acid is used in a mixture with methyl esters. These lubricants are utilised as uneconomical lubricants in ecologically threatened areas and as hydraulic liquids. A more extensive use depends on a better ecological legislation and an economical subsidy (petrochemically produced lubricants are cheaper).
- ***Liquids in civil engineering***
- ***Detergents (alkanolamides and betaines)*** based on fatty oil (methyl esters). Production in the CR is a maximum of tens of tonnes per year, and only coconut oil is used.
- ***Ethoxylated methyl esters of partial hydrogenated rape oil*** as a stabilizer against oxidation used in wash detergents and cleaners instead of ethoxylated fatty alcohols. However, this is primarily factual because at present as there are only a few productions in the Czech Republic where ethoxylated methyl esters are used instead of ethoxylated fatty alcohols, as it is very expensive to change the technology and equipment, and there is no pressure to do it.
- ***Stearic acid*** and ***oleic acid*** are produced as by-products of crude glycerol (acidic prerefining of fat/oil, continual hydrolysis under high pressure, fractionation of fatty acids by crystallization,

distillation of fatty acids, conversion of crude glycerol – from soap and methyl esters production and production of pure glycerol). Nowadays their production from greases (bone, sanitary slaughter of skin fats) is still more cost-effective.

- *Waste oils after frying* - usually a mixture of plant and animal fat (thousand tonnes per year), after filtration and separation, are used as second-rate lubricants in building.
- *Varnishes* - there is no production in the CR based on linseed oil
- *Metallic soap* - production of some derivatives on the basis of stearic acid (Ca, Zn, Mg, Al...)
- *Soaps* - today's production of 45 kt/year is based on treatment of beef tallow, which represents more than 80% of fatty components in soap

2 Markets and Barriers to Progress

The importance of non-food product utilisation of oilseeds is growing; oilseed rape appears as the most suitable crop to be significantly developed in the Czech Republic. Other species could only develop to a limited extent in order to satisfy very specific markets. Oilseed rape could become a basic commodity for the oleo-chemistry industry. There is no consideration of ecological and agricultural aspects at the current cost structure in petrochemistry and oleo-chemistry and an economical subsidising of oleo-chemistry is necessary (first and foremost methyl esters).

There is an absence of ecological aspects (governmental ecological policy) in relation to the protection of the environment through the handling of lubricants, not even in protected areas and forestry. There is no legislation for their use and the production of biolubricants is negligible in contrast to the situation ten years ago.

Through a vigorous assistance of the Czech government, manufacturing methyl esters of rapeseed oil (MERO) was utilised to its capacity. In 2000, the 'Association for Biofuel' recorded production of 67,245 tonnes of which 62,705 tonnes was used for the production of methyl esters (93%). Domestic consumption of biofuel reached 9.7% of the total diesel consumption in the Czech Republic (227,131 tonnes produced in the CR and 231,754 tonnes imported), see Table 11. Existing manufacturers are not able to satisfy the demand for biofuel and must be enlarged. Consequently, in accordance with the situation concerning non-food products in other European countries, the Czech

Government ratified in January 2001 decree No. 86/2001 Sb. and the Ministry of Agriculture (State Agricultural Investment Fund) partly subsidises, from the national budget, programmes concerned with the non-food use of agricultural land. The following important bolster programmes were initiated:

- support of arable land with the requirement of initiation of some percentage of land area to rest (production from that land area can not be used for food, feed or seedling purposes)
- support of green fertilisation
- support of growing rapeseed for the production of methyl esters
- support of growing fibre flax
- support of other crop species (such as hemp) for non-food use
- support of herbs for energy use
- indirect support of production of biofuel and methyl esters

2003 was the third year of government programme concerned with the non-food use of agricultural land, and the production of methyl esters increased 67% comparing to 2001.

Table 11. Import and export of biofuel and methyl esters (tonnes)

Index	1997		1998		1999		2000		2001		2002 (1.1. - 31.10.)	
	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export
MERO	11,360	-	25,842	83	22,644	26	3,237	72	2,862	3,273	73	-
Biofuel	5,800	635	17,099	8	10,375	97	8,463	3,840	-	67,765	-	-
Total	17,160	635	42,941	91	33,019	123	11,700	3,912	2,862	71,038	73	-

MERO - methyl esters of rape oil

FIBRE CROPS

1 Opportunities

Generally, fibrous raw materials are of forest and non-forest origins. In the Czech Republic, flax and hemp are the basis (raw materials) for vegetable fibres and lignocellulosic products other than from forest wood. Several other sources, such as sorghum and herbaceous perennials, have been proposed in recent years but have not yet been employed commercially for fibre production. All these crops produce mainly carbohydrates and provide two main basic products: fibres and other lignocellulosic compounds (short fibres, cellulose, hemicellulose and various carbohydrates).

1.1 Crop species and their production methodologies

Bast flax

Bast flax is a traditional crop in highland and potato producing areas. In the 1980's flax was grown on approximately 21,000 hectares, but after 1989 quite extensive restructualisation of the flax industry took place, especially changes of ownership, closures of unproductive companies and an increase of capacity of still producing ones.

Since 1992, no funding is provided to growers. Increasing production costs in agriculture and lower market prices of main products, e.g. flax stalk (in 1997 only 111 Euros/t contrary to 1995 - 144 Euros/t), resulted in a decreasing flax area, to 2191 hectares in 1997. Consequently, Government grants have been used to change that unfavourable trend (see Table 12), and which, together with a rapid progress in an alternative using of flax (paper industry, civil engineering), contributed to the reversion of the trend.

2000 was not a good year for growing flax. Harvest ended on the 20th September and almost all parts of the plants were not dew retted, without good strength, thinness and color. Hectare yields were very low and the content of fibre below normal (see Table 13).

In 2001 bast flax was cultivated on 7,009 hectares. For that purpose, seed (average sowing 135 kg/ha) was provided mainly from the domestic production, and only a small amount was imported (maximum 30 t). The production supplied the textile industry in the CR with approximately 40% of

the requirement; the rest was imported (mainly from Central Asia, than Greece, Turkey, Syria and West Africa).

In 2003 it is assumed that approximately 20,000 tonnes of fibre flax will be harvested from 6,000 ha, from which approximately 2,000–2,400 tonnes of long fibre will be produced. It follows from this assumption that a higher increase of self-sufficiency in flax fibres cannot be expected because the area of the fibre flax should amount approximately to 15,000 ha in order to meet the demand of the textile processing industry. An insufficient domestic production can also be seen if compared to the capacity of sorting facilities amounting to 56,000 tonnes of retted straws annually.

With regard to a low domestic production, it is necessary to import an extensive amount of flax fibres in order to ensure this raw material for the textile processing industry. The Czech Republic has made preferential arrangements with many countries (e.g. EU, CEFTA, EFTA and others), which arrangements favour the mutual trade in flax, flax raw material and flax seed. In 2002, 7,412 tonnes of flax and flax raw material were imported to the Czech Republic, which means an increase by 32% in comparison with the preceding year. But on the other hand, the export decreased almost by 36% to 2,219.7 tonnes in comparison with 2001.

The yield of bast flax is approximately 14.5% flax seed, 75% stem and 10.5% waste (chaff). The yield of flax dew retted stem is approximately 77% chaff, 14% long fibres (for manufacturing of yarns, fabrics, twines etc.) and 9% tow (for manufacturing of yarns, fabrics, twines etc.).

Table 12. Production of dew retted flax stalks

Harvested year	Sowing area (ha)	Harvested area (ha)	Yield of stalk (t/ha)	Harvested stalks (t)
1980	24,412	24,144	3.47	83,770
1985	23,243	22,242	3.97	88,410
1990	21,425	20,913	3.90	81,570
1991	17,875	15,199	2.09	31,723
1992	9,858	9,333	2.45	22,857
1993	7,859	7,571	3.31	25,038
1994	11,047	10,118	2.68	27,118
1995	10,626	9,966	3.44	34,300
1996	6,836	5,899	3.10	18,272
1997	2,191	2,017	3.19	6,439
1998	4,744	3,719	3.01	11,185
1999	7,315	5,292	3.22	17,065
2000	8,484	8,332	1.82	15,137
2001	7,094	5,565	3.23	17,865
2002	5,885	5,694	2.73	15,271

Table 13 Overview of production of bast flax

	Year	2000/01	2001/02
Seedlings production	t	1,200	600
Total flax stalks production	t	15,137	15,271
Average price for 1 tone of dew retted stalk	Euro	109	132
Total content of fibre in stalk	%	27	27.5
Average content of long fibre	%	10	13.7
Average yield of seeds	t/ha	0.5	0.5
Total production of fibre	t	4,083	4,107
Total production of long fibre	t	1,512	2,088
Total production of oakum	t	2,571	2,019
Number of planters		158	142

Hemp

From 1960 to 1997 there was no cultivation of hemp in the Czech Republic for reasons linked to its possible use as a drug. In 1997-1998 it was only cultivated for experimental purposes on 2 ha. From 1999 two varieties with low THC (tetra hydrocannabinol) content have been permitted for agricultural production: Polish variety BENIKO and Ukrainian variety JUSO-11 planted on 25 ha (in 2000 at 58 ha). See Table 14.

The cultivation of hemp grown for standard fibre for technical purposes is getting to the operational verification phase in the Czech Republic. The technical hemp harvest area was 29 ha in 2001, at least 91 ha were seeded in 2002 and the crop area of 115 ha is expected in 2003. For the needs of spinning factories hemp is irregularly imported from Romania, China and India (3-5 tonnes per year). Because nowadays there is no manufacturing procedure for hemp stalks, processing hemp fibre in the CR, no complex data on evaluating growing, harvesting and processing exist.

New growing technology consists of slashing, shortening of the stalk and field dew retting. After several weeks of dew retting it is machine harvested with a separation of the hemp fibre at the automatic sorting lines without a human touch. There is no need to use fertilisers or improve the ground composition when growing.

The yield of hemp dew retted stem is approximately 80% chaff, 14% long fibres (for manufacturing of yarns, fabrics) and 6% tow (for manufacturing of yarns, fabrics).

Table 14. Progress in hemp growing

	Unit	2000	2001	2002	2003
Estimated sowing area	ha	129	29	91	115
Yield of seeds growing for seeds	t/ha	0.8	0.8	0.85	0.7
Yield of stalk	t/ha	9	9	9,5	9
Yield of fibre	t/ha	2.25	2.25	2.35	1.55
Yield of mass used for energy utilisation	t/ha	10	10	10,5	10

1.2 Crop products - science, technology and industrial uses

Because of their good properties (such as wettability, durability, permeability and thermo-isolation) together with lower energy use and their ability for recycling of the used materials, more attention is paid to the use of natural fibres than synthetic ones.

Bast flax

The majority of flax grown is used for textile applications; only international companies, which have some production in the Czech Republic, have activities using (imported) flax for paper or civil engineering. There are no figures available on the extent of this use. Domestic stocks of long fibre are not sufficient and to guarantee production of spinning factories for the needs of the textile industry large amounts of long fibre have to be imported to the Czech Republic (see Tables 15-20).

Table 15. Overview of production and utilisation of long fibre (in tonnes)

	1994	1995	1996	1997	1998	1999	2000	2001	2002
Primary stock	0	289	4145	2558	935	0	0	1261	44
Production of long fibre	3980	4650	1830	840	1443	1943	2235	1591	1598
Import of long fibre	4516	4383	517	1607	2248	3447	2221	2221	2102
Total offer	8496	9322	6492	5005	4626	5390	5705	6079	5118
Domestic use	8000	5100	3600	3900	4526	5300	4444	5969	4273
Export	207	77	334	170	100	90	0	66	21
Final stock	289	4145	2558	935	0	0	1261	44	824

Table 16. Utilisation of flax fibre for production of yarn (in tonnes)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Linnen yarn	4 340	3 327	2 063	2 974	3 153	2 484	1 461	1 922	1 890	1 830	2405	1981	1835
oakum yarn	5 354	3 974	3 319	3 761	4 194	3 479	2 157	2 159	1 960	2 683	2754	2309	2299
Total	9 694	7 301	5 382	6 735	7 347	5 963	3 618	4 081	3 850	4 513	5159	4290	4134

Table 17. Processing capacity for bast flax (year 2002)

Flax factory	Mechanical equipment	Capacity (per year) t	Original cultivated area (in 2002)		Production of long fibre	
			ha	t	%	t
Agropodnik Dvorce	1 two-section turbine	3700	238	650	4.2	650
Lenas Malá Št'ahle	2 two-section turbines	7500	459	1310	8.6	1595
Moravolen St. Libava	1 two-section turbine	3700	649	12931	8.5	1622
Sázavolen Leština	1 two-section turbine	3700	420	990	6.5	1192
Lenka Kácov	2 four-section turbines	15000	1123	3428	22.4	3456
Čemolen Humpolec	3 two-section turbines	11200	1575	4400	28.8	5523
Texlen Radvanice	3 two-section turbines	11200	1230	3200	21.0	3470
Celkem	-	56000	5694	15271	100	17508

Table 18. Request of textile industry - fricative fibre and oakum (in 2002)

	Scutched flax (t)	Oakum from scutching mill (t)	Combed Flax (t)	Combed Oakum (t)
Domestic production	1733	1202	110	39
Import	1916	441	266	734
Total	3649	1643	376	773

Table 19. Production of long fibres

	Purchase of retted stalk (t)	Average yield of long flax in scutching mill (%)	Total production of long fibre (t)	Total production of long fibre per 1 ha (kg)
1996	18 272	10	1 830	310
1997	6 439	11	708	352
1998	11185	10	1235	300
1999	17 484	12	2 098	392
2000	13929	13.3	2235	210
2001	17865	8.6	1596	230
2002	15271	9.2	1598	280

Table 20. Production of flax products

	1993	1994	1995	1996	1997	1998	1999
Flax yarn (in tonnes)	5 597	6 660	7 550	2 948	3 623	4 305	4 835
Flax textile (in thousands m ²)	61 873	49 049	44 436	27 329	27 504	23 577	20 938

Hemp

Hemp fibre is a recyclable natural material with no negative effect on the environment. It could be used not only for the textile industry (denim, decorative textiles) but also for the production of new special products designed for industrial use. There has not been discussion about the use of hemp in the CR for the textile industry.

Possible uses of hemp are listed below. The cultivation of hemp grown for standard fibre for technical purposes is getting to the operational verification phase in the Czech Republic.

- built material with favourable thermal and acoustic properties - applying high temperature and pressure to hemp fibre, strengthened and flameproof material can be obtained and used for panels instead of dry walls or plywood
- car industry - products from hemp fibre can substitute some metallic parts
- hemp oil is used not only for cosmetics (skin application) but also for the production of laundry detergents, dyes and varnishes
- the residual products from hemp oil production are used because of its chemical composition (4.3% fat, 23.9% proteins, 10.3% carbohydrates) as feed (chicken-feed)
- production of hemp paper - hemp fibre or hemp scutch (containing 77% of cellulose) could be used for the production of paper, which has better qualities (more durable and lasting) than wood paper (contains 18-30% of lignin while hemp scutch only 4%). For the production of cellulose paper all lignin has to be destroyed. It has been established that hemp produces 2.5 times more biomass per year than forests of the same area.
- by-products of processing in the scutching mill (oakum and scutch) could be used for the production of boards, as a litter (for animal housing) or ecological fuel

2 Barriers to Progress

Bast fibre

The needs of the textile industry are creating the space for an expansion of bast flax cultivation in the CR. Another possibility of flax utilisation is its use for technical purposes. Based on the current harvest of dew retted stalks it is possible to expect that full capacity of available scutching mills will be used first in 2003 because the harvest in 2001 (see Table 21) was still not sufficient for forestocking with dew retted stalks.

Table 21. Necessary extent of cultivation of bast flax for full covering of the needs of the manufacturing industry in long fibre

		2000	2001	2002	2003
Need of long fibre	t/year	4500	5970	4300	4900
Production of long fibre	t/ha	0.21	0.23	0.28	0.4
Yield of dew retted stalks	t/ha	2.4	3.4	2.73	3.4
Sowing area need	ha	20000	25000	15300	12250
Expected sowing area for flax	ha	6302	7094	5885	6050

For continual production the fore stocking is necessary from previous harvest.

Consumption of selected textile raw materials in the textile industry in the Czech Republic is shown in 22. The main domestic processors are Texlen a.s. (Trutnov), Moravolen a.s. (Šumperk), Opavlen a.s. (Opava), Vrsan spol.s r.o. (Vrbno pod Pradědem), Paja s.r.o. (Trutnov), Nobleslen a.s. (Šumperk), Zlatex a.s. (Zlaté Hory). The main textile products based on flax produced in the Czech Republic are:

- fabrics for clothing purposes (dress wear, suits, blouses, shirts...)
- fabrics for home-textiles (bed linen, table cloths, napkins, towels, furnishing fabrics...)
- fabrics for technical and industrial uses (filter fabrics, geo textiles, canvas, bags, mattress covers, hoses...)
- linear textiles (ropes, strings, cords...)

The consumption of textile products based on flax in the Czech Republic according to final applications is 50% technical and industrial use, 30% home-textiles and 20% clothing textiles.

Table 22. Consumption (in tonnes) of selected raw textile materials in 1995-2000

Year	Scutched flax (t)	Flax scutched tow (t)	Scutched hemp (t)	Flaxy yarn (t)
1995	7214	4229	5	3505
1996	3765	1707	66	2279
1997	4223	2950	-	4833
1998	5576	1046	1,5	6373
1999	4298	668	4,5	3996
2000	4879	1625	18	3096

Hemp

The first industrial manufacture for processing of hemp with a capacity for 300 ha of hemp is under construction (to be completed in 2003) by the company Lenka Kácov in cooperation with the Ministry of Industry and Trade.

Consumption of fricative hemp is mentioned in Table 22. The main textile products based on hemp produced in the Czech Republic are:

- fabrics for outer-wear (i.e. waterproof jacket from hemp)
- fabrics for industrial uses (car and paper industry, fire-proofing building materials, cosmetics).

There are no figures available on the distribution between textile and industrial use.

CARBOHYDRATE CROPS

1 Opportunities

The crop species that are grown in Czech Republic for their high content of carbohydrates in the form of starch or sugar and potentially usable in non-food applications are primarily sugar beet, potatoes and wheat. The products obtained are mainly different starches and sugars, but cellulose and bioethanol (methylterbutylether) are also products of interest.

1.1 Crop species and their production methodologies

Sugar beet

There are about 700,000 hectares of arable land available for growing sugar beet in the Czech Republic. However, in the season 2000/01 sugar beet was harvested from about 70,000 hectares, with a yield of 47.45 t/ha, and from which more than 2,800,000 tonnes were processed for sugar resulting in a production of 434,000 tonnes of saccharose, i.e. 15.5%. Projection for the harvest season 2001/2002 was to gain higher saccharose production, i.e. over 18%. In the harvest year 2002/03 sugar beet was grown on 77,499 hectares with a yield of 5 t/ha, which is comparable with the production from last year. Leaves and tops are chopped and blended into the soil. The Czech Republic provides favourable conditions for sugar beet cultivation on approximately 120,000 ha of arable land. Considering an average yield of sugar, the production of 600,000 tonnes of sugar would be possible. This amount is 150,000-180,000 tonnes higher than the domestic consumption of sugar, which can in the future be produced for technical uses. This requires high quality seeds, fertilisers, herbicides and insecticides and specific equipment for harvesting.

Potato

The situation of potato production from 1995 to 2004 is shown in Table 23. In the years 2000/2001 potato was cultivated on 69,000 hectares, of which 4,000 hectares were for non-food production. Whole production was approximately 1,600,000 tonnes, from which 50% was predestined for human consumption, 7% for starch production, 16% for seedling, 27% as feed and less than 1% for export (in the long-term at a negligible level). See Tables 24 and 25. In 2001/2002 the cultivation area dropped by 13% and in 2002/2003 another 5% decrease is expected.

In 2001, the production of industrial potatoes was expected to grow (see Table 26), and that trend was expected to be maintained in the following years, but due to EU regulations for potato starch production a slight decrease is expected after joining the EU. The export of industrial potatoes is, on the long-term basis, at an insignificant level, only dextrin and modified starches are exported (see Table 27).

The present starch potato cultivars give sufficient yields. New cultivars could be developed, for example with the use of gene manipulations, to withstand early frosts.

Table 23. Cropping patterns for potato

Marketing year	Arable land by crop (ha)	Yield per hectare (t/ha)	Complete production (t)
1995/96	77 869	17,08	1 330 119
1996/97	85 710	21	1 800 272
1997/98	72 625	19,3	1 401 663
1998/99	71 855	21,15	1 519 768
1999/00	71 455	19,69	1 406 832
2000/01	69 198	21,33	1 475 992
2001/02	54 137	20,88	1 130 477
2002/03	46 914	23,57	1 105 960
2003/04*	44 585	20,51	914 517

*... estimated

Table 24. Overview of potato production, 1996-2004

Year	Units	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04*
Early potato (human consumption and seedling)									
Harvested area	1000 ha	20.48	18.5	18.48	17.91	15.66	11.38	11.60	10.07
Aver. yield	t/ha	15.88	14.66	15.63	16.62	14.46	16.46	18.65	18.92
Consumable potato (human consumption and seedling)									
Harvested area	1000 ha	60.19	49.21	49.39	49.7	49.50	37.54	38.39	37.85
Aver. yield	t/ha	22.48	20.72	22.84	20.54	22.96	21.64	24.67	21.04
Industrial potato (processing and seedling)									
Harvested area	1000 ha	5.03	4.92	3.98	3.85	4.04	5.23	6.92	6.65
Aver. yield	t/ha	24.21	22.52	25.78	22.98	28.01	25.05	27.29	20.71
Complete harv. area	1000 ha	85.71	72.63	71.86	71.46	69.20	54.30	46.91	44.58

Potato production

Early cultivars	1000 tonnes	325.23	271.17	288.92	297.58	226.43	187.24	216.37	190.67
Late cultivars	1000 tonnes	1353.18	1019.75	1128.18	1020.76	1136.36	812.44	700.60	586.11
Industrial potato	1000 tonnes	121.86	110.74	102.67	88.49	113.18	130.79	188.99	137.73
Complete potato	1000 tonnes	1800.3	1401.7	1519.8	1406.8	1475.9	1130.5	1105.9	914.5
Complete yield	t/ha	21	19.3	21.15	19.69	21.33	20.88	23.57	20.51
Potato import	1000 tonnes	12.45	39.12	13.27	50.77	17.41	65.53	39.70	50.00
Complete offer	1000 tonnes	1812.7	1440.8	1533.0	1457.6	1493.4	1312.2	1269.7	1094.5

Usage of potato *

Human consump.	1000 tonnes	796	800	780	780	780	778	778	770
Starch production	1000 tonnes	150	110	75	80	151	131	197	138
Seedling	1000 tonnes	280	240	240	240	210	216	141	132
Feed and losses	1000 tonnes	584.05	288.82	429.69	354.56	339	163	128	15
Export	1000 tonnes	2.67	1.96	8.35	3.04	13.50	3.70	3.76	10.00
Complete	1000 tonnes	1812.7	1440.8	1533.0	1457.6	1493.4	1312.2	1269.7	1094.5

*...estimation of Ministry of Agriculture

Table 25. Evolution of production of industrial potato including seedling, 1990-2004

	Harvested area (ha)	Aver. yield (tonnes/ha)	Production (tonnes)
1990/91	14 054	15,7	220 649
1991/92	8 891	18,86	167 750
1992/93	7 771	20,32	157 906
1993/94	5 500	28,5	156 750
1994/95	5 205	17,59	91 560
1995/96	4 834	18,91	91 434
1996/97	5 034	24,21	121 862
1997/98	4 917	22,52	110 745
1998/99	3 983	25,78	102 670
1999/00	3 851	22,98	88 493
2000/01	4 041	28,01	113 184
2001/02	5 221	25,05	130 759
2002/03	6 924	27,29	188 994
2003/04*	6 650	20,71	137 731

*...estimation

Table 26. Progress of growing industrial potatoes for starch production

Year	Harvested area (ha)	Average yield (t/ha)	Aver. starch content (%)	Aver. starch yield (t/ha)
1997	4917	28.65	18.4	5.3
1998	3983	28.20	18.1	5.1
1999	3851	26.30	18.6	4.9
2000	4041	34.09	18.2	6.2
2001	5232	30.08	17.6	5.3
2002	5007	35.00	17.6	6.1

Table 27. Import and export of dextrin and modified starches (metric tonnes)

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Import	5 393	3 719	5 223	5 904	8 100	9979	7630	13106	6718
Export	2 376	620	749	1 089	2 304	2541	4986	8663	5536

* up to 30.6.2003

Wheat (spring and winter wheat) and small grain cereals

An overview of cereal production in the Czech Republic is given in Table 28. Only wheat is utilised for technical use. Nowadays (1999-2003) wheat is grown on almost 900,000 hectares; production was 4,028,000 metric tonnes and internal consumption was 3,349,000 metric tonnes, of which 35% was for human consumption, 6% for seedling, 60% for feed and 0.6% for technical use. Representation of wheat on arable land in 1999 achieved 28% and its proportion of the total area devoted to the production of cereals increased to 55%. Winter wheat is conventionally the most common cereal produced in the Czech Republic. Other minor grain cereals grown in the CR are triticale, millet, canary-grass, sorghum, buckwheat and other second-class crops.

Table 28. Overview of cereal production in 1999/2000 (from May 2000)

	Unit	Winter wheat	Spring wheat	Wheat (total)	Rye	Winter barley	Spring barley	Barley (total)
Sowing area	1000 ha	745	122,6	867,6	55,2	164,4	379,3	543,7
Harvested area	1000 ha	744,6	122,5	867,1	55,1	164,1	378,8	542,9
Yield	t/ha	4,77	3,91	4,65	3,67	4,05	3,89	3,94
Production	1000 t	3 549,7	478,6	4 028,3	202,4	664,1	1 473,3	2 137,4
Reserve	1000 t			826,1	161,5			568,7
Import	1000 t			30	2			30
Complete offer	1000 t			4 884,4	365,9			2 736,1
Internal consumption	1000 t			3 348,9	232			2 271,8
From that	1000 t			1 170	180			615
-food								
-seedling	1000 t			198,9	12			96,8
-feed	1000 t			1 960	40			1 560

-technical use	1000 t	20	0	0
Export	1000 t	950	10	320
Complete use	1000 t	4 298,9	242	2 591,8

	Unit	Oats	Corn	Triticale	Other cereals	Other cereals (total)	In total
Sowing area	t/ha	54,4	33	26	6,8	32,7	1 586,6
Harvested area	t/ha	54	39,4	26	6,6	32,6	1 591,1
Yield	t/ha	3,32	6,6	4,14	2,01	3,71	4,35
Production	t/ha	179,1	260,5	107,4	13,3	120,7	6 928,4
Reserve	t/ha	24,4	96,7			5	1 682,4
Import	t/ha	1	80			1	144
Complete offer	t/ha	204,5	437,2			126,7	8 754,8
Internal consumption	t/ha	174,6	342,2			103,8	6 473,3
From that	t/ha	20	10			6	2 001
-food							
-seedling	t/ha	14,6	12,2			7,8	342,3
-feed	t/ha	140	320			90	4 110
-technical use	t/ha	0	0			0	20
Export	t/ha	10	30			10	1 330
Complete use	t/ha	184,6	372,2			113,8	7 803,3

1.2 Crop products - science, technology and industrial uses

Sugar beet - sugar

The potential of sucrose as a raw material obtained from renewable resources is discussed in terms of its degradation to compounds with a lower number of carbon atoms, modification of all hydroxyl groups, synthesis of polymers, other chemical transformations of sucrose, and the enzymatic oligosaccharide synthesis.

Possible non-food products derived from sucrose:

- Biologically degradable polymers, the source of which can be sugar beet or starch from cereals in a mixture with propionic acid; the copolymer formed is linear, thermoplastic and biodegradable
- Biologically degradable surfactants on the base of esters of sucrose
- Medical products used in human medicine and zoo pharmacy
- Classical and modern fermentation products – production of ethanol, yeast, organic solvents and acids (namely citric and lactic acids, amino acids)

- Bioethanol, produced from sugar beet or beet succus, used as an energetic fuel, additive of fuel-air mixture or for preparation of ethyltercbytyletheru (ETBE), which can displace cheaper but toxic methanol so far used for preparation of methyltercbuthylether (MTBE), which is a gasoline additive. Through processing 1 ha of sugar beet with the yield of 40 metric tonnes and sugar content 17%, approximately 40 hectoliters of absolute alcohol can be obtained. The content of polarized sugar in a beet root and an absence of accompanying non-sugar substances essentially influences the yield of bioethanol. The by-products of processing of sugar beet to bioethanol - sugar beet slices could be used as feed and distiller's slops could be used as fertilizer.

The actual share of renewable energies in the total energy consumption of the CR is about 2.5%. The potential share of renewable energies is estimated about 5.6% of total energy consumption by 2010. The potential renewable energy use should be increased by about 3.6 times from 27,210 TJ/year in 2002 to 97,500 TJ/year in 2010. The main potential share of energetic biomass after 2010 belongs to firewood (up to 35%) and cereal straw (22%), but after 2020 - to energetic crops (30%) and woods (25%).

Table 29: Estimated results of potential biomass use for energy in the Czech Republic after 2010 and after 2020.

Type of biomass	Source of biomass	after 2010		after 2020	
		Mt/year	PJ/year	Mt/year	PJ/year
Firewood	waste of cut and manipulation	2.6	31.2	3.0	36.0
Cereal straw	25% of total yield	1.6	22.4	1.6	22.4
Straw of oil	100% of total yield	0.9	12.2	0.9	12.2
Grasses	perennial growth	0.8	4.8	1.2	7.2
Used wood	wood residues	0.6	8.1	0.9	12.2
Energetic crops	plantation on devoted soil	0.8	8.8	4.0	44.0
Bio-diesel	rape oil	0.1	4.2	0.2	8.4
ETBE/ ethanol	sugar beet, cereals	--	--	0.1	4.1
Total biomass potential		7.4	91.7	11.9	146.5

Starch – from potato, wheat and corn

Potato, wheat and corn starch in natural or modified forms are processed for non-food use in the Czech Republic. All are grown in the Czech Republic for technical uses. Although the CR is a small

country there is quite a big production of starches. The technology of starch production and processing is well known, furthermore new synthesis routes are sought for starches, cellulose and rosin acids.

The main domestic suppliers are AMYLEX Radesinska Svatka, AMYLON a.s. Havlickuv Brod, Krnovska starch factory s.r.o., LYCKEBY AMYLEX a.s. Horazdovice, NATURAMYL Podhledsti Dvoraci and Pelhrimov starch factory. Among the main foreign suppliers of starches for non-food use can be mentioned Emsland Starke, Roquette, Agrana, Ceresan, AVEBE, and Amylum.

From starches are produced dextrin and gluten (wheat protein), which are than utilised for different industrial uses, listed below (see Figure 1). There are also some potential special uses, which have not yet been exploited on a commercial scale. In that category can be included their use for the production of biodegradable plastics, an application in geology (as a lubricant of drilling ring), in a sewerage plant as a flocculate or in pharmacy as binders or components of coating mixtures.

- ***Paper industry***

It is the main consumer of starches and modified starches (potato starch and dextrin) in the Czech Republic. Consumption of paper in the CR is about 85 kg/person/year (USA 337 kg/p/y, EU 191 kg/p/y). Starches, applied to the material in the form of solutions, are used for the preparation of the paper surface. The use of starches will improve not only surface quality but also strength of paper and production costs (see Table 30). Cationized starches are used for the improvement of drainage, retention and formation of sheets on the net of the paper machine.

- ***Adhesives***

Adhesives made on the basis of starch (yellow dextrin) and products of their chemical treatment are biologically degradable. They are produced from accessible and regenerated materials but in recent years have gradually been substituted with adhesives based on an organic base, which have better adhesion to surfaces and a shorter drying time. The production of corrugated cardboard is a noticeable branch of the paper industry where the starches are used.

- ***Textile industry***

In the textile industry starches are used as a part of sizing mixtures, as a thickening agent of textile printing suspensions and the component of mixtures used for gumming of textiles.

- ***Foundry industry and ganisters***

In this sector thermally modified starches in combination with other components are used as binder in the production of foundry forms. The starch products make the forms become more compact after drying and easily crumbling (i.e. removable) after baking.

- ***Civil engineering and varnishes***

Derivatives of starches are used for their high adhesivity and lower temperature of gelatinization as binders in the production of building materials and plasters.

- ***Others***

Starch can be used as an additional component in the production of plastics, as a filler of plastics or can serve as a starting material for the thermoplastic starch (its properties are close to the properties of plastics). Biodegradable plastics are not commonly produced and used as compared to regular plastics in the Czech Republic. The commercialisation of biodegradable polymers is closely connected with the general development of the infrastructure as well as the related legislation and the political and other decisions made both at the national and the EU level. The use of biodegradable plastics is predicted to grow fast in disposable packing, hygiene, sanitary products, paper and board coatings and laminations and disposable cutlery and dishes e.g. in fast food restaurants.

Although the use of starches in the technology of earth drill (a special product for this was developed in the 1990's) is well known, it is not used in the Czech Republic.

Natural or modified starches could be used as a flocculate in water-purifying procedures, but synthetic polyelectrolyte which allow to dose in smaller amounts and which do not escalate biological consumption of oxygen are more suitable for this purpose.

In pharmacy, starches are used for coating tablets and as binders. For this application, mainly corn starches are used, which are not produced in the Czech Republic.

Figure 1. Non-food use of starches

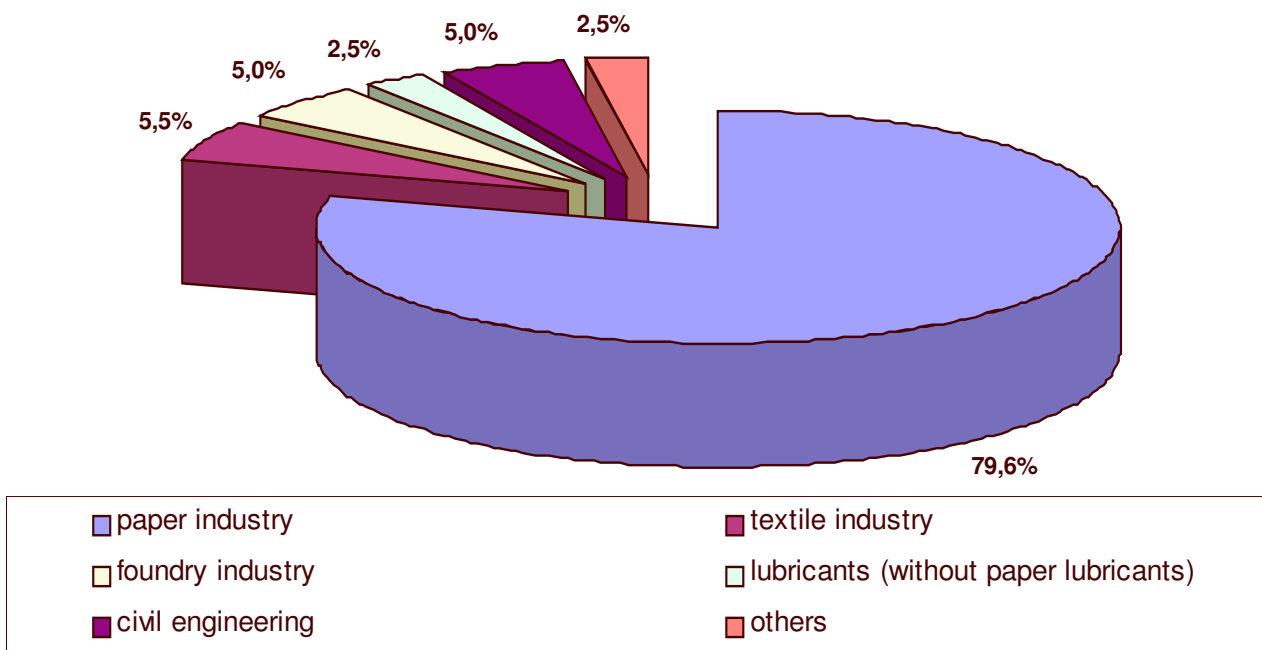


Table 30. Import of preparations for surfacing in 1995-2000 (in tonnes)

Import	1995	1996	1997	1998	1999	2000*
1.1.-31.8.	5 498	1 643	2 648	3 718	3 787	2 765
1.9.-31.12.	3 467	978	1 783	2 247	1 434	971
Total	8 965	2 621	4 431	5 965	5 221	1 365

Export	1995	1996	1997	1998	1999	2000*
1.1.-31.8.	103	182	255	284	225	207
1.9.-31.12.	134	86	92	120	98	45
Total	237	268	347	404	323	252

*...until 31.10.2000

Wheat - sugar

At the present time the main industrial application of wheat is the use of saccharose in the production of bioethanol. According to the Czech Ministry of Agriculture, processing of cereals (from which wheat is the only one used in the Czech Republic for bioethanol production), from 25,000 ha of arable land for treatment of 200,000 tonnes of cereals and production of 600,000 hectolitres of bioethanol.

One of the required effects of utilisation of agricultural crops is a replacement of unreconstructed sources of energy on the earth. The Czech Republic is currently using only 1.5% of agricultural crops as energy sources as compared to 5.1 % in the EU (proportionally).

Production of 100,000 hectoliters of bioethanol means 6,700 hectares of wheat. Bioethanol is used as an additive to petrol propulsive mixtures. 'Ceska rafinerska a.s.', the only one producer of alternative fuels in the CR, used for that purpose 11140 hectoliters of bioethanol in 2000.

One of the raw materials which might be used for the production of biodegradable plastics is wheat gluten, a byproduct of wheat starch production. "Vital" gluten is used for food and feed consumption in the Czech Republic.

1.3 Potential uses of plant species (not yet commercially exploited)

Pea - starch

Possibilities of production and utilisation of pea starch is described in the book Czukor B. (ed.): 2001 Processing. In:Hedley C. L. (ed.): '*Carbohydrates in Grain Legume Seeds: Improving Nutritional Quality and Agronomic Characteristics*' - paragraph Legume seeds as a source of raw material pp. 116, CABI Publishing, division of CAB International, Wallingford, Owan, UK, pp. 89-116, ISBN 0 85 199 467 9

Chicory - inulin

Inulin, isolated from underground parts of topinambour or chicory (storage of polysaccharides), is matching up requirements for roughage supplements in human nutrition in relation to civilisation diseases (higher cholesterol and urea in blood, intestinal problems, and arteriosclerosis). In the past there was a planned project in the Czech Republic to grow chicory and produce inulin, using experiences from the production of chicory for making coffee substitutes, but the project was stopped at the stage of proposal. Chicory is cultivated on approximately 100 hectares, with crop yield varying between 20-40 t/ha. Chicory is tested as a raw material for bioethanol production.

2 Market and barriers to progress

The State Program for Support of Energy Savings and Renewable Resources Exploitation was created and ratified in July 1998. The program is intended to create suitable conditions for RES exploitation and to associate all supporting programs of different government departments and is embodied into long-term conception and particular annual programs. About 0.1% of GDP (approx. 1.9 billion CZK) was intended for the Program in the 2000. But the government has not found this Program as a priority and that is why the environmental program is financed from the State Fund of the Environment, at a maximum amount of 400 million CZK.

Sugar beet - bioethanol

In 2000/2001 there were 13 sugar refineries but these were/are not linked to distilleries and little alcohol is produced from sugar beet. Under the supervision of the Ministry of Agriculture there was, in 2001, a grant provided for the production of 100,000 hectoliters of bioethanol (fermented ethanol without water content) from the agricultural crops grown in the Czech Republic to be used in the production of alternative fuels.

Potato - paper industry

The production of paper in the CR is comparable to Austria (about 1% of European production). The paper industry is a very capital-intensive sector. Construction of a new factory costs 300,000-400,000 Euros and special attention must be given to sewage disposal and generally to possible effects on the environment.

Among the main producers (privatised) in the CR belong Sepap Štětí, Žatec and Žebrák (AssiDomän - Sveden), Bupak České Budějovice (Duropak - Austria), Karton Morava (Kappa - The Netherland), Jipack Příbyslavice (Vaas Leer - The Netherlands) and Roto Štětí (Norske Skog - Norway).

Under the present circumstances capacities for processing of waste paper, notably for de-inking, are missing in the approach of treatment with packaging materials in the CR. Investment of at least 140,000 Euros is needed. The manufacturing base of the paper industry (except production of cellulose) is quite outdated, with low capacity and insufficient assortment of products, see Table 31.

Table 31. Paper production (year 1997-1998), in thousand tonnes

Sort of paper	1997	1998
newspaper	94	102
woody, non-coated	37	47
non-woody, non- coated	134	118
woody, coated	0	0
non-woody, coated	14	13
hygienic and home	25	23
materials for corrugated cardboard	217	212
jigsaw cardboard	37	21
packing papers	178	182
other papers and cartonnes	57	66
Total	793	784

Wheat - sugar

Company CHEMOPETROL started in 2000 with the construction of a new factory complex for the production of bioethanol from wheat near Chemopetrol Litvinov and should be finished in 2003. The capacity will be 70,000 tonnes of pure alcohol and 85,000 tonnes of pelletized stillage, which will be reused as feed in agriculture. For that purpose 56,000-60,000 hectares of wheat will be grown. To 2003 only 100,000 hectoliters of bioethanol will be produced, which means the growing of wheat on 5,300 hectares or sugar beet on 2,300 hectares. An ethanol yield from cereals is 40% which presents a yield of 1.6 tonnes of ethanol per hectare.

SPECIALITY CROPS

A group of agricultural plants possessing medical and/or aromatic properties comprises a lot of species with a great diversity of uses. Some of them are grown in the Czech Republic, however, the agricultural area dedicated to this purpose is not greater than 1000 ha. As shown in Table 34, approximately one third of the harvested plants are used by the pharmaceutical industry for the production of various types of medicines and drugs (33%). They are also used in the cosmetics industry or as additives for detergent production. Nevertheless, their main outlet is still in the food industry (herbal teas, spices and seasonings). As only small private farms are concerned with growing this type of crop and because of a great diversity of plants and products there is, unfortunately, still no central evidence of their production rates. First steps to improve this situation were undertaken in 2001. The Association of Producers of Herbs and Medicinal Plants “PELERO” was established. Regarding planned production, it depends on the requirements of the pharmaceutical and food industry as well as on market prices. These are regulated by the world market and in many cases it is more advantageous to import special crops or raw substrates from Asia or Latin America because of their lower cost. Therefore, the cultivation area in the Czech Republic used for the production of special plants will probably stay well below that used for oil or carbohydrate crops.

The plants with the highest acreage in the Czech Republic include caraway (*Carum carvi* L.), milk thistle (*Silybum marianum* L.) and ergot (*Claviceps purpurea* TUNL., inoculated in rye). For pharmaceutical use poppy head, a by-product of poppy seed production, is used. Two varieties with mid-morphine content (Gerlach and Opal, 0.43%) and one variety with a high content of morphine (Lazur, 0.8%) are grown in the Czech Republic. Total production of Léčivé A Kořenové Rostliny (LAKR, Herbs and Medicinal Plants) is shown in Table 32. Production without the three main plants is listed in Table 33.

In 1995, LEROS s.r.o. – the leading producer of herbs and herbal products for pharmacy in the Czech Republic, was established by the privatisation of the state-owned company ‘Léčivé rostliny’ which had had the monopoly position in purchasing, processing and distributing herbs and herbal products, not only in the former Czechoslovakia, but it had been intended to be a main supplier for the whole of the socialist sector. At present, LEROS s.r.o. is a private company partly owned by the management. Unlike its competitors, LEROS, s.r.o. controls all stages of the production cycle from purchasing and processing of raw materials, preparing mixtures, up to the packaging of final

products (working with Bio Certification - for the growing, gathering, treatment and storage of herbs). LEROS s.r.o. occupies the leading position in purchasing raw materials (see Annex 3) on the Czech market.

Regarding the research related to this field, it is mainly carried out by The Faculty of Pharmacy, Charles University, Hradec Kralove (<http://www.faf.cuni.cz>) and is aimed at methods for plant cultivation as well as procedures appropriate for isolation, identification and characterisation of plant-derived compounds that can serve as pharmacological tools or as drug prototypes.

Table 32. Total production of medicinal, flavouring and spice plants

Year	Medicinal plants			Spice plants		
	Harvest. area (ha)	Production (t)	Yield (t/ha)	Harvest. area (ha)	Production (t)	Yield (t/ha)
1996	5306	3636	0,69	10483	7314	0,70
1997	6127	3570	0,58	7018	5663	0,81
1998	6362	5282	0,83	3315	2039	0,62
1999	950	578	0,61	2557	1565	0,61
2000	2201	2118	0,96	4818	2440	0,51
2001	1500	974	0,65	4871	3292	0,68
2002	2841	2086	0,73	5118	3709	0,72

Table 33. Production of medicinal, flavouring and spice plants except the three main plants (caraway, milk thistle and ergot)

	Harvest. area (ha)	Production (t)	Yield (t/ha)
1993	470	127,1	3,7
1994	420	120,4	3,5
1995	366	98,9	3,7
1996	350	89,7	3,9
1997	360	83,7	4,3
1998	389	99,7	3,9
1999	420	113,5	3,7
2000	352	90,5	3,9
2001	327	87,1	3,8

There are two main sources of plants in the Czech Republic - cultivation and collection. Chamomile, peppermint, lemon balm, thyme, long plantain, burdock, marshmallow, valerian and garden angelica are cultivated in the largest amounts and rosehip, lime flower, common St. John's Wort, ribbon tree, stinking nettle, fragrant agrimonies, colt's tail, raspberry, black elderberry and blackberry are the collected in the largest amounts.

Processing and usage of medicinal and aromatic plants in the Czech Republic is summarised in Table 34. The Netherlands, India, Germany, Italy, Philippines, Mexico and Denmark are the countries were the main import of plant juices and principals came from in 2002.

Table 34. Processing and usage of medicinal and aromatic plants (without spices) (tonnes)

	1997	1998	1999	2000	2001	2002
Pharmaceutical	93.0	156.0	325.0	1118.0	930.0	900.0
Food	360.2	366.2	324.4	640.0	650.0	660.0
Others	919.0	1000.0	923.0	1100.0	1112.0	1115.0
Total	1372.2	1522.2	1572.4	2856.0	2692.0	2675.0

Project FB-C2/39 – LINTEX – new technology in the manufacture of 100% flax textile fabrics

Project solved by: Cotton Industrial Research Institute
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Czech Republic

Subject matter of solution

Development of a new technology in the production of flax containing textiles from raw material preparation and yarn production up to the finished textile product, based upon the application of more effective and more economic short staple (cotton-type) technology of the production of flax containing yarns.

Main goal of the project: to solve new technology in the production of flax containing woven and knitted fabrics, based upon the application of more effective short staple spinning technology and to prepare it for realization in the Czech textile mills.

Thanks to processing cheaper raw material, these products should be significantly cheaper compared to the similar assortment produced by means of standard flax processing technologies in a certain market segment.

Main researcher, Výzkumný ústav bavlnářský a.s., has managed the production of blend short staple (cotton-type) OE yarns with different shares of flax fibres in the blend, for example:

- 100% flax yarn counts Tex 92 – 150
- blend yarns cotton/flax 90/10, yarn counts Tex 29,5 – 150
80/20, yarn counts Tex 29,5 – 150
70/30, yarn counts Tex 35,5 – 150
50/50, yarn counts Tex 42 – 150
30/70, yarn counts Tex 64 – 150
20/80, yarn counts Tex 72 – 150
- blend yarns viscose/flax 80/20, yarn counts Tex 29,5 – 150
70/30, yarn counts Tex 35,5 – 150
50/50, yarn counts Tex 50 – 150
30/70, yarn counts Tex 64 – 150
20/80, yarn counts Tex 72 - 150
10/90, yarn counts Tex 78 - 150

Also blend yarns polyester/flax or acrylic/flax can be manufactured.

Any questions concerning the subject matter of project solution and its results incl. the demands for the production of above mentioned yarns can be consulted with:

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Raw materials and Semi-products - Production of LEROS s.r.o, CR

<i>Latin name</i>	English name	<i>Latin name</i>	English name
<i>Absinthii herba</i>	Wormwood herb	<i>Lini semen</i>	Flax seed
<i>Agrimoniae herba</i>	Agrimony herb	<i>Liquiritiae radix mund.</i>	Licorice root peeled
<i>Alchemillae herba</i>	Common ladies mantle herb	<i>Liquiritiae radix nat.</i>	Licorice root natural
<i>Althaeae folium</i>	Marschmallow leaves	<i>Lupuli strobilus</i>	Hops flowers
<i>Althaeae radix mund.</i>	Marschmallow peeled root	<i>Lycopodium</i>	Clubmoss herb
<i>Althaeae radix nat.</i>	Marschmallow nat.root	<i>Malvae arb.flos</i>	Mallow flowers black
<i>Angelicae radix</i>	Angelica root	<i>Malvae flos</i>	Mallow flowers
<i>Anisi fructus</i>	Anise seed	<i>Malvae folium</i>	Mallow leaves
<i>Anserinae herba</i>	Silverweed herb	<i>Marrubii herba</i>	White Horehound herb
<i>Asperulae herba</i>	Sweet woodruff herb	<i>Melissae herba</i>	Lemon balm herb
<i>Aurantii pericarpium dlc.</i>	Orange peels sweet	<i>Menthae pip. folium</i>	Peppermint leaves
<i>Avenae fructus</i>	Oats	<i>Menthae pip.herba</i>	Peppermint herb
<i>Bardanae radix</i>	Burdock root	<i>Millefolii flos</i>	Yarrow flowers
<i>Bellidis flos</i>	Daisy flowers	<i>Millefolii herba</i>	Yarrow herb
<i>Betulae folium</i>	Birch leaves	<i>Myrtilli folium</i>	Huckleberry leaves
<i>Boldo folium</i>	Boldo leaves	<i>Myrtilli fructus</i>	Huckleberries
<i>Bucco folium</i>	Bucco leaves	<i>Myrtilli herba</i>	Huckleberry herb
<i>Bursae pastoris herba</i>	Shepherds purse herb	<i>Ononidis radix</i>	Restharrow root
<i>Calami radix</i>	Calamus root	<i>Origani herba</i>	Wild marjoram herb
<i>Calendulae flos c.c.</i>	Marigold florets	<i>Paeoniae flos</i>	Peony flowers
<i>Callunae flos</i>	Common heath flowers	<i>Petroselini radix cs</i>	Parsley root
<i>Callunae herba</i>	Common heath	<i>Phaseoli fructus s.s.</i>	Kidney bean pods without seeds
<i>Cardui mar. fructus</i>	St.Mary's thistle fruits	<i>Plantaginis folium</i>	Ribwort plantain leaves
<i>Carvi fructus</i>	Caraway seed	<i>Polygoni avic.herba</i>	Knotgrass herb
<i>Caryophyllatae radix</i>	Herb Bennet root	<i>Primulae flos c.c.</i>	Promrose flowers
<i>Cassiae flos</i>	Cinnamon flowers	<i>Pulmonariae folium</i>	Lungwort leaves
<i>Centaurii herba</i>	Centaury herb	<i>Quercus cortex</i>	Oak bark
<i>Cichorii herba</i>	Chicory herb	<i>Rhei radix</i>	Rhubarb root
<i>Crataegi flos</i>	Hawthorn flowers	<i>Rhoeados flos</i>	Red poppy petals
<i>Crataegi folium c.f.</i>	Hawthorn leaves with flowers	<i>Ribis nigri folium</i>	Black currant leaves
<i>Crataegi fructus</i>	Hawthorn berries	<i>Ribis nigri fructus</i>	Black currant fruits
<i>Cynosbati fructus</i>	Rose hips	<i>Rosmarini folium</i>	Rosemary leaves
<i>Dauci sativi radix cs</i>	Carrots	<i>Rubi fruticosi folium</i>	Blackberry leaves
<i>Epilobii herba</i>	Willow flowers herb	<i>Rubi idaei folium</i>	Raspberry leaves
<i>Equiseti herba</i>	Horsetail herb	<i>Salicis cortex</i>	Willow bark
<i>Euphrasiae herba</i>	Eyebrigt herb	<i>Salviae folium</i>	Sage leaves
<i>Farfarae flos</i>	Coltsfoot flowers	<i>Salviae herba</i>	Sage herb
<i>Farfarae folium</i>	Coltsfoot leaves	<i>Sambuci flos c.s.</i>	Black elder flowers

<i>Foeniculi fructus</i>	Fennel fruit	<i>Sambuci fructus s.s.</i>	Black elder berries
<i>Fragariae folium</i>	Strawberry leaves	<i>Sennae folium</i>	Senna leaves
<i>Frangulae cortex</i>	Buckthorn bark	<i>Serpylli herba</i>	Mother of Thyme herb
<i>Fucus vesiculosus</i>	Sea-weed	<i>Solidaginis herba</i>	Common Goldenrod herb
<i>Galangae radix</i>	Galange root	<i>Sorbi nigri fructus</i>	Black Mountain-Ash
<i>Galegae herba</i>	Goats Rue	<i>Spiraeae herba</i>	Drop-Wort herb
<i>Gentianae radix</i>	Gentian root	<i>Symphyti radix</i>	Comfrey root
<i>Herniariae herba</i>	Flax weed herb	<i>Tanaceti flos</i>	Tansy flowers
<i>Hibisci flos</i>	Hibiscus flowers	<i>Tanaceti folium</i>	Tansy leaves
<i>Hippocastani semen</i>	Horse-chestnut seed	<i>Taraxaci folium</i>	Dandelion leaves
<i>Hyperici herba</i>	St. John's wort herb	<i>Taraxaci radix</i>	Dandelion root
<i>Hyssopi herba</i>	Hyssop herb	<i>Thymi herba</i>	Thyme herb
<i>Chamomillae flos</i>	Chamomile herb	<i>Tiliae flos</i>	Lime flowers
<i>Inulae radix</i>	Elecampane root	<i>Tormentillae radix</i>	Common tormentil root
<i>Iridis radix</i>	Iris	<i>Trifolii fibr.folium</i>	Marsh Trefoil
<i>Juglandis folium</i>	Walnut leaves	<i>Urticae folium</i>	Stinging nettle leaves
<i>Juniperi fructus</i>	Juniper berries	<i>Urticae herba</i>	Nettle herb
<i>Lamii albi flos</i>	White deadnettle flowers	<i>Uvae ursi folium</i>	Bearberry leaves
<i>Lamii albi herba</i>	White daednettle herb	<i>Valerianae radix</i>	Valerian root
<i>Lavandulae flos</i>	Lavender flowers	<i>Verbasci flos</i>	Mullein flowers
<i>Lavandulae herba</i>	Lavender herb	<i>Violae tric.herba</i>	Pansy herb
<i>Levistici radix</i>	Lovage root	<i>Visci albi herba</i>	Mistletoe herb