IENICA

Interactive European Network for Industrial Crops and their Applications

Forming Part of the IENICA-INFO*RRM* Project

REPORT FROM THE

REPUBLIC OF HUNGARY

INFO*RRM*-IENICA is a project funded under the Fifth Framework Programme by DG XII of the European Commission

Prepared by:
Non-food Group
Department of Agricultural Chemical Technology
Budapest University of Technology and Economics

Contact: Kati Reczey, Budapest, 1111, Szt. Gellért tér 4
Tel: +36 1 463 28 43 kati_reczey@mkt.bme.hu

BUDAPEST, 2002
(with updates in January 2004)

ACKNOWLEDGEMENT

This work was funded under the IENICA workstream of the IENICA-INFO*RRM* project. IENICA is the Interactive European Network for Industrial Crops and Applications. The overall project is funded by the Fifth Framework Programme of the European Commission under the Quality of Life Programme. This project is a development of the FAIR Programme (FP4)-funded IENICA project.

CONTENTS

Tables

METHODOLOGY

Hungary joined the IENICA project at the end of 2001, with the intention to report the existing and future opportunities in non-food renewable raw material production. A drive behind the report is also the approaching EU accession of Hungary, which will cause minor structural changes in the agricultural sector and will create room for non-food agricultural production.

This study was prepared and summarised by Kati Réczey Ph.D, Béla Simándi PhD, Ákos Máthé PhD, János Domokos, Gergely Köves, Judit Ádám and Balázs Kis at the Budapest University of Technology and Economics. The information has been collected from papers, national statistics and through extensive personal communication.

The figures on Hungarian agriculture and sociology were kindly provided by the *Központi Statisztikai Hivatal (Central Statistical Office)*. It must be noted that the non-food industrial crops are usually produced as minority products, and are therefore not reported to the regional statistic offices and the amounts are based on statistical estimations.

We hope that the report is a useful overview of the Hungarian agricultural and the existing non-food applications for both experts and those who are interested. The Hungarian version of this report will be available soon at **http://www.non-food.bme.hu**.

Budapest, March 2002 (with updates in January 2004)

EXECUTIVE SUMMARY

Hungary's fortunate climate — the high number of sunshine hours, plentiful rainfall, the relief situation, moderate temperature and good quality soils — created an opportunity for exceptional yields in the past for most agricultural crops. After the political changes at the beginning of the 1990's the structure of the Hungarian economy has changed rapidly and drastically and the effects can still be seen in the structure of the agriculture.

Significant amounts of oil crops are produced in Hungary. The major crops are sunflower and rape due to their well-mechanised production. Small amounts of oil are produced from soy, rose, hemp, hazel, raspberry, elder, currant, flax, maize, almond, poppy, pepper, castor, walnut and grape. Today the oil production in Hungary is controlled by one company, which produces 95% of the food-purpose sunflower oil, which amounts to 146,000 tonnes of oil annually. There are also 83 independent oil manufacturers that mainly use cold pressing techniques and their annual production is estimated to be between 1,000-2,000 tonnes. These small capacity factories are the producers of special oils, such as oil from poppy seed, saffron, Borago, Oenothera, maize kernel, wheat seed, peach seed, tomato seed, beech seed, pepper seed and oak seed.

The most promising non-food crop in Hungary is fibre hemp. Hemp is one of the oldest plants cultivated in the country and still has outstanding opportunities. Due to the ideal climate and fertile soils the situation for fibre hemp production is exceptional. Fibre flax used to be an important raw material before 1980, but since then farmers have ended the cultivation of flax due to its sensitivity to droughts.

In Hungary, the following major starch-containing crops are cultivated: wheat, maize, potato, rye, barley and oats. Of these, wheat and maize are used for non-food purposes. The amount of non-food starch production in Hungary is approximately 32,000 tonnes per year. About 61% of this is used in the paper industry and 8% is used in the pharmaceutical industry; the remaining amount is used as a raw material for flocculation agents. Starch is also used as a hardener in the textile industry or as a glue in construction.

According to the current Hungarian regulations there are 214 plant species being sold for medical purposes. Of these there are approximately 180–200 domestically cultivated plant species and about 50–60% of these herbs are native to Hungary. The annual domestic production of dried herb plants is 35,000–45,000 tonnes. About 75%–80% of total production is cultivated and the rest is collected. 10% of the medical morphine used worldwide and 30% of the morphine used in Europe is produced in Hungary at *ICN Tiszavasvári*.

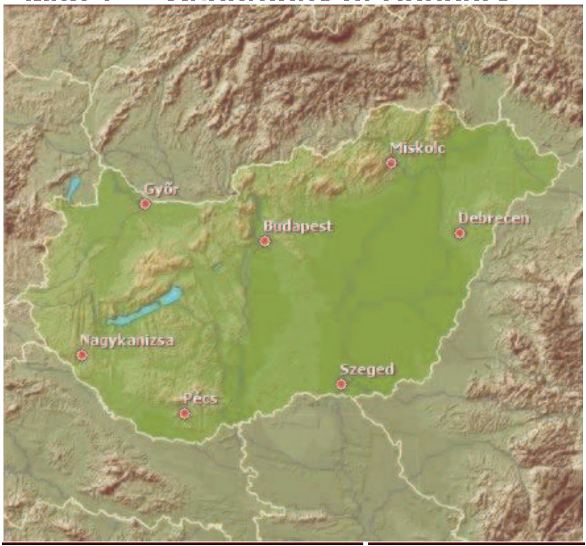
Black elder is cultivated on approximately 750 hectares with an annual production of 30,000-40,000 tonnes per year. Other wild fruits are also cultivated on small areas as test cultures.

INTRODUCTION

Geography

Hungarian agriculture has a history more than a thousand years old. Since the Middle Ages agriculture in Hungary has provided a significant amount of goods - mainly cattle, wheat and wine - for the markets of Northern and Western Europe. Due to the relative isolation of the Carpathian Basin the climate has a tendency for droughts, especially on the *Alföld (Great Plain)* in the east of the country. Almost 80% of the country's land is located under 200 metres above sea level and only 2% of the total area is located above 400 metres.

Map 1 — Geography of Hungary



Total area:	93 030 km^2
Langth of boundary:	2246 km
Neighboring countries:	7

Elevation	
Under 200 meters:	84 %
Between 200-400 meters:	14 %
Above 400 meters:	2 %

The geography of Hungary can be seen on Map 1. The agricultural arable land represents 83.1% of the country's total area (2003) [1]. The country's fortunate climate - the high number of sunshine hours, plentiful rainfall, the relief situation, moderate temperature and good quality soil – has created an opportunity for exceptional yields in the past for most agricultural crops. As a result, the fruits and vegetables produced in Hungary have always been known as top quality products. These good climatic conditions and the fact that Hungary is situated in the centre of Europe has resulted in an agriculture and food-production based economy.

Climate

Hungary is situated in the Temperate Zone, on the borderline of, and affected by, three large climatic zones: Oceanic, Continental and Mediterranean. It is prone to rhapsodic weather changes and due to the relative isolation of the Carpathian Basin the climate has a tendency for droughts, especially in the *Alföld.* The annual average wind speed is 2.4 m/sec.

Temperature

The annual average mean temperature is 9.7°C in the whole of the country and 11.2°C in Budapest. The mean temperature in the hottest month, July, is 20°C, and in the coldest month, January, it is 2.1°C. In the summer temperatures may reach 33-38°C, while in the winter temperatures may drop to -25.0 to -30.0°C. The difference in temperature between the northern and southern parts of the country is about 3°C, because the southern part of the country receives more sunlight and the northern part has a higher elevation.

Rain

In the central part of the *Alföld* the annual average rainfall varies between 470-550 mm and in the mountains between 700-800 mm. The Hungarian countryside provides the ideal situation for the technology requirements of agricultural production. Agricultural yields are principally affected by the amount of rainfall. Precipitation patterns show big differences in the country; most of the rain falls on the western part and less falls on the *Alföld*. On the 'driest' places of the *Alföld* the annual rainfall is less than 500 mm and on the most humid places it is more than 1000 mm. The number of days when the land is covered with snow is less than 60 annually.

Sunshine

The number of hours of sunshine varies between 1700-2200 hours per year; the area between the rivers *Danube* and *Tisza* is the sunniest, while the regions with the least amount of sunshine are *Alpokalja (Lower Alps)* and *Északi-Középhegység (North Mountain Ranges)* - the northern mountain ranges. [5]

Agriculture

The population of Hungary is around 10 million, which represents 2.8% of the total population of the European Union. The total land of Hungary represents 2.9% of the EU's total, which is 0.9 hectare per inhabitant. The average agricultural arable land per inhabitant is 0.4 hectare in the EU; in Hungary it is 0.7 per hectare. In Hungary 76% of the total arable land is ploughed compared to the EU average of 53%. In Hungary orchards and gardens have a bigger importance in the arable land share than in the EU. Also, significant difference can be seen in forestry; in Hungary the forested area represents only 19% while in the EU that area is more than 35%. [2]

After the political changes at the beginning of the 1990's the structure of the Hungarian economy has changed rapidly and drastically. During the privatisation the ownership of land used for agriculture has shifted from the quite well equipped and organised co-operatives to the low capitalised, poorly mechanised privatised small-scale (family) farms.

After 1992 a significant increase could be seen in the amount of construction. By 2000 the amount of construction had increased by more than 250% and investments in machinery had grown by more than 300%, compared to the volume in 1992. [3, 4] The figures can be seen in Table 1.

Table 1 - Agricultural construction and machine investments (at current price; million Euro)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Construction	29	23	27	30	35	63	90	116	107	107	80
Machines	39	29	38	51	60	105	137	169	152	138	152

<u>Agricultural Production</u>

The share of agriculture in the GDP was 7.8% in 1991 and by continuous decrease this share reduced to 4.2% in 1999. The wider 'agribusiness' still represents around 15-18% of Hungary's GDP. The two main fields of agriculture - vegetable and meat production - have had adverse growth; the approximate 3% increase in plant production balances the 3% decrease in meat production. The share of agriculture from exports has also started to decrease as a result of the loss of market in the former eastern block. [3]

Table 2 — Share of agriculture in the national economy (%)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
GDP	7.8	6.5	5.8	6.0	6.0	6.0	5.2	4.9	4.2	3.7	3.8
Investments	4.3	2.9	3.1	2.9	2.9	3.4	3.6	5.2	5.5	5.0	6.2
Export	N/A	10.0	6.8	6.8	8.2	6.0	4.7	4.2	2.9	2.6	2.9

Workforce in Agriculture

Agriculture's reduction of share in the national economy is well represented by the continuous reduction of share in the workforce. The workforce in the agricultural sector is shown in Table 3.

Table 3 — Agricultural workers

1000 people	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**	**2001**	**2002**
National economy (total)	4 107	4 735	4 980	5 074	4 880	3 856	3 868	3 870
Agriculture, forestry and fishing	2 093	1 732	1 023	765	693	256	243	241
Percentage of workers (%)	51.0	36.6	20.5	15.1	14.2	6.6	6.3	6.2

Until the 1950's more than half of the population was working in the agricultural sector, but due to the application of better technologies and mechanisation until 1970 only 20% of the population earned their living from agriculture. The reduction in the share of workforce slowed down in the 1980's. Due to the break up of the socialist type co-operatives in 2000 only 6.5% of workers were in agriculture. [2, 3, 4]

Structure of Ownership

After the privatisation at the beginning of the 1990's more than 50% of the arable land became owned by private small-scale farmers. These non- or badly-mechanised, under-capitalised farms could not perform well in mostly plough-type cultivation. Yields started to decrease at the beginning of the 1990's. An increase started after 1993 with the help of low interest loans from the Government. [3]

Table 4 - Land Use, by legal form (%)

	1990	**1992**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Companies and corporations	30.8	38.7	33.2	27.9	28.1	25.4	25.9	28.2	29.1	25.9	25.9
Co-operatives	55.3	45.4	29.3	23.7	21.6	19.6	18.0	16.1	12.5	4.7	4.2
Private farmers	13.9	15.9	22.3	43.4	45.1	49.7	51.0	50.4	41.9	63.4	64.2
Other	-	-	15.2	5.0	5.2	5.3	5.1	5.4	16.5	6.0	5.0

Share of Land Used for Agriculture

The amount of agriculturally used land has decreased by more than 1.5 million hectares since the 1950's, which represents 21% of the total agricultural arable land. According to the agricultural statistics in 2001, 48% was plough land, 11% was grassland and 5% was orchard and vineyard. Since 1980 the reduction of orchards' share is typical.

Table 5 — Agricultural used land ('000 ha)

	1950	1960	1970	1980	1990	2000	2001	2002	2003
Arable land	5 518	5 310	5 046	4 735	4 713	4 500	4 516	4 516	4 516
Garden	94	108	146	291	341	102	98	99	96
Orchard	58	82	172	138	95	95	98	97	98
Vineyard	230	204	230	168	138	106	93	93	93
Total	7 376	7 141	6 875	6 627	6 473	5 854	5 846	5 846	5 842

Changes in Yields

Table 6 presents the yields for the main agricultural products between 1950 and 2000. The yields are affected be several factors such as weather, sociological factors and market demands.

Table 6 — Yield of main agricultural products between 1950-2002 (kg/ha)

	1950	1960	1970	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Wheat	1520	1680	2130	4760	3999	4392	4406	5415	4827	4355	4371	5446	5240
Maize	1570	2500	3380	5320	5860	6854	5582	5884	6285	6285	6126	5465	6216
Potato	4830	10510	10410	14960	18198	17339	15743	20155	19574	18631	15964	18513	16698
Sunflower seed	850	970	1010	1754	2062	1949	2052	1879	1962	2190	2092	1949	1946
Sugar beet	14600	25330	28730	37640	38754	42555	34698	40006	37910	36186	36287	39333	43977

	1990	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Wheat	5050	4070	3050	4590	4160	3280	4210	4140	3590	3600	4310	3510
Maize	3990	3650	3500	3850	4430	5610	6410	5950	6380	4150	6220	5050
Potato	16920	16850	13310	12770	15780	17790	16280	18850	18390	15290	21280	18280
Sunflower seed	1971	1789	1751	1605	1606	1836	1228	1682	1521	1620	1960	1860
Sugar beet	36090	27190	22950	31980	33950	39590	37680	41960	44540	34350	43780	41080

Harvested Amounts of Main Agricultural Products

Data shown in Table 7 represents the harvested amounts of the main agricultural crops.

Table 7 — Harvested amounts of main agricultural products between 1980-2002 ('000 tonne)

	1950	**1960**	**1970**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Wheat	2085	1768	2723	6077	4602	5751	5968	7367	6554	5740	5685	6975	6509
Maize	1820	3534	4072	6673	6813	7752	6255	6514	6619	7029	7007	6028	6742
Potato	1574	3001	1813	1392	1112	966	790	1048	975	815	694	883	819
Sunflower seed	254	80	96	456	623	578	587	596	673	856	790	708	692
Sugar beet	1640	3370	2175	3941	4719	5370	3782	4360	4073	3760	4254	4511	5298

	1990	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Wheat	6198	3453	3021	4874	4614	3910	5258	4895	2638	3692	5197	3910
Maize	4500	4405	4044	4761	4680	5989	6828	6143	7149	4984	7858	6121
Potato	1226	1212	1057	946	1099	1308	1140	1148	1199	864	908	752
Sunflower seed	684	765	682	667	789	868	540	718	793	484	632	777
Sugar beet	4743	2928	2182	3370	4199	4677	3691	3361	2934	1976	2903	2274

OIL CROPS

1 Science and Technology

The climate in Hungary makes the country ideal for seed and oil crop production. Before World War II, not only had Hungarian plant oil export been notable but oil plant breeding research was also legendary. In the field of oil crop production and research, Hungary is still one of the leaders in Europe. Some of the Hungarian laboratories, like the *Gabonatermesztési Kutató Kht (Cereal Research Institute),* has 48 registered sunflower strains and 8 oil flax strains cultivated in 18 countries on 500-600 million hectares. This Institute was the first in the application of cytoplasm sterile male strains of maize. Research into new perspectives for industrial plants is also in progress at the *Agrobotanikai Intézet (Agrobotanical Institute)*. The Institute is currently examining the possibilities of cultivation for *Camelina sativa, Cuphea lanceolata, C.viscosissima, Lallemantia iberica, Euphorbia lathytris, E.marginata, Lesqurella fendlerii*, a *Limnanthes alba, Lunaria annua, Madia sativa* and *Vernonia galamensis* species. Most of the agricultural universities have their own breeding research laboratories. The harvested areas of the main oil crops and the yields are shown in Tables 8 and 9. CEREOL is conducting unmolding and pesticide adjuvant research based on vegetable oils.

Table 8 — Oil Crops - Harvested area (ha)

	1980	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sunflower seed	272919	346857	N/A	427584	389424	409442	491295	473043	440012	426968	521272	298795	320019	418020
Rape seed	50599	59984	N/A	34160	22266	35065	45144	93921	89453	52055	180522	115788	109656	129389
Castor-oil bean	–	–	–	–	–	N/A	N/A	N/A	N/A	–	–	–	–	–
Oil flax seed	8761	8578	N/A	5814	2211	1841	1438	965	402	1061	1749	1008	782	397
Hemp seed	1849	1081	N/A	50	165	236	50	372	98	80	–	N/A	N/A	N/A
Marrow seed	800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	360	N/A	N/A	N/A

Table 9 — Yields of main oil crops (kg/ha)

	1980	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sunflower seed	1754.0	1971.1	N/A	1788.5	1750.6	1605.0	1606.0	1835.8	1227.9	1682.4	1521.1	1620.0	1960.0	1860.0
Rape seed	2025.1	1760.6	N/A	1297.4	1002.7	1809.2	1965.2	1465.2	1618.9	1403.0	1793.6	1550.0	1870.0	1600.0
Castor-oil bean	–	–	–	N/A	N/A	N/A	N/A	N/A	N/A	–	–	-	–	–
Oil flax seed	1300.1	1145.8	N/A	811.3	541.8	1197.2	1128.0	897.4	1054.7	1116.9	1029.2	870.0	1000.0	1170.0
Hemp seed	941.0	1105.5	N/A	1200.0	945.5	546.6	920.0	572.6	1051.0	750.0	–	N/A	N/A	N/A
Marrow seed	900.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1500.0	N/A	N/A	N/A

Numerous crops cultivated in Hungary contain oil, such as sunflower, rape, soy, rose, hemp, hazel, raspberry, elder, currant, flax, maize, almond, poppy, pepper, castor, walnut and grapes. Only sunflower and rape are cultivated in notable amounts, because the cultivation of these crops can be carried out easily with machines.

2 Sunflower

Sunflower is the one of the most important industrial crops in Hungary and has the highest annual production in the group of oil plants. Sunflower yield has shown some increase worldwide in the past 20 years. The oil produced from sunflower is mainly used for food purposes, but is also an important raw material for margarine and soap manufacturing. The by-product arising after cold pressing is rich in proteins and is used as an animal feed. The sunflower 'leftovers' are important green fertilisers and feeding materials. For fertilisation purposes - especially in biofarming (organic production) - the tightly grown sunflower culture is the best practice. Traditionally sunflower was cultivated on residue areas, such as free areas of large potato and maize fields. Only later, in the communist command-type agriculture was sunflower grown on better quality soils, as a target crop. Due to the spread of sunflower hybrids and complete mechanisation sunflower is one of the most important industrial crop produced in Hungary today.

2.1 Biological Properties

Sunflower (*Helianthus annuus L.*) is in the family of *Asteraceae*. It has a strong central root system and several rich side roots. Its stalk is strong and depending on the type it is 1.5-2.5 metres tall. For large-scale farming only medium sized (1-2 metres tall) one-headed types are suitable. Nowadays only hybrid types are cultivated to fulfil the mechanisation requirements. In comparison, 25 years ago only 5% of the cultivated sunflowers worldwide were hybrids. The old (wild) type sunflowers are only cultivated in non-significant amounts.

The climate in Hungary is suitable for sunflower cultivation almost everywhere, because it has a high demand for warmth and sunlight, but isn't sensitive to drought. The cultivated special hybrids are sensitive to rain in the growing time and are also sensitive to cold in the middle and at the end of the growing cycle. These hybrids can be grown successfully on almost every soil type in Hungary. The best sowing time is in the middle of April when the soil temperature is continuously over 10-12°C. The only disadvantage of sunflower is that it can only be cultivated in every seven years of the crop rotation.

2.2 Harvesting and Storage

Sunflower ripens irregularly, therefore the mechanised harvesting requires good timing. The time of harvesting is affected by several factors; the best timing is at the end of the yellow ripening, when the water content of the head is between 15-18% and its colour is stain brown. At this time the yield is maximum and the peeling-off waste is minimal. The storage of oil seeds also requires attention, because only clean, dry seeds can be stored without waste. The harvested sunflower must be dried and cleaned before storage. During the drying process spontaneous combustion of the dry, oil-containing seeds requires attention. After the drying process sunflower can be stored in 15-20 cm deep layers. As a basic rule for longer-term, wider-layer storage the seeds must have 8% water content to avoid rotting and spontaneous combustion. [6]

3 Rapeseed

Rape is also an important oil crop because in favourable conditions it can be grown economically. In the recent past rapeseed oil was only used as a lamp oil, but nowadays it is used as a raw material for several industrial processes and after refining it is suitable for food purposes as well. Currently several low erucic-acid containing strains are selected and used for cooking oil. Cultivation is increasing due to cooking oil utilisation, the good mechanisation possibilities of cultivation and the important by-products, which are suitable for animal feed. Rape also can be used as a green fertiliser.

3.1 Biological Properties

Rapeseed (*Brassica napus L. ssp. napus MSF*) is in the family of *Brassicaceae* and in the nationality of *Brassica.* Two forms of rape are known: autumn type (*f. biennis*) and spring type (*f. annua*). In Hungary the autumn type rape is primarily cultivated, due to the high sensitivity and low yields of the spring type. Under a rainy climate rape can be used as green fertiliser. Its root system is a strong spike-root system, which can reach 2 metres depth. Its shaft is clear and wax covered. The oil content of the seed can reach 40-45%. Rape is sensitive to climate and weather conditions; it can be cultivated in the rainier western and north-eastern region. Its' rain demand in autumn and in spring is notable. Rape is sensitive to subzero temperatures both in winter and spring. For cultivation, only humus-loaded soils with a good water supply are suitable. Rape fits perfectly in the crop rotation between wheat and maize, but the disadvantage of rape is that it can only be cultivated in every 5 to 7 years in the crop rotation.

3.2 Harvesting and Storage

Rape is harvested when the central top seeds turn brown. If the harvesting is delayed the waste could be significant because seeds peel-off easily. Usually in Hungary rapeseed can be harvested in mid to late June, in two steps with a combine harvester. After harvesting the seeds must be dried before storing. For storage in wider layers the seeds must be dried to 9-11% water content, for the reasons mentioned for the storage of sunflower. The weight of the leftover rape (except the root) is about two to three times as much as the weight of the seeds. The combine harvested rape stalk is only suitable for animal bedding. [6]

4 Production of Plant Oils

In terms of oil extraction the yield and value of the by-products are very important. The two main techniques used for processing oil crops are pre-pressing and extracting. Pre-pressing is used for higher volume, lower priced crops while the extraction process, which has high yields, is used for crops with lower oil contents and a higher price.

Pre-pressing: a mechanical process where the seeds are physically pressed. Nowadays "runner" pressing machines are used. The maximum yield can reach 95%, with this equipment depending on the pre-heating of seeds. This technology is the best for high oil-containing seeds like sunflower and rapeseed. Pressing without pre-heating is only suitable for high oil-containing seeds, but for higher yield pre-heating is essential.

Extraction: With this technology almost 100% of the theoretical oil content could be retrieved. This technology is mostly used when the crop has a low oil content, but due to the high relative cost the product is valuable. The energy demand of extraction is much higher than for pre-pressing.

These two technologies are commonly combined to achieve maximum yields. The by-products of sunflower and rape oil production are important and valuable protein sources for animal feed. Generally, the seed content for each crop is around 40%.

5 Utilisation of Plant Oils

5.1 General Utilisation of Plant Oils

Currently in Hungary one company controls most of the food-purpose plant oil production. There are also 83 independent oil-pressing manufacturers that use solely cold pressing technology with a daily production capacity of around 3-5 tonnes of oil. These small capacity factories are mainly the producers of speciality oils such as poppy seed oil, saffron oil, Borago oil, Oenothera oil, maize oil, wheat seed oil, peach seed oil, tomato seed oil, beech seed oil, pepper seed oil and oak seed oil. The biggest of the 83 oil-factories are listed in Annex I. Excluding flax and hemp seeds the other plant oils have priority for the food industry.

Before the privatisation of the plant oil industry in the early 1990's the oil processing capacity was around 400 tonnes per day. The largest plant oil company in Hungary, *CEREOL Inc.,* has reported the same current process capacity. Between 1980 and 1992 sunflower oil production reached 300,000 tonnes per year; rape oil production was more than 40,000 tonnes per year; soy oil production around 2,000 tonnes per year; castor oil production 50 tonnes per year and maize germ oil production was around 5,000 tonnes per year. Only the poor quality oils from improper storage were used for industrial oil processes. Nowadays the use of these oils for biodiesel is under way. Before 1992 the chemical industrial utilisation of the hydrogenated and detergent type material production was significant, as shown in Table 10.

Table 10 — Utilisation of main plant oil products between 1960 and 1975

Raw material	Utilisation	product type	Amount of production (tonnes / year)
Sulfonated castor oil	Cosmetics and household chemicals	Emulsion material. Moisturiser	70-95
Sunflower oil REG ester	Household chemical. textile industry	Detergent and moisturiser	100-150
Sulfonated sunflower oil	Construction	Bitumen production	80-120
Sunflower oil sarkisine	Metal industry	Corrosion protection	20-50
Hydrogenised sunflower oil	Cosmetics	Emulsion hardener	40-70
Sunflower oil amide	Household chemical. textile industry	Antifoam agent	10-15

It must be noted that flax oil utilisation in the middle of the 1980's was approximately 300 tonnes annually, in 1988 the utilisation had reached 2,000 tonnes, and in 1992 the utilisation dropped back to around 800 tonnes. After 1992 flax oil in the paint industry was substituted with fossil-derived chemicals and the production in 1999 was only 1.8 tonnes.

In Hungary the poppy seed is a traditional food product, and only the industrially-cultivated poppy head is used for medical morphine production. The bad quality seeds and the improperly stored seeds are used for oil production. Poppy seed oil is the raw material of top quality art painting-oils and is also an important industrial oil due to its high linoleic and linolenic acid content. The biggest user of the plant oils was the cosmetic company *CAOLA Inc.*

After 1975 the utilisation of plant oils for cosmetics reduced and almost everywhere was substituted with cheap fossil oil derived synthetic oils. After 2000, the total amount of plant oil utilised for non-food products is now less than 10 tonnes.

5.2 Biolubricants

The project described here is an ongoing joint R&D program with the participation of the *University of Kaposvár*, *Szent István University* and *Magyar-Bio Kft*. These entities have some results in the field of lubricant related developments. The biolubricants investigated were made with sunflower seed oil. Motor engineering experiments were carried out and where the biolubricant was used a 3-4% power increase and an acceleration increase were observed.

The goal of the current research is to find an environmentally friendly, low-waste biolubricant manufacturing technology utilising plant oils and by-product long-chain alcohols and iso-amile-alcohols from ethanol production and also the by-product glycerine from biodiesel production.

6 Market Opportunities

The multinational companies in the Hungarian cosmetics market have more then an 85% share, but neither production nor manufacturing of non-food products are significant. Since the privatisation the domestic production of plant oil derived detergents had been eliminated. After the EU accession numerous Hungarian oil crop producers hope to become suppliers for the huge, already present, enterprises. Due to the lack of domestic oil processing capacity, transportation would create significant costs and the local production of speciality oils is only possible if the processing capacity is developed.

Nowadays farmers have only limited information on the most promising oil crops. These crops are *Calendula* and *Lunaria (holdviol)*, which could be used for the substitution of fossil-oil-derived oils in the paint industry. *Cuphea* oil could be important for the replacement of palm and coconut oil in detergent manufacturing. The oil from *Dimorphotheca pluvialis* has a conjugated double bond in its hydroxy-fatty-acid chain and could be used in the plastics industry. In addition, other crops like the *Lamiaceae* family - rich in lanoline acid - could be cultivated with excellent yields for multiple utilisation (spice, spice oil, fatty oil). In Hungary, *CAOLA Inc.* was producing cosmetics containing Borago oil, which were used with success in the treatment of *psoriasis* and *atopiasis* eczema. The utilisation of this Borago oil was less than 3 tonnes per year.

7 Barriers to progress

The barriers to plant oil production and processing are connected. Currently, a few multinational companies control the food-purpose plant oil production and also the processing, and only a few independent producers are in the situation to apply new cultivation technologies. Currently no legislation or policy is in force on the utilisation of the non-food plant oil products.

The lack of a national specific subsidy system is also a problem, which is blocking the spread of non-food plant oil utilisation. As mentioned earlier, multinational companies whose understandable logistics optimum is to place the non-food production in countries where subsidy is available, own a large share of the local processing capacity. Although there are numerous examples of non-food plant oil utilisation initiatives, standards are absolutely lacking and this is blocking the spread of plant-based motor oils and pesticide utilisation.

Currently there is no processing capacity in operation which can produce high purity glycerine from the by-product contaminated glycerine arising from plant oil processing, although the cosmetics industry would be able to take off a significant amount of purified glycerine.

FIBRE CROPS

Fibre crops are important raw materials for the textile industry. Although their importance in fibre utilisation has reduced in the past 20 years they still have a significant role alongside non-natural fibres. Cotton, the most regularly used fibre crop, grows only in warmer, tropical climates. In Hungary hemp production has great opportunities. It is also possible to produce flax although the climate is not ideal.

1 Hemp

1.1 Science and Technology

Hemp is one of the oldest plants cultivated, and one of the best utilisable. Archaeological findings show evidence of hemp textile production 8000 years ago in the Carpathian Basin. Hemp-based manufacturing is as old as pottery and much older than metal manufacturing. Nowadays, as a result of research and development into hemp, the opportunities for hemp utilisation are considerably enlarged.

The lifecycle of hemp production and products is advantageous. Hemp is a good weed suppresser and relatively resistant to insects and diseases, so production requires minimal pesticides or other chemicals. Due to its biodegradable property, hemp is a renewable raw material with a low impact on the environment.

Hemp could be described as the most important non-food crop of Hungary. Fibre hemp is a raw material that could be produced in almost any amount. The fine fibres are used for linen production; the harsher fibres are used for the production of string, rope, bag, canvas and hoses for extinguishing fires. Hungary is one of the biggest and oldest hemp growers and manufacturers in Europe. Although hemp production was only typical for home utilisation, in recent decades large-scale industrial hemp growing and manufacturing has begun, as a result of mechanisation.

1.2 Hemp Production in Hungary

In the 1950's and 1960's the production of fibre hemp was significant. As shown on Map 2 the main hemp growing areas were in the southern parts of Hungary [7]. The amounts and yields of hemp fibre produced in Hungary are shown in Table 11. It is estimated that the cultivated area in 2002 was 1,300 hectares.

Map 2 — Hemp Production in Hungary [7]

Table 11 — Hemp fibre produced in Hungary

	1980	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Harvested area (ha)	7516	1380	N/A	320	114	415	386	1031	1107	1030	171	58	68	925
Total harvested production (tonne)	50510	7034	6162	1734	261	3087	2738	9033	10458	8648	1510	560	608	3779
Yield (tonnes/ha)	6.720	5.097	N/A	5.419	2.289	7.439	7.093	8.761	9.447	8.396	8.830	9.655	8.060	4.090

1.3 Biological Properties

Hemp (*Cannabis sativa L.*) is a member of the *Cannabinaceae* family and categorised to the *Cannibis* nationality. The *Cannibis* nationality contains two species: *Cannabis sativa /L./ Serebr.* and *Cannabis indica Lam*. The main *C. sativa* phenotypes are north, middle-russian, southern or mediterranean and asian types. The hemp cultivated in Hungary belongs to the group of southern-type hemp. Hemp has a strong root system, which is relatively small compared to the parts above the ground, so cultivation requires good quality soil. For germination, low temperatures (1-2°C) are enough, but for optimum growing it requires a warm and humid climate. Hemp is only sensitive to drought in its early growing stages and its shaft remains short in a long and dry climate, which is undesirable for fibre application. The weather until flowering (mid-July) has a strong effect on the quality and quantity. The climate in Hungary is in general suitable for hemp production. The best places can be found in the southern parts of the *Alföld*. The quality of the hemp produced depends strongly on the time of harvesting. Usually the flowering of the male plant sets the harvesting time. At the time of flowering the male plant is both technically and physically matured; this happens usually at the end of July or in the first third of August. [6]

1.4 Industrial Processing of Hemp

In large-scale industrial production, hemp is first treated with a defoliation agent, then harvested and bundled into sheaves. Once the hemp dries out the sheaves are compacted into bales and are taken to the processing unit. Before processing hemp is qualified into three classes under standardised rules. The harder, woody parts of the hemp are removed from the shaft and fibres are selected for length. The longer swingled[1] parts are more valuable than the short tow type fibres. The long fibres are then cleaned and selected again for weaving. During weaving fibres are spun into thin yarns. At processing the fibres get longer, thinner and more parallel.

1.5 Industrial Utilisation

In Hungary today *Agro-Hemp Ltd*. organises hemp production. *Agro-Hemp* is not only a buyer of hemp, but also supplies hemp seed to farmers. Additionally, the company has its own hemp variety, *Tiborszállási*, which has a short growing season, is low in psychoactive material content and has an outstanding yield. This variety received an official honour in the year 2000. The amount of hemp produced depends on the industrial demand. Between 1990 and 2001 the production has varied between 100 to 1,350 tonnes with an average yield of 9-10 tonnes per hectare. The price of dry hemp is set by the contract each year depending on quality, but was set between EUR 52 and 88 per tonne. Currently in Hungary there are two hemp processing units: the *Első Magyar Kenderfonó Rt. (First Hungarian Hemp Spinnery Inc.)* at *Szeged* and the *HUNGAROHEMP Kenderipari és Logisztikai Rt. (HUNGAROHEMP Hemp industrial and logistic center Inc.)* at *Nagylak.*

The *Első Magyar Kenderfonó Rt.* is the producer of hemp ropes with a diameter between 4-40 mm. These ropes have high tensile strength, are extremely durable, have minimal stretching and are fire, heat and flame resistant. The ropes are used for sailing, transportation, agriculture, oil industry drilling and also for decoration. [8]

1.6 Advantages of Hemp

The geographical and climatic characteristics of Hungary are ideal for hemp cultivation. Hemp is ideal if cultivated before cereals in the crop rotation because of its good weed suppressing properties. After the EU accession of Hungary this plant could be one of the most important non-

[1] To swingle: to clean, as for flax, by beating with a swingle, so as to separate the coarse parts and the woody substance from the fibre; to scrutch.

food agricultural products, because the hemp products have a stable market and it is ideal in crop rotation.

2 Flax

2.1 Flax Production in Hungary

Map 3 — Flax Production in Hungary [7]

Fibre flax used to be an important industrial plant before 1980. Linen was made from finer fibres, and string, rope, bag, and canvas were made from harsher fibres. Flax favours a moderate wet climate. The optimal growing places are the colder climate countries such as Poland and Holland, but the biggest producers of fibre flax are the Newly Independent States (Former Soviet Union). The climate in Hungary is not wet enough for flax production. Some examples could be found for flax cultivation in Hungary but at present all producers have ceased flax production. Areas where flax has previously been produced are shown on Map 3. The areas marked with a '+' are places where additional irrigation had been applied. [7]

2.2 Biological Properties

Flax is in the family of *Linaceae* and in the nationality of *Linum*. Only one flax species is suitable for fibre production: *Linum usitatissimum L.* Flax is a shallow rooted plant and oil flax has a stronger root system than fibre flax. For fibre flax it is not ideal to have branches on the stalk of the plant, whereas for oil flax it is better for there to be more branches and more flowering ends. Flax fibres are raffia-type fibres, which are located between the woody tissue and the outer part of the stalk. Soil and climate affect the quality of fibres. The diameter of the stalk depends upon the distance between plants in the line. Fibre flax needs to be planted in tight cultures, to have good quality fibre. Fibre flax is sensitive to hot weather; high temperature can even stop flax growing. [6]

2.3 Industrial Processing of Flax

Flax is harvested from June to July. The colour of flaxseeds could be green, yellow or 'red ripe' (when fully matured). When the flaxseeds turn yellow the plants must be pulled out to have the longest available fibre length. When the seeds are green the fibres are too weak, and if fully matured (red ripe) the fibres are too harsh and cannot be irrigated. The harvested flax is left on site for biological degradation and drying for 4-6 weeks. During this time micro-organisms attack the flax and fibres become separated from each other and from the shaft. There are other technologies available for the separation of fibres such as swelling, but due to heavy odour the technology had been abandoned. The properties of fibres are strongly affected by the weather conditions during this ripening. After ripening the fibres are separated with mechanical techniques and then the short and long fibres are selected for processing.

2.4 Properties of Flax Fibre

Flax fibre, when compared to other natural fibres, has outstanding properties. The flax fibre has the highest pectin content and the lowest lignin content, which means the flax fibres are the finest and most flexible fibres. It is tensile, due to its high wax content and has high tensile strength and flexibility. The strength-flexibility diagram is almost flat for flax fibres and also a temperature increase up to as much as 80°C has almost no effect on the result. In the group of raffia fibres, flax can produce the thinnest fibre. Flax fibres have excellent hydroscopic properties. The higher water content increases the mechanical properties of flax. Flax fibres have excellent shape retention properties, which make them optimal for composites in the plastic industry.

2.5 Industrial Utilisation of Flax

In Hungary only *Hungaro-Len Ltd.* processes flax, since 1904. Since the elimination of Hungarian flax production, the factory uses Belgian and French raw material. The output of the applied wet process is 1,800 tonnes annually and its products are ropes and industrial yarns. The amount of end products is around 900 tonnes per year. The shorter fibres are used for string and yarn manufacturing in a semi-wet process - about 350 tonnes per year. The company sells 200-250 tonnes of product inside Hungary and the remainder is exported. The string and yarns are not only sold but are also woven and then sold for export.

In the *Department of Polymer and Textile Technology* of the *Budapest University of Technology and Economics* an R&D program is in progress related to the utilisation of flax fibres in the field of fibre-strengthened polymers. According to the latest results, flax fibre provides a much more stable mechanical performance than glass fibre. The main problem is the lack of homogeneity of flax fibres.

3 Reed

Nowadays, with environmental friendly technologies in focus, the utilisation of reed (*Phragmites communis)* is common and increasing, and it is likely that its use in architecture will soon be as much as it was a hundred years ago. There is a high demand, both outside and inside Hungary, for reed products.

Reed is an important part of the waterside ecosystem. Its harvesting is only possible in winter when the ice is strong enough to hold the harvesting machines. In Hungary, one reed company is *NÁD-KER Nádtermelő és Kereskedő Rt. (NÁD-KER Reed production and trading Inc.)* that is both the processor and the marketer of reed products. Its products are reed textiles, panels and roof products that are used for decoration, gardening, furniture and architectural purposes. Reed products are environmental friendly building materials. Reed is an excellent heat and noise insulator**,** and has a low weight. Nowadays, more and more house roofs are covered by reed. Reed products also have quality classes and only the best quality reed is suitable for roofing. [9] The amounts of reed harvested are shown in Table 12.

Table 12 —Amounts of Reed Harvested

	1980	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Harvested area (ha)	37676	8360	N/A	5928	5669	9526	12550	15851	18130	15798	21108	N/A	N/A	N/A
Total harvested production (sheaf)	204960	6441	4413	2587	2235	4499	3035	3596	6295	3248	4126	N/A	N/A	N/A
Yield (sheaf/ha)	5.440	0.770	N/A	0.436	0.394	0.472	0.242	0.227	0.347	0.206	0.195	N/A	N/A	N/A

4 Sorghum

In Hungary, the Sorghum- (*Sorghum dochna var. technicum)* made broom is a widely used industrial and outdoor cleaning tool. Sorghum is mostly cultivated in the south-eastern part of

Hungary. Sorghum tolerates a wide range of soils and is not sensitive to drought. It is harvested when the panicle is yellowish and the seeds are matured. For broom production, the panicles must first be dried. After harvesting the seeds are removed from the panicle and the panicles are bundled around a wooden stick. The harvested area and production are shown in Table 13.

Table 13 — Production of Sorghum

	1980	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Harvested area (ha)	3355	2384	N/A	2404	2176	2074	2385	831	1130	837	992	4214	3043	3273
Total harvested production (tonne)	8020	7264	7567	5370	3328	2529	4255	2523	2917	1731	3744	7858	6460	5496
Yield (tonnes/ha)	2.390	3.047	N/A	2.234	1.529	1.219	1.784	3.036	2.581	2.068	3.774	1.864	2.122	1.679

5 Wheat Straw Fibre

In Hungary the *Dunaújvárosi Cellulózgyár Kft. (Cellulose factory of Dunaújváros Ltd.)*, a subsidiary of *Dunapack Rt.,* produces cellulose from straw fibre. The pulp mill has operated under the current name since 1997 but straw pulp manufacturing in *Dunaújváros* at the paper and pulp plant has a forty-year history. The straw pulp mill started its operations in 1962. The activity is an example that wheat straw, produced as by product of cereal growing in Hungary, provides renewable raw materials for industrial activity in appropriate quantity and quality. In *Dunaújváros* the straw replaces wood fibre, which has environmental benefits - the protection of forests, and the resulting product also has multi-purpose uses.

The plant presently processes 50,000 tonnes of wheat straw and producing approximately 30,000 tonnes of cellulose, which is used for paper production (two thirds) and for food purposes (one third). At the plant most steam power is provided by the chemical regenerating boiler, where burning organic materials released from the straw generate heat, and chemical agents are retrieved. As a result, the product range has expanded to include bleached leafy pulp and bleached mixed pulp, in addition to bleached straw pulp. The products are used both by domestic and foreign paper mills and the export of special straw pulp manufactured for the production of additives for industries other than the paper industry continues to be significant.

6 Barriers to progress

6.1 Scientific barriers and research

Hemp breeding research is fairly strong in Hungary and some of the top quality Hungarian clones are used worldwide. Notable research Institutes are:

- *Fleischmann Rudolf Növénytermesztési Kutatóintézet* (*Szent István University*) located in Kompolt, where the hemp breeding research is carried out by Professor Iván Bócsa.
- *Tessedik Sámuel University* is active in hemp breeding research and other agrotechnical research.
- Some companies from the private sector are active in agrotechnical research connected to hemp. The Békés-based *Opligép Kft* conducts development of processing and harvesting machinery, while the Nagylak-based *Hungarohemp Kft* and the Szeged-based *Első Magyar Kenderfonó Kft.* are conducting research on processing. *Hungarohemp* is also active on the utilisation of hemp in the construction industry.

6.2 Technical barriers

The main barrier in terms of fibre crop production is the lack of harvesting and processing machinery capacity. The existing processing capacity is unable to fulfil the needs of improved production volumes. Currently the hemp processing companies are looking for new hemp fibre utilisation opportunities, such as the use of hemp as heat and noise insulation material, which would also require special processing machinery. In general, the traditional products are pushed out from the market by synthetic products and no processing capacity exists for the new hemp products.

6.3 Economic and market barriers

The main problem of the Hungarian fibre crop production is the lack of market information. No clearinghouse exists with up to date information on cultivation technologies, subsidies, buyer requirements and market prices. The export of the products is not organised. Until 1990 the Soviet Union was a great market place and a high fraction of the hemp and flax products were sold there. With the fall of the Soviet market most of the hemp producers have shifted to the cultivation of other industrial crops.

6.4 Legislation

The legislative issues in connection with hemp production are the lack of state and bilateral subsidies for the construction of modern hemp processing factories. Also the existing subsidy for hemp cultivation is low (33 Euros/hectare!) and there is no subsidy for processing. As a result, although South Hungary is ideal for hemp production and processing, cultivation is relatively small scale and the processing capacity is highly underdeveloped.

CARBOHYDRATE CROPS

In Hungary, several starch containing carbohydrate crops - such as maize, wheat, potato, rye, barley and oats - are being cultivated. Of these, maize and wheat are cultivated for non-food utilisation. The yields and amounts harvested of the main carbohydrate crops are shown above in Tables 6 and 7.

1 Maize

Maize is one of the most important food and feed crops in Hungary and it also has several other utilisation opportunities. In the past, maize has only been used as a raw material in spirit and starch manufacturing. Nowadays, maize utilisation has increased through the utilisation of maize germ oil and High Fructose Syrup (Isosugar) production. Maize-derived products are used in the food, medical, textile and paper industry.

1.1 Biological Properties

Maize is an annual, soft stalked plant with high temperature demand. For germination it requires 8-12°C but for faster and improved growing it requires 12-14°C. The composition of a typical maize seed is 77% starch, 2% sugar, 9% protein, 5% oil and 2% salt. The main differences in composition of different types are in the oil and protein content. For good yields maize requires a warm climate, high number of sunshine hours and moderate rain. Its highest demand for warmth is during May; for rain from June until August when the cobs are formed. The best results can be expected in the south of Hungary with watering, but maize is cultivated on almost 60% of the arable land in Hungary. Hybrid-type maize tolerates a range of soils, but for outstanding and secured yields good quality, humus-loaded, fertile soils are required.

1.2 Harvesting and Storage

Maize needs to be harvested when the water content of the seeds is in the range of 30-36%. If the water content is higher the starch content is too low, the drying becomes too expensive and the seed can break easily. If the water content is low, the seeds start to fall and high wastes can be observed, and the feed value of the stalk is reduced. Maize can be stored on the cobs, after removal from the cobs, after grinding or in a silo. In Hungary most of the maize is stored after removal from the cobs. The drying is important, as mentioned above for sunflowers and rapeseed. The best practice is drying until 14-15% water content. [6]

2 Wheat

Wheat is one of the most important cereals in the world and also in Hungary. Its food value can only be compared to rice. Wheat in Hungary is cultivated mainly for food purposes.

2.1 Biological Properties

The quality of wheat depends on the ratio of protein to starch; the higher the protein content the better the quality of the wheat. Yields are highly affected by climate and weather conditions. Irrigation is very important and droughts can have a dramatic effect on production. The climate of Hungary makes the country an ideal place for wheat production. The western parts have more rain so the yields are more stable, but the *Alföld* is warmer, which is appropriate for better quality. Wheat requires a good water supply and quality soils.

2.2 Harvesting and Storage

The wheat produced in Hungary can usually be harvested at the end of June until the first half of July. Before drying, wheat needs to be cleaned of stalk parts with the seeds. Usually for short-term storage, wheat is dried until 14-15% water content but for safe storage the wheat is dried to 0.5-1.5% water content. [6]

3 Starch Production and Utilisation

Starch production for non-food purposes in Hungary is approximately 32,000 tonnes per year. About 61% of this volume is used in the paper industry. The remaining amount is used in the medical industry, in the textile industry, as a flocculation agent and as glue in construction. For the production of flocculation agents a few tonnes a year of imported waxy starch is used.

3.1 Flocculation Agents

The *Department of Chemical Processes* at the *University of Veszprém* is currently conducting research to examine the opportunities for starch derived flocculation agent production. The raw material is waxy starch from Belgium and the yearly production is around 8-10 tonnes. Another research program is also on line, in co-operation between *Hydra Bt.* and *Nitrokémia 2000 Ltd*. The main goal is to develop an anionic flocculation agent and the formation of a cationic flocculation agent from starch.

3.2 Cyclodextrin

Cyclodextrin is a crystalline, water soluble, cyclic (α type) and non-reducing oligosaccharide that is built from 6-8 glucose molecules. Cyclodextrins can take up other molecules and bind them to the inside of the spiral and are used for the elimination of odour and taste materials and for the solubilisation of almost insoluble materials. These properties are well known, but the high price of cyclodextrin hampers industrial utilisation. However, due to recent developments in enzymatic processes the price of cyclodextrin has decreased and other utilisations are now emerging, such as the remediation of oil and PAH contaminated soils with cyclodextrin. [10] *Cyclolab Ltd.* is working on cyclodextrin research and also manufacturing special cyclodextrins. The laboratory was established in 1973 inside *Chinoin Inc.*, one of the biggest medical plants in Hungary. Currently there are 5 companies world-wide producing cyclodextrin in the volume of more than 1000 tonnes per year. As a pilot project Cyclolab has started the manufacture of the modified cyclodextrin. The raw material was purchased from their German partner.

4 Barriers to progress

Starch production in Hungary for non-food uses is approximately 32,000 tonnes per year. About 61% of this volume is utilised in the paper industry. The remaining amount is used in the medical industry, in the textile industry, as a flocculation agent and as glue in construction.

Research Institutes, such as the *Department of Chemical Processes at the* University of Veszprém and *Cyclolab Ltd.*, are working with waxy starch originating from Belgium or cyclodextrin originating from Germany. In general it can be stated that there is now only a low demand on non-food starch products, and if there is any it is imported from abroad.

SPECIALITY CROPS: HERBS, MEDICAL PLANTS AND WILD FRUITS

1 Science and Technology

The resurgence of interest in natural products which starting during the last decade shows every promise of continuing its rapid development in the 21st century. Herbal products, phytomedicines, healthcare remedies etc. are becoming mainstream in Europe and the USA. The sector is being driven by increased consumer demand and this steadily increasing market shows an opportunity for Hungarian producers.

Cultivation and processing of herbs and medicinal plants has been a successful sector of Hungarian agriculture in the 20th century. The traditional herbs and medicinal plants are cultivated on about 37,000–42,000 hectares with a yearly production of 35,000–45,000 tonnes. Because of many political and economic issues during transition to market, the safeguarding of the position of Hungary in this field has required every effort of the farms and processing industries. Development of an EU compatible regulation and subvention system of the sector, including harvesting, processing, production and marketing of raw materials, extracts and final herbal products is essential.

According to the Hungarian Pharmacopeia (VII. Ed.) and other regulations, 214 plant species are actually being sold. These represent approximately 180–200 domestic plant species. About 50–60% of these herbs are native to Hungary. The yearly domestic production of dried plant materials is 35,000–45,000 tonnes. About 75–80% of total production is cultivated. The main companies producing and processing medicinal plants are *Rózsahegyi Ltd.*, *Mezőprodukt Ltd.* and *Schmidt und Co*. In some cases the cultivation takes place in local gardens; these localities are not well known or cannot be registered. Regarding the amounts of collected medicinal plants only estimated data is available. The major companies engaged in buying up these collected plants are *Rózsahegyi Ltd., Schmidt und Co., Herbária Ltd.* and *Pusztadrog Ltd*. The most important medicinal plants either cultivated or collected from wild are listed in Table 14 and 15 respectively. About 120 plant species are collected resulting in 10,000–15,000 tonnes of dried plant material per annum. [11]

Table 14 — The most important cultivated medicinal plants (1996 - 2000)

Common name	Latin name	Acreage (ha)	Production (t)
Mustard	*Sinapis alba L., Brassica nigra L*	12,000 - 15,000	9,000 - 12,000
Caraway	*Carum carvi* L.	1,500 - 2,500	1,500 - 2,500
Fennel	*Foeniculum vulgare* Mill.	1,500 - 2000	1,200 - 1,500
Lady's thistle	*Silybum marianum* L.	1,500 - 2,000	1,200 - 1,300
Coriander	*Coriandrum sativum* L.	1,500 - 3,000	1,500 - 2,500
Anise	*Pimpinella anisum* L.	400 - 500	250 - 350
Dill	*Anethum graveolens* L.	400 - 500	350 - 500
Marjoram	*Majorana hortensis* L.	50 - 100	60 - 120
Lemon-balm	*Melissa officinalis* L.	200 - 250	200 - 300
Valerian	*Valeriana officinalis* L.	50 - 100	70 - 150
Chamomile	*Matricaria recutita* L.	250 - 400	150 - 250
Lovage	*Levisticum officinale* L.	40 - 60	35 - 50
Savory	*Satureja hortensis* L.	50 - 100	60 - 120
Thyme	*Thymus vulgaris* L.	40 - 60	40 - 60
Angelica	*Angelica archangelica* L.	40 - 60	45 - 65
Basil	*Ocimum basilicum* L.	50 - 100	60 - 120
Peppermint	*Mentha piperita* L.	50 - 100	35 - 70
Hollyhock	*Malva mauritania L.*	15 - 25	9 - 15
Lavender	*Lavandula angustifolia* L.	50 - 100	11 - 22
Marigold	*Calendula officinalis* L.	15 - 25	12 - 20

Table 15 — The most important collected medicinal plants (1996 - 2000)

Common name	Latin name	Production (t)
Hiprose	*Rosa canina* L.	200 – 250
Horsechestnut	*Aesculus hippocastanum* L.	350 – 500
Horsetail	*Equisetum arvense* L.	250 – 350
Nettle	*Urtica dioica* L.	250 – 350
Yarrow	*Achillea millefolium* L.	250 – 350

Golden rod	*Solidago gigantea* Ait.	100 – 150
Mistletoe	*Viscum album* L.	150 – 200
Elder (flower)	*Sambucus nigra* L.	100 – 150
Dandelion	*Taraxacum officinale* Weber	50 – 100
Linden	*Tilia cordata* Mill.	100 – 150
Liverwort	*Agrimonia eupatoria* L.	30 – 40
Wormwood	*Artemisia absinthium* L.	25 – 35
Greater celandine	*Chelidonium maius* L.	25 – 35
Hawthorn	*Crataegus laevigata* (Poir.) DC.	50 – 100
St. John's wart	*Hypericum perforatum* L.	50 – 100
Centaury	*Centaurium minus* Much.	150 – 200

2 Industrial Plants

Plants that are processed industrially by pharmaceutical firms are placed in the industrial category. The important crops of this group are listed below.

Ergot (*Claviceps purpurea* (Fr.) Tul) (*Secale cereale* L.) Ergot is produced in fields by inoculating the spikes of rye with a spore suspension of a parasitic fungus (*Claviceps purpurea*). The raw material, the ripe sclerotia is harvested about 6 to 8 weeks later. The ergot alkaloids are obtained by extraction.

Hullless Pumpkin seed (*Cucurbita pepo* L. subsp. Pepo convar. Pepo var. styriaca GREBENSC). Numerous cultivated varieties exist. Traditional use of the seeds and seed oil is in the prevention and treatment of chronic prostatic hypertrophy (enlargement of the prostate gland).

2.1 Processing

Herbs and medicinal plants can be used as fresh products (in the household), but in order to transport them over a longer distance and store them over a longer time they are dried for preservation purposes. Some plants require cleaning or washing before drying.

The majority of the plants are dried in the open air using basic solar dryers. Plants can also be dried under a roof with natural air ventilation, following harvesting. Herbs with low volatile contents are slowly dried by hot air in industrial dryers. Plants used commercially are available in whole, broken, chopped, rubbed or grinded form. Primary processing is usually carried out at farms and by the companies which harvest the plants.

Steam distillation to obtain essential oils from plant materials has been used for many years. In this extraction technique a packed bed of plant material is continuously flushed by steam. Volatile organic compounds in the plant material are taken up by the vapour phase. The compounds carried by the vapour stream are isolated by condensation and settle in a separator. As the density of essential oil differs from that of water, it either floats on the top or sinks to the bottom, where it can be drawn off.

Some plants have to be distilled immediately as they are harvested, for example melissa. Some plants are left in the field for a few days, so that surplus water in the plant can leave (e.g. lavender). Some other plants, like peppermint, can be totally dried before distillation. The annual distilled herb oil production is 80–100 tonnes.

Grinding of raw material to a specific particle size is the initial step of the process. The pre-treated plant material is put into water or some common organic solvents (e.g. hexane, ether, ethyl acetate, isopropanol or ethanol). At the end of a prescribed amount of time, after dissolution of the valuable components, the exhausted solid residue is filtered off. Following extraction, simple evaporation of the solvent is often sufficient to obtain the final product, but legislation requires the removal of organic solvents to a prescribed residual level. Vacuum is often applied. The type of solvent system used varies for different plants and determines the character of the extract. Resinoids are obtained with the application of hydrocarbons; absolutes are prepared with ethanol. In a double stage separation process the volatile fraction is removed by steam distillation prior to solvent extraction where the resinous fraction is recovered.

Recently, there has been increased interest in sub- and supercritical extraction that use carbon dioxide as a solvent. Thus far, this method has no commercial application in Hungary.

2.2 Market Opportunities

The market of crude drugs is changing and phytomedicines are becoming mainstream in Europe and America. Germany is the leader in herbal crude drug consumption, phytomedicines and healthcare remedies based on plant extracts. The Hungarian market of herbs and medicinal plants is limited.

Traditionally, the dried plants are supplied to the rural distributors and they export the raw material to foreign countries. The processing is carried out in these countries. Recently the situation has somewhat changed. Farmers are often in direct contact with importers and processor companies. However, this requires people skilled in foreign business, who are often not available at the small farms. Some foreign organic farming companies rent fields in Hungary and cultivate the plants by their own technology, because they want to control the entire route of the plant from farming to the finished products.

About 15,000 tonnes of crude drugs are exported from Hungary. The most relevant plants are listed in Table 16. Half of this quantity is oriented to Germany. Other important importer countries are Austria, The Netherlands, Switzerland and Italy. Competition between the Eastern European and former Soviet Union countries including Poland, Bulgaria, Romania, Albania and Ukraine has resulted in stagnancy or a decrease in prices. Producers from other regions, particularly from Egypt, Israel, Morocco and China have heavily increased the oversupply. [12], [13]

Table 16 - Quality drugs from medicinal plants exported in relatively large amounts (1996-2000)

Common name	Latin name	Exported (t/year)
Mustard	*Sinapis alba L., Brassica nigra L.*	3800-6500
Caraway	*Carum carvi L.*	270-1950
Coriander	*Coriandrum sativum L.*	600-1620
Fennel	*Foeniculum vulgare Mill.*	150-340
Anise	*Pimpinella anisum L.*	100-160
Chamomile	*Matricaria recutita L.*	50-170
Hiprose	*Rosa canina L.*	50-100

Nettle	*Urtica dioica L.*	50-100
Marjoram	*Majorana hortensis L.*	50-100
Horsechesnut	*Aesculus hippocastanum L.*	50-100

The imported amount of plants cultivated in Hungary are insignificant (e.g. 10-50 tonnes of caraway, 5-20 tonnes of fennel, 5-20 tonnes of coriander etc.). Plants cultivated in tropical areas or in Asia are imported in remarkable quantities (the sum of ginseng, cinchone, senna and ipecacuana imported is 20-130 tonnes per annum).

Pharmaceutical products containing plants or plant extracts exist in great variety. However, the regulatory status of these products is confused. The following categories can be specified:

- OTC (over–the–counter) drugs, proven to be safe and effective, sold in pharmacies;
- Herbal remedies – as intermediary category – (herbal preparations with pharmaceutical action, not classified as medicine) until January 2004. Sold in pharmacies, drugstores and chemist's;
- Herbs, teas, health foods, food supplements, nutritional products, etc. labelled only with the name of the plants, sold in food and health food stores.

According to the Hungarian Ph. Hg. VII., 71 vegetable drugs, 16 essential oils and 8 waxes are official. 8 vegetable drugs are strong ('mite') and 63 vegetable drugs are moderated strength according to the strength of the effects of the medical plants. In a ministerial decree of the Ministry of Internal Trade, 214 freely distributed medical plants and 51 essential oils are listed. Other simple recipes of products containing medical plants (3 tea-mixtures, 3 spirits, 4 syrups, and 18 tinctures) have been stated in the Ph. Hg. VII.

3 Barriers to progress

3.1 Scientific barriers and research

The scientific research of medical plants, herbs and spices is mainly carried out in Research Institutes and Universities across Hungary. In the centre of this is a federation: the *Association and*

Product Board of Herbs, which has members[2] including independent farmers, cultivation producers, buying up companies, processing industries and the research Institutes and departments of Universities.

The *Research Institute for Medical Plants* is located in *Budakalász*. Its main research activities include breeding and maintenance of cultivars and agrotechnical developments. Other main tasks of the Institute are qualification and controlling during the procedures of collection and primary processing. They have been responsible for the high level of education about medicinal plants and herbs for the collectors, suppliers, laboratory assistants and shopkeepers.

Two Institutes of the *Hungarian Academy of Sciences* have carried out research work in the field of medical plants and herbs. The main fields of research at the *Institute of Ecology and Botany* (*Vácrátót*) are theoretical, basic and applied research in certain fields of ecology, botany and hydrobiology, such as the organisation and dynamics of terrestrial plant communities and populations. Work also includes hydrological research in streams and lakes, conservation biology, basic research for the protection of nature and new plant resources and their utilisation. The Institute is also in charge of the *Vácrátót Botanical Gardens* and acts as the *Ecological Centre* of four other research Institutes of the *Hungarian Academy of Sciences* engaged in long-term ecological research.

The *Plant Protection Institute* of the *Hungarian Academy of Sciences (Budapest)* handles basic research in the fields of plant patho-physiology, physiological and molecular aspects of plant disease resistance, biotechnology, taxonomy of insects, insect physiology, insect ecology and ecotoxicology and the chemical aspects of pest control.

The *Department of Pharmacognosy* at the *Semmelweis University, Faculty of Pharmacy (Budapest)* has an important role. Highly qualified pharmacists have been educated here since 1914. The Institute has great influence on the research and development of medical plants and herbs, as demonstrated by the range of patents and scientific publications. Some research work has been supported by funds of PHARE and DAAD. The main research areas are:

- Analysis of medical plants, extracts, medical products; standardisation of medical plants.

[2] For the list of members please visit: **http://www.kertnet.hu/HungarianHorticulture/gb/112s.htm**

- Studies on negative selection of hemp and the application of genetic modifications.
- Chemistry of natural antioxidants and the analysis of antioxidant activity of herbs.
- In the fields of biotechnology, research is carried out in cell and tissue cultures and their fermentation and the production of transgenic plants for processing secondary metabolites. Research and development work has been carried out with pharmaceutical factories and laboratories.

The *Department of Pharmacognosy* at the *University of Szeged, Faculty of Pharmacy* has also played a major role in research into natural organic compounds for almost 50 years. The Institute has achieved its scientific results in collaboration with international, regional and national research groups. Research topics include:

- Isolation of biologically active compounds from plants or other natural sources and their chemical characterisation.
- Elaboration of new methods for the isolation and the rapid quantitative and/or qualitative characterisation of natural compounds.
- Development of new healing/therapeutic products from plants and other natural sources.
- Chemotaxonomic evaluation of various plant taxa.
- Chemical investigation of plant narcotics and psycho tropic substances.

The isolation and structure elucidation work on various natural compounds at the Institute involves: mono-, sesqui-, di- and triterpenoids, steroids (Lamiaceae, Euphorbiaceae, Asteraceae, Celastraceae, Caryophyllaceae, Schrophulariaceae etc.); alkaloids (Rutaceae, Papaveraceae, Celastraceae); and phenolics (Rutaceae, Lamiaceae, Fabaceae, etc.).

At the *Szent István University, Faculty of Horticulture* at the *Department of Medical and Aromatic Plants (Budapest)* much research has been achieved in the field of wild growing medical plants and collection as well as in the field of cultivated medical plants and production. The main research activities are:

- Gene reservation and introduction.
- Breeding and maintenance of cultivars.
- Agrotechnical development.

- Analytical and chemical investigations.

At the *Budapest University of Technology and Economics, Faculty of Chemical Engineering* at the *Department of Chemical Engineering*, important research has been carried out into a newly developed technology (supercritical fluid extraction), for the extraction of biological active compounds from medical plants and spices. The research group has worked on the development of the applications of supercritical fluids since 1986. The main research activities are:

- Extraction of volatile oils from herbs and spices.
- Extraction of fats and oils (from raw materials originated from plants and animals).
- Separation of volatile oils and fatty oils.
- Isolation of non-volatile terpenoids (sesqui-, di-, tri- and tetraterpenoids).

At the *Eötvös Loránd University, Faculty of Science, Institute of Biology,* the *Department of Plant Anatomy (Budapest)* scientific results in the field of medical plants have been achieved. Their main research topics are:

- Production and biotransformation of secondary products in callus- and cell cultures of medicinal plants.
- Plant cell fermentation.
- Establishment of new endosymbioses between nitrogen fixing prokaryotes and plants.
- Development, structure and function of plastids under experimental conditions.
- Plant secretory cells- and tissues.
- Structural investigations in the early stages of embryogenesis: isolation of germ cells and artificial fertilisation.

At the *University of Pécs, Institute of Biology, Department of Plant Physiology* the following research topics has been studied:

- Revelation of special plant metabolites (exp: alkaloids, phenoloids, terpenoids, cianogenic glycosides) by the mean of TLC and densitometry.

- Study on the dynamic of CAM-taxons.
- Other chemical and phytochemical investigations and analytical methods.

They have collaborated with the *Plant Biology Institute of Szeged Biology Centre of Hungarian Academy of Sciences* in the research of the bioactive plant metabolites.

Investigations in the field of medical plants are taken part at the *University of West Hungary, Faculty of Agricultural and Food Sciences at the Department of Medical and Aromatic Plants (Győr).* The main research programme is the developing of production technology of medical and aromatic plants and energy crops.

Also R&D activities are carried out at the pharmaceutical factories (*Richter Rt., Egis Rt., ICN Alkaloida Ltd.*) and at the small enterprises, but the main and important research work has been managed by the research groups, Institutes, and Universities mentioned above.

3.2 Technical barriers

In the case of collected medical plants, only small amounts of plants are produced and so mechanisation would be non-sense. In the cases of small farms, greenhouses and local producers, mechanisation is not required especially in the cases of sensitive and small seeded plants (e.g. mint, lemon balm). Much higher quality can be achieved by hand harvesting. In larger fields (in the cases of fennel, mustard) the mechanisation is inevitable especially for sowing and harvesting. With the use of machines higher productivity can be achieved, although the initial investment is higher. For harvesting medical plants, special machines are available. Modernisation is strongly required as much as in the other sectors of Hungarian agriculture.

3.3 Legislative barriers

Herbs and medical plants must meet the standards set by the Hungarian legislation. *The National Research Institute for Medical Plants* has been responsible for qualification and controlling during the procedures of collection and primary processing. Herbs used for herb-tea mixtures have to be licensed by the same organisation. The *National Institute for Food and Nutrition* (OÉTI) has been responsible for the labelling of nutraceuticals and natural products, which contain medical plants and/or the extracts of medical plants or spices, but these products are not pharmaceuticals. The *National Pharmaceutical Institute* (OGYI) has carried out the qualifications and controlling of pharmaceuticals. The regulation procedures must be carried out for all the imported products. Throughout the authorisation, the Institute has applied all the official and world-wide utilised pharmacopeias (exp.: Ph. Hg. VII., Ph.Eur., DAB 9.), the national standards (MSZ) and the accepted forms of the quality insurance of pharmaceutical products.

3.4 Economic barriers

For Hungarian farmers who have grown medical plants and herbs it is not easy to compete with the Western European and world market, although the quality and also the quantity of some species are much superior than in the other supplier countries. The low price of the labour intensive production can be a successful field of business. Some Hungarian herbs and medical plants (e.g. camomile, fennel, caraway) are still well priced on the market according to their fame and quality.

According to the environmental regulations the collection of medical plants and herbs in protected areas can endanger the natural wildlife. Endangered plants should be cultivated under control with the utilisation of gene banks.

4 Prioritisation

The utilisation of the regional natural plant flora based on the collection, processing and selling of camomile (*Matricaria recutita*) is a well-known example all over Europe. Since the beginning of the century the Hungarian camomile has became famous and is called "Hungaricum", which characterises a crude drug with outstanding quality. These high qualities can be attributed to unique ecological conditions of the arable land. In the cases of rosehip (*Rosa canina*), elder flower (*Sambucus nigra*) and other traditional Hungarian herbals, the processing industry has also settled near the areas of collection and cultivation. Some specified areas in Hungary are cultivated with characteristic medical plants and spices, so the high quality and quantity is easily achieved. Also the good soil and weather conditions are favourable in regard to the contents of valuable compounds.

Unfortunately, the heavy usage of artificial fertiliser in the past still has an effect on the environment and is required to be fully cleaned up. According to the growing interest in natural and fertiliser-free products, herbs and spices, farmers and producers are inclined to convert to biofarms (organic production), avoiding artificial fertilisers and the use of other chemicals. More and more organic farms cultivate medicinal plants and herbs with higher quality but less productivity. The production, usage and the commerce of medicinal plants and herbs are being regulated by quality insurance (accredited farms, technologies, laboratories, industries).

Efficient production also depends on information, know-how and research activities. Recently, the education and research have become well understood and the industry (farmers, producers, consumers and researchers) is able to handle the difficulties. As the society knows the value of the Hungarian medical plants and herbs research has been carried out, continuously producing new results in the scientific world. The main retarding factor is the lack of funds and enough governmental financial assistance.

5 Medical Plants

5.1 Poppy

In Hungary the poppy *(Papaver somniferum L.)* seeds are used as traditional food products, and only the industrially cultivated poppy capsules head is used for medical morphine production. Depending on the weather conditions the yield of poppy strongly varyies between 0.6-1.8 tonnes of poppy capsules per hectares. The production of dry poppy capsules in Hungary is about 8,000–10,000 tonnes annually. For production, special permission and continuous guarding are required.

Poppy production is human labour intensive and needs good quality soils. Poppy is sensitive to pesticides so cultivation requires special knowledge and attention. The *ICN Hungary Inc.* (a subsidiary of *ICN Pharmaceuticals Inc.*) is the exclusive producer of the morphine and morphine-derived medicines and psychotropic chemicals. *ICN* is also one of the few companies that produces these materials. 10% of the medical morphine used world-wide and 30% of the morphine used in Europe is produced at *ICN Tiszavasvári*. For securing the supply the company has signed long-term contracts with the farmers and also provides the seeds and the technology for the farmers. ICN has acquired the *Alkaloida* plant in 1996. The plant has the capacity for more than 300 tonnes of morphine production annually. After non-professional cultivation problems and unfortunate weather seasons *ICN* has started to reorganise the poppy capsule production. In two years time, *ICN* paid 70% more for poppy capsules, in order to maintain the production and to establish good conditions for farmers. In 2000 the *Magyarországi Máktermelők Szövetsége (Hungarian Union of Poppy Producers)* entered into a long-term contract with ICN to reformulate the poppy production and to integrate the poppy producers on 5,600 hectares. The production of poppy is securely controlled due to the capsules' drug content. The Ministry of Health, the Ministry of Internal Affairs and the Ministry of Agriculture and Regional Development strictly control both the cultivation and the production of poppy. The UNESCO's anti drug office also has controlling and supervising rights on the cultivation of poppy and the manufacture of morphine. [14]

6 Botanical pesticides and insecticides

The structure of Hungarian agriculture has changed considerably since the political change. Now private farms are dominant and the majority of these are very small. Co-operatives have a vastly reduced role. This change highly influences the approach of solving environmental problems. Farmers are increasingly aware of environmental consideration, but they have to maintain financial progress.

Organic farming (farming without manufactured chemicals) is steadily growing in the country. In organic farming the farms use only natural materials in the protection against diseases and insects. Historically, producers have realised that some plants produce chemicals such as alkaloids, fenols and terpenoids for their own protection that can also be used as natural pesticides.

Plant oils like rapeseed oil are effective in enhancing the effect of other plant production chemicals and this is used in tobacco farming to inhibit the growth of side stalks. Sunflower seed oil is used in the insecticides *Vegesol* and *Biona*. Some types of sunflower produce insecticide citotoxins named sesquitepene-lactons. Since the 17th century it has been known that the juice squeezed out of the tobacco leaf could be used effectively against insects. Some other plants like *Alangium spp.* (Alnginaeae), *Asclepias syrica* (Asclepiadaceae), *Anabasis apylla* (Chenopodiaceae), *Duboisia spp*, *Nicotiana spp.,* (Solanaceae), *Equisetum arense* (Equisetacae), *Sedum acre* (Crassulaceae), *Spartium junceum* (Fabacae), *Virola calophylla* (Myrtacae), *Zinna elegans, Zolliferia aliquinsis* (Asteracae) could also be used as insecticides, because of their nicotine content. A chemical named

Fito-Insect is a product made out of *Artemista vulgaris* (Asteracae) and is used with good results against plant lice. The nortritepenoid containing plants like *Brucea amarissima*, *Quassia africana*, *Quassima amara*, *Soulamea tomentosa*, *Picrusma spp. (Simbarubaceae)* have also been used as anti-insect chemicals since the 1800's. Some other plant species have also been used in the past for the production of insecticides.

7 Wild Fruits

7.1 Elder

Nowadays more and more wild fruits are cultivated on farms. Within these fruits black elder or elderberry is cultivated in the highest amount. The utilisation of black elder began for its natural ink content, but in the past few years there have been other utilisations. Black elder is cultivated on approximately 750 hectares. In 1977 black elder farming began to satisfy the export needs of 30,000-40,000 tonnes per year. Originally the fruit was used, but later harvested elder flower and oil derived from elder-seed were also reported. At the beginning of the cultivation tests a few elder types were used at the *Fertődi Gyümölcstermesztési Kutató Institute (Research Institute for Fruit Production, Fertőd)* in co-operation with an institute in *Klostenburg*. During the test the researchers chose the Haschberg elder type. This type has very positive properties such as high yields and big fruits, which do not fall down after maturity as for the wild types. This type of elder flowers relatively late so the late subzero temperatures which are common cannot destroy the fruits. As a result of the large fruit, hand harvesting is also much more effective than for wild types. The research conducted at the *Department of Fruit Plants and Canning Technologies* at the *Szent István University* will have a huge effect on the current elder production. The research has focused on the suitable cultivation and processing technologies in the Hungarian conditions. After the formation of the *Elder Producers Selling Union* in 1998, the industrial processing of elder food products has started. The flower of elder is collected by hand in May and the fruit is collected in early August, but the fruits are best for liquid pressing in September.

The flower of elder has about 0.03-0.14% oil content, which is extracted with steam distillation. The distilled middle product is butter-type material, due to the high palmitin acid (66%) and n-alkane content (C_{14-31}, 7.2%). When the extraction process is boosted by ether-extraction the oil yield could reach up to 32%.

Elder fruit processing is dependent on the goal. In the case of liquid production the fruit is first washed and rendered. The rendered product is treated with pectinase enzyme for about 10 hours and than the rendered product is pressed.

The active materials in the flower oil are flavonoid types and P-vitamin improvers. These kinds of materials are good for the increased flexibility of blood vessels. Due to this effect the micro-circulation of dermal tissue is increased. The active materials in the elder fruits are flavonoid-glikozids, rutin, izokvercitrin and hiperozid, the tanning agent content is more than 3%. The AHA acid content (alfa-hidroxy acid) content of the fruit is also high and could reach 1%. The antocianin content that colours the fruit is a problem in the cosmetic industry. Also a white type of elder is known that has even higher vitamin-C content than the black type, but contains no antocianin. During the processing of elder the seeds arise as a by-product. The oil pressed from the seeds has an unwanted odour and colour, so before utilisation for cosmetic or food purposes it must be cleaned. The elder seed oil is rich in linoleic acid and alfa linolenic acid and these two components together can reach 78% of the oil. Both fatty acids have important cosmetic, industrial and food industrial utilisation. In cosmetic products these fatty acids can eliminate the trans-membrane water losses. Also A and G type tokoferol can be measured in elder seed oil.

7.2 Other Wild Fruits

In the pharmacy of nature the various plant species are well known to primitive societies. The modern man has almost forgotten these medicines, but nowadays it seems that each and every plant contains biologically active substances. As a result of scientific verification more and more people heal themselves with natural medicines. Some of the wild type herbs contain higher amounts of antioxidants like vitamin-C or colouring agents like xanthophylls, antocyanin and karotin than other industrial plants. These substances may have a very positive effect both on the immune system and on the whole body.

Mulberry (*Morus alba, nigra*): This tree provides the only feeding material for the silk worm. Its' fruits, due to their high sugar content, are commonly used for spirit manufacturing.

Sorb tree (*Aronia melanocarpa and arbutifolia*): The plant is native in North America. In Europe it is widespread as a decorative garden plant. Its fruits have high antocyanin content that could be used as a natural pigment. The food utilisation is also important. Yield varies in the range of 8-11 tonnes per year. In Hungary the industrially-utilised area is about 15-20 hectares.

Hawthorn species (*Crataegus monogyna, oxyacantha, orientalis, lavellei*): A native plant in Hungary. It tolerates a wide range of soils. The fruit have a high pectin, flavon and protein content. It is not grown at an industrial scale. The most important form of utilisation is in herbal tea production.

Sea Buckthorn (*Hipophae rhamnoides*): Fruits of this shrub are a source of immuno-stimulants. Its oils are used for medical treatment of burns. Its vitamin-C content is outstanding and is used for natural pigment production. In Hungary it is mainly utilised by the food industry. Sea Buckthorn is cultivated on more than 30 hectares.

Cornel (*Cornus mas*): A native plant to Hungary. Cornel has a high vitamin-C content and carotin content. Mainly utilised by the food industry.

Rose taxa (*R. canina, rugosa, pomifera*): The plant supplies a valuable and important product, rich in vitamin-C (more than 2000mg per kg). Its fruits are also rich in oils, nutrients and pectin. In Hungary fruits of the various rose taxa are collected in the annual amount of 900-1000 tonnes per year. The industrially cultivated area is around 10-15 hectares.

Blackthorn (*Prunus spinosa*): Blackthorn is a native plant to Hungary. Its flower and fruit are gathered for food purposes. It has an immune stimulant effect and is also rich in pectin.

REFERENCES

[1] **http://www.ksh.hu/pls/ksh/docs/** (statisztika)

[2] Statistical Yearbook of Agriculture 2002 (Hungarian Central Statistical Office, Budapest, 2004)

[3] **http://www.gak.hu/fm/** (ált. jellemzés)

[4] **http://www.kertnet.hu/HungarianHorticulture/gb/3fr.htm**

[5] Bacsó Nándor: Magyarország éghajlata (Akadémiai Kiadó, Budapest, 1959)

[6] **http://omega.kee.hu/mzg/** (növények jellemzése)

[7] Farkas Károly: Len-, kender- és jutaipari ismeretek (Táncsics kiadó, Budapest, 1964)

[8] **http://www.kenderfono.hu**

[9] **http://www.nadker.hu**

[10] **http://www.cyclolab.hu**

[11] Bernáth J., Németh É.: Traditions and contemporary efforts in developing the medicinal and aromatic plant sector of Hungary, Hungarian Agricultural Research, 3, 20-25 (1998)

[12] Bernáth J.: Production and marketing of medicinal and aromatic plants (in Hungarian), International Journal of Horticultural Science, 6 (2), 63-75 (2000)

[13] Németh É., Bernáth J.: Anbau und Markt von Arznei- und Gewürzpflanzen in Ungarn, Z. Arzn. Gew. Pfl., 6, 103-108 (2001)

[14] **http://www.icn.hu**

ANNEX 2

CONTACTS

	Company / Institute	Town	Address	Postal code	Contact person	Phone	E-mail	Main activities
1	BUTE Dept. of Agricultural Chemical Technology	Budapest	Gellért tér 4	1111	Kati Reczey	36-1-463-2843	Kati_Reczey@mkt.bme.hu	IENICA activities, research in the pulp and paper industry and in
2	Magyar Bio Ltd.	Százhalombatta	Vörösmarty u. 68.	2440	Tamás Gatai	36-23-356-588	gatairt@mail.battanet.hu	Biolubricant processing, utilisation of glycerin from biodiesel process
3	BUTE Dept. of Polymer Eng. and Textile Technology	Budapest	Műegyetem rkp 3, T ép. III.33.	1111	Tibor Cigány	36-1-463-2003	cigany@eik.bme.hu	Research in biopolymer production from fibre crops
4	Első Magyar Kenderfonó Kft.	Szeged	Pf. 89.	6724	Tibor Tóth	36-62-487-287	tothexport@kenderfono.hu	Hemp cultivation fibre processing
5	Agrohemp Ltd.	Algyő	Téglás út 98.	6750	Antal György	36-62-267-086		Research and cultivation of hemp
6	Hungaro-Len Ltd.	Komárom	Igmándi út 45.	2900	Sándor Nagy	36-34-540-751	nagy.hulen@axelero.hu	Flax fibre processing, selling
7	Tessedik Sámuel College, Fac. Of Agric. Water and Env.	Szarvas	Szabadság út 1-3.	5540	Ildikó Iványi	36-66-313-311	ivanyi@wem.date.hu	Production of fibre crops
8	DNS Group	Budapest	Gervay utca 77	1147	Szabolcsi Miklós	36-1-363-0194		Hemp cultivation, hemp products, applied arts
9	HUNGAROHEMP Kenderipari és Logisztikai Rt	Nagylak	Gyár u.1	6933	Tóth György	36-62-515-616	toth.hungarohemp@vnet.hu	Hemp production, processing, rope products
10	NÁD-KER Nádtermelő és Kereskedő Rt.	Dinnyés	Pákozdi út	2485		36-22-357-557		Reed products
11	Dunaújvárosi Cellulózgyár Kft.	Dunaújváros	Papírgyári út 42-46.	2400		36-25-283-200	kovacsj@dunapack.hu	Utilization of straw fiber
12	Cyclolab Ltd.	Budapest	Pf. 435	1525	Lajos Szente	36-1-347-6075	cyclolab@cyclolab.hu	Research in cyclodextrin production and applications
13	University of Veszprem, Dept. of Chemical Engineering	Veszprém	Pf. 158	8200	Judit Dencs	36-88-422-022	dencsj@almos.vein.hu	Flocculants from starch
14	BUTE Dept. of Chemical Processes	Budapest	Műegyetem rakpart 3	1111	Béla Simándi	36-1-463-1490	simandi.vmt@chem.bme.hu	Herb and spice extraction

	Company / Institute	Town	Address	Postal code	Contact person	Phone	E-mail	Main activities
15	Rózsahegyi Kft.	Erdőkertes	Gyümölcsöskert utca 1.	2113	Gábor Rózsahegyi	36-30-486-122		Dried drug plants and spices
16	Schmidt és Tsa. Kft.	Baksa	Pf.: 3.	7834	József Schmidt	36-72-372-012		Dried drug plants and spices
17	Herbária Rt.	Budapest	Dózsa György út 144	1134		36-1-350-2074	herbaria@vherbaria.hu	Dried herb products and trading
18	Pusztadrog Kft.	Balmazújváros	Kodály Zoltán u. 1.	4060	István Jókai	36-52-377-218		Herb products
19	Agroherba Kft.	Herencsény	Pf.: 3.	2677	Lajos Praszna	36-35-357-159		Dried drug plants and spices
20	BOTESZ Elderberry Cooperation	Vál	Vajda János u. 12.	2473	György Csizmadia	36-22-353-469	botesz@botesz.hu	Elderberry processing, selling, research in elderberry non-food
21	Szent István University Department of Fruit Production	Budapest	Villányi út 27.	1114	János Papp	36-1-372-6285	gyum@hoya.kee.hu	Elderberry application research
22	ICN Alkaloida	Tiszavasvári	Kabay János út 29.	4440	Horváth Tibor	36-42-27-5511	thorvath@icnpharm.com	Medicines from poppy

PLANT OIL PRODUCERS

	Company / Institute	Town	Address	Postal code	Contact person	Phone	E-mail	Main activities	Annual processing capacity
1	Amygdalin Kft.	Keszthely	Herman Ottó u.16.	8360	Imre Pozsgai	36-83-310-055		Mandel, borago, calendula, poppy	3
2	BIO-OLAJ TRADING Rt.	Bakonszeg	Hunyadi u. 81/b	4164	Mihály Takács	36-54-469-101		Pumpkin, calendula, tomato seed, pepper, grape, poppy, saffron,	3
3	NATUROL Kft.	Kunhegyes	Arany János u. 77.	5340	Endre Végső	36-59-326-984		Sunflower, rape, pumpkin	5
4	SOLIO Rt.	Fadd	Mátyás király u. 29.	7133	Gábor Palcsó	36-74-546-000		Sunflower,rape, flax ,pumpkin	5
5	REBIOL Kft.	Nemesvámos	Kossuth u. 20	8248	Ferenc Takács	36-88-265-330		Sunflower	3
6	BOLIO Kft	Bóly	Park u. 36.	7754	Zsolt Majer			Sunflower, rape, flax, pumpkin, maize kernel, wheatgerm, sesam	2
7	ANNUUS Étolaj Bt.	Kaba	Cukorgyári lakótelep	4183	Imre Kotsis	36-30-928-9710	annuus@matavnet.hu	Sunflower, saffron, rape, poopy	3
8	Laboda József	Heves	Batthány u. 57.	3360	József Laboda	36-36-345-469		Sunflower	3
9	Oleum Europe	Egerág	Pozsony u. 62.	7763	Jenő Kiss	36-72-376-306		Sunflower, pumpkin, rape	3
10	Agrobotanical Institute	Tápiószele	Külsőmező	2766		36-53-380-016	lholly@agrobot.rcat.hu	Introduction of new non-food crops	N/A