

# IENICA

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

**Forming Part of the IENICA-INFORM Project**

## **REPORT FROM THE STATE OF LITHUANIA**



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# CONTENTS

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Methodology	5
Executive summary	6
<b>General Information</b>	<b>8</b>
<b>Oil Crops</b>	<b>10</b>
1 Opportunities	
1.1 Science and Technology	10
1.2 Industry	13
1.3 Markets	15
1.4 Environment	15
2 Barriers to Progress	
2.1 Scientific and Technical	16
2.2 Environmental	16
2.3 Legislative	16
2.4 Economic	17
3 Prioritisation	17
<b>Fibre Crops</b>	<b>18</b>
1 Opportunities	
1.1 Science and Technology	18
1.2 Industry	21
1.3 Markets	23
1.4 Environment	23
2 Barriers to Progress	
2.1 Scientific and Technical	24
2.2 Environmental	24
2.3 Legislative	24
2.4 Economic	25
3 Prioritisation	25
<b>Carbohydrate Crops</b>	<b>26</b>
1 Opportunities	
1.1 Science and Technology	26
1.2 Industry	28
1.3 Markets	30
1.4 Environment	31

2 Barriers to Progress		
2.1 Scientific and Technical		31
2.2 Environment		31
2.3 Legislative		31
2.4 Economic		32
3 Prioritisation		32
<b>Specialist Crops</b>		<b>33</b>
1 Opportunities		
1.1 Science and Technology		33
1.2 Industry		37
1.3 Markets		38
1.4 Environment		38
2 Barriers to Progress		
2.1 Scientific, Technical and Economic		39
2.2 Legislative		39
3 Prioritisation		39
<b><u>Annexes</u></b>		
Annex 1	Crop area in all farms 1994-2003	40
Annex 2	Total crop yield in all farms 1980-2002	41
Annex 3	Areas and yields of current industrial crops 1980-2003	43
Annex 4	Key contacts	44
Annex 5	Bibliography	46
<b><u>Tables</u></b>		
Table 1	Area with rapeseed in Lithuania 1996-2003	10
Table 2	Yield and fat content of linseed varieties	11
Table 3	Area and yields of flax in Lithuania	18
Table 4	Production of starch in Lithuania	29
Table 5	Caraway area in Lithuania	33

# METHODOLOGY

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Three steps were undertaken in the research phase. First, relevant literature sources, websites and statistical data on land use, crop and industrial production were collected and analysed. Second, the legal acts and orders of the ministers were studied. Finally, telephone or personal consultations with relevant people from agriculture, industry, research, advisory services and decision-makers were conducted in order to identify the main areas of non-food crop application, current industrial uses and future prospects.

Statistical data on non-food crops were rarely available on an adequate level to characterise activities in detail. None of the methods applied provided comprehensive information on non-food industrial crop uses and prospects. In some cases, the authors of this report made judgements or estimations themselves.

Key information was gathered from:

- Department of Statistics of the Republic of Lithuania
- Lithuanian Agricultural Advisory Service
- Lithuanian Chamber of Agriculture
- Ministry of Agriculture
- Lithuanian Institute of Agricultural Economics
- State owned and private companies
- Researchers from Kaunas University of Technology, Lithuanian University of Agriculture, research institutes

The report was prepared at the Group for Information Technologies of the Lithuanian Institute of Agriculture, under the guidance of Dr. Sigitas LAZAUSKAS. Dr. Z. Jankauskiene, Dr. A. Endriukaitis (Upyte experimental station) and Dr. A. Kryzeviciene (Grassland Husbandry Department of LIA) provided the main information on fibre crops. M Paliulis (Institute of Agricultural Economics) provided information on biofuel development issues.

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## EXECUTIVE SUMMARY

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Lithuania's mild climatic conditions are suitable for dairy and meat production, horticulture and arable crops typical of the country's latitude. The main arable crops in Lithuania are cereals, oilseed rape, potato, sugar beet, flax and fodder crops. Agriculture and processing industries concentrate on food, fodder and seed production. The textile, starch, alcohol, sugar and pharmacy sectors are well established.

Oilseed rape is the largest oil crop in Lithuania with relatively short traditions of growing for oil. The area under oilseed rape in 2003 was 66,800 hectares. Production is for edible oil and exports. Only a few hundred tonnes were processed domestically for biodiesel. Recently, processing capacities have been constructed and biodiesel can be produced in significant amounts, if the economic environment is favourable. Flax seeds were traditionally used in Lithuania for a wide range of applications. Growing true linseed was started in Lithuania in 1995. The area is limited to a few hundred hectares (400ha in 2003), with production used for linseed oil preparations for wood impregnation, cosmetics and pharmacy. This crop has good prospects for development in Lithuania. Castor, poppy, safflower, soya, garden cress and mustards were investigated and gave some positive results, but wider commercial use of these crops in the near future is doubtful.

Flax is a traditional crop in Lithuania. The area under fibre flax in 2003 was 9,000 hectares. The annual flax long fibre demand is about 6,000-7,000 tonnes. Linen thread is used in the following way: 55% for weaving of fabric for clothing industries; 20% for furniture upholstery; 15% for household use (tablecloths, table-napkins, towels, sheets, curtains etc.); 10% for other technical needs (packaging materials etc.). Factories use by-products in different ways (produce and market insulation material, shives briquettes for heating, etc.). The market for flax as a raw material for cellulose will most likely remain limited, because of cheap wood raw material.

Willow (*Salix*) is grown as plant for wickerwork on a dozen hectares.

Carbohydrates are the largest group which covers the major arable crops: wheat, barley, sugar beet and potatoes. Grain and potatoes are used in spirits; potato – for starch; sugar beet – for

sugar production. The potato starch industry, with a production capacity of 8,500 tonnes per year, is underused at the moment. More than half of starch production is used in non-food industries (mainly cardboard, paper and textile production). Grain is considered an important potential source for biofuel (ethanol) production.

Specialist crops occupy a very limited percentage of the total agricultural land, but have a large potential for development in economic terms. A variety of species grown in Lithuania have medicinal and aromatic properties, and potentially can be of interest for the domestic and foreign markets. In 2001 there were 214 growers with a total area of 3125 ha under the medicinal and etheric plants (mentha, caraway, etc.) and 45 growers with crops such as tobacco, hops - a total of 111 hectares. Caraway is a major crop in the specialist crop group with an area of 6,500 hectares in 2003. Camomile, Calendula and other plant species occupy about 250-300 hectares and are widely used in the pharmaceutical and cosmetics industries.

Seed production for grasses for amenity lawns is of growing importance. Estimations show that the area of such lawns in Lithuania is approximately 130,000-150,000 hectares.

Interest in the cultivation of non-food crops today in Lithuania is increasing. However, there is limited experience of non-food industrial applications, and significant improvement can be expected with the investment and know-how coming from the most advanced EU countries. A scarcity of legislative and economic measures directed to the development of non-food crops industrial application today is a major barrier in Lithuania.

## GENERAL INFORMATION

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Lithuania's climate is temperate between maritime and continental. The average annual precipitation level is 630 mm, which is higher in the western and lower in the eastern part of the country. The average annual temperature is 6°C (the lowest -4.8°C in January and the highest 17.2°C in July). The length of active plant growth season, with temperatures above 10°C, is 135-150 days. Low fertility acid soils account for 63% of the country. Fertile soils account for 26% and prevail in the central part of Lithuania.

Natural conditions in Lithuania are suitable for dairy and meat production, horticulture, cultivation of flax, cereals, potatoes, sugar beet, rape and other crops typical of the country's latitude. The area of agricultural land per person is relatively large, so national agriculture is capable of producing supplies of the main food products for domestic consumption and exports. Agricultural production per capita in Lithuania in 2002 was: 750 kg of grain, 441 kg of potatoes, 84 kg of vegetables, 27 kg of fruit and berries, 50 kg of meat, 510 kg of milk, 230 eggs. Imports of certain kinds of cereals, vegetable oil, vegetables and fruit that are not produced in Lithuania's latitude is important.

### Total land area as of January 1, 2003

Category of land area	'000 ha	%
Total land area	6530.0	100
<i>Of which:</i>		
Land used for agricultural activities	<b>39607.0</b>	<b>60.7</b>
Land of forestry units	1966.1	30.1
Conservation land	39.9	0.6
Other land area	381.7	5.8
Free state stock of land	9.7	0.2
State water stock land	171.9	2.6

Lithuanian farms do not have a clear specialisation in agriculture. Mixed farming dominates, combining both crop and livestock production. Grain, meat and milk production account for the largest share of total agricultural production. The rural population at the beginning of 2002 accounted for 33.1% of the total population and 17.8% of the working population in Lithuania was engaged in agricultural production (including hunting and forestry). Land reform in

Lithuania has created a diverse set of farms with contrasting sizes, degree of specialisation, level of education and prospects for future development. 39,700 farmer farms, 657 agricultural partnerships and enterprises, 230,800 households were recorded in 2002. This development absorbed part of the rural population, providing some income, but hindered the consolidation of land and modernisation of farms and agriculture in general.

In 1999 there were 775 food and beverage production companies in Lithuania. 74% of these companies represented small businesses employing up to 50 people. Dairy and meat factories provided almost 45% of the total sales of the food processing industries. Over 80% of the production of food and beverage is sold on the domestic market.

In Lithuania a large area of agricultural land is on unfertile soils where traditional agricultural production is complicated. There are about 610,000 hectares of low fertility, sandy and some hilly land, where removal from traditional use must be discussed. There is also a significant area of temporarily abandoned land on relatively fertile soil because of economic and other reasons.

The awareness on non-food industrial crops in Lithuania is growing, however, there is still no clear state strategy on this issue. Main discussions and strategy are centred around plants as renewable energy resources. However, there is still no effective legislative and economic privileges for non-food crops, i.e. the same tax regime as for the other farming activities applies.

Attitudes of farmers and industries are slowly changing as more information and positive working examples are available on how to grow and process non-food industrial crops, however, there is a need for agronomic, economic, marketing and other know-how.

Major events in Lithuania's agriculture are expected to occur with the accession to the EU, namely changes in the level of direct payments for arable crops; availability of structural funds; quotas for sugar, flax fibre and starch, etc. In the case of non-food crops, further development of the legislation and support system is essential in Lithuania.

# OIL CROPS

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## 1 Opportunities

### 1.1 Science and technology

The main oil crop grown in Lithuania is oilseed rape. Linseed occupies a very limited area. Attempts have been made to introduce soybean and some other species. Investigations showed prospects for the growing of several crops with a high oil content in Lithuania:

- Rape - for food, fodder, biodiesel, biolubricants
- Linseed - for a wide range of products in food, cosmetics, paints and other industries
- Castor and poppy - in pharmacy
- Safflower - in the paint industry
- Soya - for food and fodder
- Garden cress - for food and spices
- Mustards - for green manure and forage

#### **Oilseed rape (*Brassica napus L.*)**

Oilseed rape has been grown in Lithuania since the beginning of the 20<sup>th</sup> century, but only in 1986 did the growing of rape for seeds and the food industry start to increase. Spring oilseed rape prevails, because of the poor cold-resistance of winter rape. Rapeseed yield on the large, specialised farms of Lithuania with intensive farming is about 2.5–3 tonnes/hectare. However, the average yield is below 2 t/ha with wide variation among farms and years.

**Table 1 Area with rapeseed in Lithuania ('000 hectares) in 1996-2002**

	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>
Winter rape	0.9	0.3	1.2	3.0	5.4	10.0	21.0	8.1
Spring rape	10.9	21.8	37.4	80.8	50.1	26.4	39.0	58.7
<b>Total</b>	<b>11.8</b>	<b>22.1</b>	<b>38.6</b>	<b>83.8</b>	<b>55.5</b>	<b>36.4</b>	<b>60.0</b>	<b>66.8</b>

*Cropping practices.* Spring oilseed rape is sown at the end of April/beginning of May. Optimum sowing rate is 8-10 kg/ha of seed. Fertiliser rate depends on yield level and soil quality. To obtain 2 t/ha of seeds, fertilisers need to be applied with the rate: 90-120 kg/ha N, 60 kg/ha P<sub>2</sub>O<sub>5</sub> and 100 kg/ha K<sub>2</sub>O. On average, crop protection requires one/two herbicide, one fungicide and one/two or even three insecticide applications. Harvest occurs in August and conditions of harvesting can be complicated because of rainy weather. Problems because of dark leaf spot (*Alternaria brassica*) and pollen beetles (*Meligetes aeneus*) can arise. Winter oilseed rape is sown at the end of July/beginning of August. Harvest occurs in July.

### **Linseed**

Seeds of flax were traditionally used in Lithuania for a wide range of applications. The yield level of flax seed in 1931-1939 was 0.37-0.45 t/ha and remained at this level until the end of the century. It was seeds of flax *intermedia* and not of *brevimulticaulia* - true linseed.

The growing of linseed was started in Lithuania in 1995. The area under linseed is still limited to a few hundred hectares (400ha in 2003). The main reason is that it is difficult for farmers to find a market for linseed. The average yield of linseed at the Upyte experimental station was 1.5 t/ha. In 2003 there were 4 linseed varieties 'Lirina', 'Olinette', 'Barbara' and 'Gold Merchant' on the List of Registered Varieties.

**Table 2 Yield and fat content of linseed varieties**

Variety	'Lirina'	'Olinette'	'Barbara'	'Gold Merchant'
Yield, t/ha	2.2	1.9	2.3	2.3
Fat content, %	46.8	39.8	42.0	46.9

Data from the Lithuanian variety testing centre (2001)

*Cropping practices.* It is recommended to drill 40-70 kg of seed per hectare early in spring (end of April). Nitrogen applications must be limited in order to avoid lodging in rainy seasons (recommended average rate for Lithuania - 30-70 kg/ha of N). Linseed is sensitive to shortages of boron and zinc. Harvesting is rather late - in September or even October, depending on the variety and weather conditions of the growing season. A problem can be the harvesting of seeds when the stem has high moisture content. To avoid this problem, desiccation is recommended.

### **Mustard (*Sinapis alba* L.)**

Mustard has been grown in Lithuania as green manure since the 19<sup>th</sup> century. Since the Second World War this plant has been used as a raw material for vegetable oil and spices. The List of the Recommended Varieties in 2003 included only one variety (from Denmark) 'Valiant' - for oil production. In the Variety testing centre in 1996-1998 the seed yield was 2.09 t/ha with 31.6% fat content. The major use of mustard is for fodder or as green cover, because of its phytosanitary effects on diseases and weeds. Mustard cannot compete with oilseed rape in vegetable oil production because of lower crop yields and oil quality. However, there is a possibility that some farmers may use mustard seed together with rapeseed for biodiesel production on a small scale.

### **Soya**

Soya was introduced into Lithuania in 1924. Several local varieties were developed, however low yields limited the spread of this crop. Low level of yield and late harvesting are still major limiting factors for increasing soya growing in Lithuania. In 2001, soya occupied, together with other minor legume crops, 146.49 hectares on 81 farms. A realistic estimation of the area of soya is about 80 hectares, with fields in farms up to 20 hectares. Soya is grown by enthusiastic farmers mainly for their own use (fodder, food). Under good conditions in field experiments soya produces 2 t/ha of grain. Estimation of market value is complicated, because there is no stable market price for local soya production (if not taking into account prices for soya as seed or for food).

### **Breeding**

*Oilseed rape*: started in 1989 at the Lithuanian University of Agriculture. Dihaploid lines are used in breeding along with classical methods. Spring rape variety 'Auksiai' was included in the List of the Recommended Varieties in 2002.

*Soya*: carried out also at the LUA. 2 new soya varieties from LUA were tested in 2002 in the Silute and Pasvalys Variety Testing Stations.

**Research on growing techniques** is carried out at the Lithuanian University of Agriculture and the Lithuanian Institute of Agriculture and aims to increase yield and yield stability. The Institute of Botany investigates disease resistance of rape.

**Linseed** research was started in 1995 at the Upyte experimental station of LIA and aims to optimise soil preparation, crop rotation, fertilisation, crop protection, harvesting and economic issues.

Research on other oil crops on a small scale is carried out at the University of Agriculture (safflower, soya), LIA (mustard) and the Institute of Horticulture.

Research on technological preconditions of **rapeseed oil ethyl ester** production was conducted in the LUA:

- investigation of the biological method of rapeseed oil extraction, transesterification of rapeseed oil by ethanol, purification of ester, solubility of biofuel components were made;
- comparable studies of exploitation properties and exhaust emission of diesel engine running with rapeseed oil ethyl and methyl esters and their mixtures with mineral diesel fuel were conducted;
- fermentation agents Celoviridin G20x and Alkaline Protease (produced by Lithuanian JSC Biosinteze) proved very efficient.

Research work on the production and use of biolubricants from oilseed rape is conducted at the LUA. Effect of oil oxidation stability using izotiocanates and other important issues were studied.

Research on rape oil properties and different applications for food and other areas is carried at the Kaunas Technology University.

## **1.2 Industry**

The major part of oil produced in Lithuania is used for food. Joint Stock Company 'Obeliju aliejus' is the main rapeseed processing (extraction and refining) company in Lithuania. Its' annual processing capacity is 18,000 tonnes of rapeseed, with the 6,600 tonnes of annual production of oil as well as 11,000 tonnes of rapeseed cakes for fodder. Obeliju aliejus uses technology developed by the German company Krupp. AB Aliejus (Vilnius) imports rapeseed oil and only refines it. The other rapeseed oil producers are not significant in economy terms.

In 2002 the factory “Rapsoila” was established for the production of biodiesel with an annual capacity of 30,000 tonnes of rape. UAB “Rapsoilis” is also preparing for the production of biodiesel in 2004.

Most of the non-food oil products used in Lithuania are not processed domestically at the moment. Only a few companies can be mentioned in this area.

Company 'Aletovis' in Šakiai has installed two presses (cold and hot systems) and started producing linseed oil for wood impregnation. The company contracted 80 ha of linseed with local farmers in 2001. During the period 2002-2003 the area of linseed expanded to 200 ha. Today linseed oil is sold for cosmetics and markets as specific food-medicinal product.

Production of polichlorvinile cover, widely used during planned economy, in Lithuania has been discontinued. Several trading companies (UAB Lispimeks and others) started importing and selling linoleum whose demand is on a steady increase especially in the buildings of health care, etc. Linoleum is a floor cover made from natural raw materials including linseed oil, wood powder, jute and pigments. Factories in Western Europe (Germany, Sweden) can be a market outlet for linseed produced in Lithuania.

Surfactants, such as VEGEOL (BASF) produced on the basis of rapeseed oil are used to increase the efficacy of pesticides. The import of such surfactants in Lithuania nowadays is only several tonnes, which is below optimum needs. On the other hand, several farmers use ordinary food oil to increase the efficacy of the pesticides in their farms.

**Cosmetics and pharmacy.** Linseed oil is used in soap (AB Naujoji Ringuva), shampoos (UAB BIOD), pharmacy (UAB Svencioniu vaistazoles).

Oils from other crops are also used in very limited amounts and are reported in the Specialist Crops section.

### 1.3 Markets

The total annual production capacity of the Lithuanian vegetable oil industry is 10,000 tonnes. The oil needs for the domestic market can be estimated at about 40,000 tonnes. Non-food oil accounts for only a small share in this demand.

**Oilseed rape.** Because of the limited domestic processing capacity a large part of oilseed is exported (43% in 1997, 60% in 1998, 74% in 1999 and 64% in 2000) to Denmark, Finland, Switzerland and Latvia (Agriculture in Lithuania, 2000). Export of oilseed rape remains a very important issue – 69,300 tonnes were exported in 2001 and 72,000 tonnes in 2002.

A domestic market for rapeseed as a raw material for a biodiesel and biolubricants is emerging and has good prospects for development in Lithuania.

**Linseed.** The market capacity for linseed in Lithuania is narrow because of the lack of local primary processors of linseed. Small quantities of linseed are purchased by trading companies for exports. On the other hand, very small production of linseed makes this sector imperceptible for industries and investors.

**Other crops.** Markets for other crops today in Lithuania exist mainly in the food sector. Other sectors (cosmetics, pharmacy) account for a few tonnes. Possibilities of exports exist, but links to foreign markets are still unstable and suffer from fluctuations in demand, market prices etc.

### 1.4 Environment

Winter oilseed rape reduces leaching of nitrates during the autumn-winter period and growing of this crop is desirable in the light of the implementation of Nitrate Directive requirements. Vegetable oils are biodegradable and for this reason are safer for the environment, especially when used in environmentally sensitive territories. In sensitive areas vegetable oils must be used instead of mineral oil.

## **2 Barriers to progress**

### **2.1 Scientific and Technical**

The success of developing high erucic or other possible types of technical rape varieties in Lithuania is doubtful. Such varieties tested in Lithuania have a high seed shatter level, so yield losses can be expected. The seeds stay in soil viable more than 10 years and can deteriorate the quality of oilseed rape seed for vegetable oil, etc. Very strict seed production and growing systems must be applied in order to implement safe growing of high erucic rape varieties. Low cold resistance of winter rape is still an important constraint in growing this crop.

The late maturity of linseed complicates the harvesting of this crop under rainy weather, which is quite common in Lithuania at the end of September and October.

Breeding can improve the other crops, such as sunflower, soybean and safflower. However, significant changes can hardly be expected in the mid-term perspective. The low yield and the long growing period will remain the main limiting factors.

Use of vegetable oil is already accepted by several industries, but further development depends upon the improvement of the economic environment.

### **2.2 Environmental**

Production of vegetable oils and their use in industry is more environmentally friendly than the production and use of mineral oil. Further efforts must be made to increase resistance of crops to diseases and to reduce the level of pesticide application in terms of times and rate of application.

### **2.3 Legislative**

More rapid development of non-food oilseed rape and linseed in Lithuania can be expected when EU rules on non-food crops on set-aside fields will be implemented.

There is no specific legislation regarding the use of vegetable oil. Basically there are no legal acts that directly support or limit the production of vegetable oil in Lithuania.

## **2.4 Economic**

The main economic issues are limited market demand and price level for plant-derived oils. Production chains and systems of contractual links between growers, primarily processors, retailers must be created in Lithuania. Great fluctuations in production and exports must be softened by introducing future contracts. Merchants and processors are reluctant to sign long term contracts with growers, because of great market fluctuations in local and foreign market. Low level of state support reduces economic interest to initiate local production of plant derived oils for industrial uses.

## **3 Prioritisation**

Oilseed rape is generally considered an important potential source for non-food raw materials (biodiesel and biolubricants). Lack of local primary processors and doubts regarding the introduction of special high erucic varieties impede progress. Implementation of EU rules and direct payments for non-food production on set-aside can be an important factor, however, the effect will probably be low because of the introduction of a simplified scheme of support in Lithuania in 2004 and rather low level of direct payments.

Seeds of flax were traditionally used in Lithuania for a wide range of non-food applications. Linseed has good prospects for development, especially for use in cosmetics, paint production, etc. Use of linseed is expanding in confectionery: bread, cookie, sweet and even haematogen production. Other crops which can be used in the future are castor, poppy, safflower, soya, garden cress and mustard.

# FIBRE CROPS

## 1 Opportunities

### 1.1 Science and technology

Flax is the only fibre crop species commercially grown in Lithuania. Other crops, such as hemp, have potential for being grown for fibre in the future, because of high fibre content. Investigations were made with miscanthus, hemp and willow.

#### Flax

Flax is a traditional crop in Lithuania which has been among the most important crops during the last century, especially in economic terms. Climatic and soil conditions are favourable for flax growing. In 2003, 9,000 hectares of flax were grown. Evaluations show that almost 1 million hectares are suitable for flax growing, 43% of which are located in the traditional growing area. Natural conditions allow to increase the flax cultivation area up to 60,000 hectares, or even more.

Flax growing is concentrated in the two main regions - Western and North Eastern Lithuania. 610 growers were growing flax in 2003 (provisional data). Yields are 3.5-4.5 tonnes of straw per hectare. In 2003 there were 9 varieties on the List of Recommended Varieties (3 Lithuanian, 2 French, 2 Dutch and 2 Belarus breeding).

**Table 3** Area and yields of flax in Lithuania in 1990-2002

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total area (‘000 ha)	22.7	13.2	5.6	6.1	6.2	8.8	8.6	4.2	9.3	9.0
Yield of fibre (t/ha)	0.44	0.71	0.84	0.83	0.90	0.49	0.83	0.97	0.66	1.11
Total yield of fibre (‘000 t)	10.1	9.4	6.2	5.0	5.6	4.3	7.2	4.0	6.2	*

Department of Statistics – Vilnius, 2001. – P. 391-442.

\* Data not currently available

*Cropping practices* Flax is sown at the beginning of May, at a seed rate of 125-130 kg/ha. Average fertiliser rate 30 kg/ha N, 60 P<sub>2</sub>O<sub>5</sub> and 80 kg/ha K<sub>2</sub>O. Flax is pulled and de-headed, afterwards the heads are dried and threshed. The straw, laid on the flax stubble, is turned at least

twice before the end of dew retting. Dew-retted straw is packed into rolls (about 25% of the total straw production is purchased in rolls) or lifted by hand and tied into sheaves and then delivered to processors. Since 1993 only dew-retted straw has been purchased in the country (until then more than half of the total raw material was purchased as straw, which later was water-retted in the scutching factories). In 1993-2000 state subsidies were paid to growers for straw, depending on quantity and quality, and since 2001 direct payments have been paid on a hectare basis.

## **Hemp**

Hemp is one of the oldest fibre crops in Lithuania. Hemp was widely grown, but on small plots close to the house. In 1941 the hemp area was 1,500 hectares. Stems were used for fibre and seeds as a food additive. Some farmers produced hemp on larger areas on fertile soils. Fibre was used for making ropes, fishing nets, sacks and the other stem parts were used as insulation material and for heating. Later growing of hemp was forbidden due to the content of psychoactive compounds.

Hemp is sown at the beginning of May at a seed rate of 30-35 kg/ha. Fertiliser rate: 90-120 kg/ha N, 60 kg/ha of P<sub>2</sub>O<sub>5</sub> and 70 kg/ha K<sub>2</sub>O. Harvest occurs at the end of August-beginning of September. Expected yield is 7-10 t/ha of dry matter. Hemp needs a good fertile soil and treatment with fungicide and insecticides.

## **Miscanthus**

Under a warm climate Miscanthus can produce a high dry matter yield. Potentially this crop can be used for energy and cellulose production. However, low cold resistance makes performance of this crop not very stable.

At LIA's experiments Miscanthus failed to produce a good stand after the winter and very poor yield (3-4 t/ha of dry matter) was achieved. In the case of better winter survival Miscanthus can be used in Lithuania for heating and as insulation material. However, there is little perspective for significant development of this crop in Lithuania in the mid term future, and at present, Miscanthus is grown only in experimental plots.

## **Reeds**

In history in Lithuania many houses were thatched and reed was normally used as a thatching material. The demand for reed is increasing, and interest for similar local material is increasing in connection with the renovation of old buildings, especially in resort places and historical buildings in towns. It is likely that naturally growing reeds are used as building material, and perhaps a few farmers have started to grow them.

## **Willows (*Salix. L*)**

Willow is a source of raw material for wicker work, extraction of tannides, production of cellulose and fuel. Natural willow plantations are located in the flood land of major rivers of Lithuania (around 2,000 hectares) and marshy lands (3,500 hectares).

Limited research information on the extraction of tannides from willows grown in Lithuania is available. According to investigations, willow has a high content (43-57%) of good quality tannins. Tannides from willow can be used for hide treatment. *Salix caprea* produced the highest percent of tannides of good quality.

Wickerwork has strong traditions in Lithuania. In the 1960's and 1970's, wickerwork started to increase and now it is an important occupation for individuals as well as for small industrial enterprises. For wickerwork, only the first year shoots can be used. In plantations *S. purpurea* populations prevail. Local hybrid *S. purpurea* x *S. viminalis* is next and has good technical properties for the use in furniture production. 2914 thousand units (sprouts) produced in Lithuania in 1999 can be produced on several hectares of plantation, according to the Department of Statistics.

Estimates show that around 15-20 ha of willow for wicker raw material is grown in Lithuania. A few farmers have 0.5-2.5 ha plantations of willow for wicker sprout production. An important obstacle for the development of willow plantations is disease, damaging shoot quality.

Willow use for fuel was investigated at the Lithuanian Institute of Forestry, but up to now no commercial production has been started in Lithuania.

## **Straw**

Estimations show that the total yield of straw in Lithuania amounts to 3.5–4 million tonnes per year. This includes rye, winter wheat, triticale, spring wheat, barley, oats, winter rape and spring rape straw. An estimated 300,000 tonnes will be wheat straw. Straw is used for fodder, for bedding and in gardening, but part is left in the fields or lost. It can be assumed that about 10-12% of the total amount of straw, or 400,000 tonnes could be used as fuel.

Straw fuel was started to be used in Lithuania in 1996. Recently, the total installed capacity of straw-fired boilers make up about 5 MW. Approximately 7500 t of straw per year is burned in these boilers. Several companies in Lithuania produce straw-fired boilers. The capacity of these boilers varies from 15 to 340 kW. Low capacity straw-fired boilers are designated for space heating of individual farmhouses. Large capacity boilers are designated for district heating systems of large objects or settlements located in the countryside.

## **1.2 Industry**

In 2003 flax straw was purchased and processed by 9 enterprises (6 JSC and three co-operatives). Eight of them have capacities for storage of purchased flax straw all year round. In each enterprise straw is processed in 1-2 processing lines. In three enterprises 3 “Depoortere” processing lines have been installed recently. Average fibre output of the enterprises is over 27%, but long scutched fibre accounts for only about 40% of it, the remaining part is short fibre.

## **Textile**

Long fibre flax is used by three flax textile enterprises. The annual fibre demand is about 6,000 tonnes. In these enterprises the scutched long fibre is hackled, spun, woven, dyed, and soft wares are made. The total annual production of ready-made linen drapery is 17-19 million.

Linen thread in textile enterprises is used in the following way:

- 55% - for weaving of fabric for making clothes;
- 20% - for weaving of fabric for furniture upholstery;
- 15% - for household use (tablecloths, table-napkins, towels, sheets, curtains etc.);
- 10% - for other technical needs (packaging material etc.)

Besides these enterprises, there are smaller private enterprises involved in fibre retting, scutching, spinning, sewing, knitting and the production of souvenirs from flax. Foreign investors are expected in the textile industry, therefore it is envisaged that the annual demand of scutched long fibre will increase to 12,000 tonnes.

In order to make flax production and processing more profitable, factories use by-products for different purposes.

Subdivision of "Linolitas" in Panevėžys produces shive briquettes for heating.

AB 'Žemaitijos linai' and AB 'Ukmergės linai' produce insulation materials from different by-products, such as shives.

Production of sacks and baskets for packaging in Lithuania was 306,000 units in 1999 and 449,000 units in 2000, a part of which was produced from flax. AB 'Linų audiniai' produces linen sacks from flax for packaging.

UAB 'Žemaičių virvės' in Northern Lithuania produces ropes from natural and synthetic fibres.

A number of companies (AB 'Tulpė', etc.), particularly small companies, produce fabric etc. from linen (towels, table-cloths, napkins, bed-linen). This outlet is traditionally important in Lithuania.

The Institute of Thermoinsulation (Vilnius) investigated the possibilities of production of insulation material (building blocks) from flax shives mixed with sapropel from local lakes.

Packaging material in a form of wicker from willow is produced for local market and exports (UAB Melynoji Uoga, Varena) and can be used to pack fruit and vegetables as well as other products. Wicker is traditionally used in Lithuania for the production of furniture. Almost 2,000 units of furniture were produced from wicker in 1999 by several companies (UAB Sensus) and individual producers.

Very small amounts of fibre are used for other purposes, i.e. production of picture post cards, brooms, etc.

Industry for processing fibres other than flax (processors also capable of processing **hemp**) currently does not exist in Lithuania. Taking into account that growing technology of hemp (varieties, fertilisation etc.) are not available for Lithuanian farmers, it is unlikely that rapid development of this crop will be in the near future.

### **1.3 Markets**

Lithuanian flax textile is the only branch of textile that could be self-sufficient in local raw material, and fully meets the demand of the local market. The nine primary flax processing factories of Lithuania are capable of processing 55,000 tonnes of flax straw per year. Now only about 30% of the long-fibre flax needs of the Lithuanian textile industry is produced in the country. In the year 2000 Lithuania imported about 5,000 tonnes of long-fibre flax (demand approximately 7,000). For this reason, the main market for local farmers will be long-fibre flax.

The building industry can be considered a rather important market for plant fibre in the future, however, at the moment plant fibre is used only marginally with no market estimates available.

The use of flax fibre in Lithuania for paper or similar production is rather unlikely. However, a project on large cellulose production factory from wood in Lithuania is seriously discussed.

Although other markets seem very limited in the near future, they can be drastically increased because of the development of new technologies.

### **1.4 Environment**

There are no marked environmental problems caused by flax growing. The use of fibre in dwelling houses construction, etc. can be positive to the environment and healthier for people. Plant fibres have higher biodegradability than most of the currently utilised synthetic products.

## **2.2 Barriers to progress**

### **2.1 Scientific and Technical**

The resistance of flax to extreme weather conditions and some diseases, resulting in a higher yield and quality stability, must be increased.

The development and introduction of new processing technologies in order to utilise flax yield more efficiently and fully, by using flax by-products in different ways (i.e. for producing insulation material) is very important.

Extensive research must be done in order to broaden fibre crop use area with the introduction of new technologies for flax as well the other fibre crops.

### **2.2 Environment**

No significant environmental barriers can be mentioned in the case of flax growing. Hemp can be of environmental benefit because of its repellent effect on some pests.

### **2.3 Legislative issues**

Putting in line direct payments for flax with those for cereals in Lithuania can reduce interest in flax cultivation.

Hemp growing is banned in Lithuania by the Law adopted in 1998. In the nearest future this prohibition, will probably be cancelled for the varieties with low content of THC (tetrahydrocannabinol). Although there is an interest in hemp from some farmers, reactions are likely to be slow, as is the initiation of local retail markets for hemp. Also, there is no available comprehensive agronomy and primary production package (seeds; growing techniques; know-how) and a negative opinion of local administrators and society. Using the history of linseed as an example, no more than a few hundred hectares of hemp can be expected in the first 2-3 years after restriction are removed. Growth will then be either rapid or stagnate, depending on circumstances.

## **2.4 Economic**

Some farmers and some flax processing factories still use out of date technologies, resulting in high production costs and low long fibre output. Large investments are needed to upgrade this sector to the EU standard level.

Availability of cheap wood materials hinders the development of new technologies and prevents the wider use of fibres (cellulose) derived from agricultural plants in Lithuania.

## **3 Prioritisation**

Flax growing for fibre production is traditional in Lithuania. Flax, probably, will remain a major fibre crop, however, the use of by-products in different ways (insulation, shive briquettes for heating, etc.) will increase. The market for flax as a raw material for cellulose will most likely remain limited, because of cheap wood raw material.

Other possible crops can hardly become important in the nearest future and will need intensive promotion (hemp - also special legislative measures) to start production on a larger scale.

# CARBOHYDRATE CROPS

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## 1 Opportunities

### 1.1 Science and technology

A number of plants can potentially be used for different non-food products, because they contain carbohydrates in the form of sugars or starch. So it is complicated to classify crops according to the importance of prospects for growing for non-food products under Lithuanian climatic, soil and economic conditions.

The main arable crops in Lithuania are carbohydrate crops: cereals, sugar beets, potatoes.

#### **Cereals**

Conditions for cereal growing are rather favourable in Lithuania (mild temperatures, good moisture supply). Cereals in 2002 occupied just over 954,000 hectares and produced 2.5 million tonnes of grain. The highest average grain yield was 3.1 t/ha - in 1991. In 1994-1995, because of the drought, the average yield was only 1.8-1.9 t/ha. The yield potential of cereals in Lithuania is much higher than the actual yield achieved. It is obvious that Lithuania is able to meet local demands for grain and grain products and to face overproduction of grain. However, there is a number of special grain and grain products that need to be imported on a regular basis. This is true for corn, soybeans and rice.

#### **Buckwheat**

The area of buckwheat in Lithuania has been on the increase since 1990. 16,300 ha were grown in 2003. With good growing techniques a yield level of 2 t/ha can be secured, however, the country average is still below 1 t/ha.

#### **Sugar beet**

There is a sufficient area of arable land in Lithuania suitable for sugar beet cultivation with a potential to produce 45-50 t/ha or more of sugar beet roots. Growing experience and know-how

to achieve this task was mastered. The average total sugar beet root yield in Lithuania is 800,000 to one million tonnes. 25,900 ha of sugar beet for industry were grown in 2003.

### **Potato**

Potatoes are an important, widely distributed arable crop in Lithuania. Potatoes are grown by most of the residents who have at least a plot of arable land. In 2003 potatoes covered 93,200 hectares, or 4.6 % of the total agricultural land under crops. However, only 0.3% of growers have a potato area over 15 ha. Using good growing technology, potatoes in Lithuania are capable of producing 30-40 t/ha, however today the country's average is only 14-16 t/ha.

### **Research**

Breeding of wheat mainly for food (high protein content, etc.), rye, barley (for food, fodder, malt), oats (fodder and food), peas, beans and some other minor species is carried out at the Institute of Agriculture in Dotnuva. Breeding of potato (for food and industry) is carried out at the Voke branch of LIA.

Research on growing techniques of major carbohydrate crops (mainly targeting higher yields and food or fodder quality and value) is carried out at the LIA in Dotnuva, LUA and some other institutions (Institute of Agricultural Engineering). Research on buckwheat growing techniques is carried out at the Perloja experimental station of LIA, on potato – at the Elmininkai experimental station of LIA, on sugar beet – at Rumokai experimental station of LIA.

### **Processing developments**

Cationic derivatives of polyacrylamide are usually used as flocculants in wastewater purification and sludge dewatering processes. They are expensive and poorly biodegradable. Starch is used as a flocculating agent in the mining and paper industries because of its availability and low cost. It can also be utilised as a sludge flocculant, although it must be modified. The sludge is negatively charged and can be flocculated using the cationic starch products.

In Kaunas University of Technology, cationic starches were produced and tested for wastewater treatment and dewatering of sludge. The results showed that CS derivatives could function in wastewater treatment as coagulants and substitute inorganic salts of aluminium or iron, cause the

precipitation of acid and reactive dyestuff in solution and flocculate suspended solids in suspensions. Their efficiency depends on the charge density in the polysaccharide chains, and solubility.

Addition of CS facilitates the flocculation of sludge particles, but gives the small floc and unsatisfactory filtration. The filtration properties were improved and floc size increased, when CS and cationic polyacrylamide flocculant (CPAA) are used together. Substitution of a part of polyacrilamide flocculant by modified starch improves the filtration of sludge and increases clearness of the filtrate. Economic evaluation of application of flocculants' mixtures revealed the possibilities to reduce their cost by 8–15%.

A joint project “To investigate the feasibility of the use of maltodextrines in food industry” was carried out by the Lithuanian Food Institute and Kaunas University of Technology. The objective of this work was to develop the technology of maltodextrine production from local material, to estimate their properties and feasibility for their use for food production. A technology for the production of maltodextrines with different dextrose equivalent was developed, and quality parameters of maltodextrines were determined. The newly-developed maltodextrines were tested in the production of mayonnaise, dreggy drinks and dry, natural food dyestuffs.

## **1.2 Industry**

### **Grain**

The major part of wheat, rye, barley and oat grains are processed into flour, groat, and combined animal feed in Lithuania. There are 20 large grain processing factories. Some companies produce wheat embryos and wheat bran (AB Malsena, AB Kretingos grudai).

Buckwheat in Lithuania is processed to groats by UAB “Galinta ir partneriai”. The husk of buckwheat is used for the production of pillows and mattresses (UAB “Galinta ir partneriai”, II Gifta). UAB “Galinta ir partneriai” also markets the husk as mulch for gardens.

## Sugar beet

In Lithuania there are four sugar factories: AB “Danisco sugar Panevezys”, its Kursenai subsidiary in Pavenciai, AB “Danisco sugar Kedainiai” and UAB “Arvi cukrus”. This sector is heavily regulated: the total sugar quota for 1999-2001 was fixed to 112,000 tonnes of sugar, and for 2002 fixed to 122,000 tonnes. None of the sugar factories are connected to distilleries.

## Potatoes

Mainly potato starch is produced in Lithuania. There are two potato starch plants in Lithuania: AB Ambraziskiu krakmolos (only potato starch) and Antanava processing factory (potato and maize starch). The latter belongs to the company AB “Stumbras”. For different reasons (economic, lack of contractual agreements with farmers, shortage of high quality raw material, lack of seeds of special varieties, etc.) production capacities are underused.

**Table 4**      **Production of starch in Lithuania**

	1990	1993	1994	1995	1996	1997	1998	1999	2000	2001*
Dried starch (‘000 tonnes)	5.4	1.3	0.3	0.4	1.7	1.3	0.2	0.8	2.4	0.6

Source: Statistics Department to the Government of the Republic of Lithuania

\* *provisional data*

Potato starch production capacities in Lithuania are about 8,500 tonnes per year and are capable of covering domestic demand at the moment. However, actual production today is too low to cover domestic demand, and starch is imported in significant amounts.

Estimations show that the food sector uses about 3,000 tonnes of potato starch per year. Roughly the same amount is used in non-food production. The major non-food user of starch is the cardboard industry (AB Klaipedos kartonas). Potato starch is also used in the paper and textile industries and pharmacy. Modified starches for paper production are imported.

A limited amount of starch is used for the production of labels, glue and other commodities.

## **Other uses**

### *Ethanol for biofuel*

Ethanol produced in Lithuania has not been used for motor transport until now. The distilleries utilise only 30% of their total capacities, which makes up about 34,000 tonnes per year. The Interdepartmental Commission has been set up, that investigates possibilities of biofuel production and usage in Lithuania. The main obstacle for biofuel production is a higher production cost compared with oil-based conventional fuel.

### *Surfactants*

3 products based on alcohol are registered and imported as surfactants for use in Lithuania with pesticides.

## **1.3 Markets**

The largest grain consuming market segment in Lithuania is livestock production, 50% of grain produced on farms is used as fodder. The Lithuanian grain processing companies are able to produce over 400,000 tonnes of flour, over 40,000 tonnes of groats, and about 2 million tonnes of combined animal feed. Other market outlets, excluding distilleries and malt production, are undeveloped and small.

Potatoes in Lithuania are used for potato flour, pellets, chips, frozen pre-fabricated food, graded potato mass, French fries, starch and spirit production. Limited amount of starch is used for the production of labels (UAB Tempera – 20 tonnes) and for the experimental production of flocculants for water treatment, etc. For the period 1991-2001 potato exports were prevailing over imports, excluding 1998 and 1999.

Distilleries produces spirit from different raw material including grain and potatoes. This market segment can increase greatly, if legislature and economic environment will be changed in favour for biofuels. There are large areas of agricultural lands that should be used for non-agricultural production. The production of ethanol would create new workplaces. Only in the Šilutė factory of AB “Stumbras” 105,000 tonnes of grain can be processed to 30,000 tonnes of ethanol, without large investments in technological process.

#### **1.4 Environmental considerations**

There are no specific environment problems in potato growing for starch, but increased intensity of soil degradation can be expected on organic and hilly soils. In processing, large amounts of water are needed.

Carbohydrate crops cover a larger part of agricultural land, so growing these crops according to the best available Good Agriculture Practice methods is of great importance.

An increasing use of biodegradable plant material in different ways will reduce pressure on the environment. The largest effect in the near future can be expected to be from the use of ethanol in motor transport. The use of 150,000 tonnes of ethanol with petrol can reduce CO<sub>2</sub> emissions to the atmosphere by 15,000 tonnes per year.

## **2 Barriers to Progress**

### **2.1 Scientific and Technical**

Growing techniques and processing are developing with the main target to satisfy consumers needs for food potato and food, fodder or malt grain products. Inadequate understanding of the need to develop special varieties, growing techniques and novel processing processes is a rather important obstacle for increasing of use of carbohydrate crops in the non-food industry in Lithuania.

### **2.2 Environment**

There are no specific environmental obstacles for growing carbohydrate crops for non-food production. Some environmental direct or indirect limitations, however, can arise in specific cases (i.e. requirement for green cover during autumn and winter) or in specific areas (such as Karst zone).

### **2.3 Legislative**

Slow development of legislature regarding the use of biofuel and non-food crops on set aside fields etc., reduces interest for initiation and limits the development of companies based on novel

technologies. Major events can be expected in connection with the harmonisation of Lithuanian legislature in line with EU.

## **2.4 Economic**

A complicated market environment, when no state support for potato growers or starch producers is available, limits the development of this sector in Lithuania. The lack of permanent links between starch producers and potato growers on a long-term contractual basis is also a barrier to progress in Lithuania.

The development of the carbohydrate crop sector in Lithuania in the near future, alongside with domestic factors, will depend highly on the outcome of the negotiations with EU. Very small potato starch quota (1211 tonnes) and sugar quota (103,000 tonnes of sugar) below traditional production level was established. Direct payment level for arable crops as well as the capacity to use structural funds is also of great importance.

Potato and sugar beet processing is seasonal and thus poor utilisation of processing equipment increases production costs.

The use of ethanol for biofuel in Lithuania on the large scale without subsidies is complicated.

## **3 Prioritisation**

Grain is considered to be an important potential source for biofuel (ethanol) production. However, measures promoting such production must be applied in order to make it profitable for all participants of the production chain (including growers). The potato starch industry is underused at the moment. More than half of starch production is used in non-food industries (mainly cardboard, paper and textile). The use of starches will probably increase in Lithuania. However, local producers will face strong competition from other countries.

# SPECIALIST CROPS

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## 1 Opportunities

### 1.1 Science and technology

A great number of plants are used or have potential for being used in medicine or cosmetics, because of the wide variety of beneficial characteristics.

In Lithuania 189 species are allowed to be used in conventional medicine and food industries, of which only 30 are cultivated species. General opinion prevails that plant raw material and its preparates are characterised by a wider range of pharmacological effects, and compared with synthetic medicine, have milder side effects.

According to the crop declaration in 2001, 214 growers had in total 3122 ha area under the plants named as medicinal or etheric-oil plants (peppermint, caraway, etc.). A total area of 110 ha was declared by 45 growers as planted with crops under the name other technical crops (tobacco, hops, etc.). As few as 0.3% of the total number of farmers are involved in commercial production of medicinal or etheric-oil plants and herbs, that occupy an area of about 400 ha. Caraway, however, occupies significant areas of land.

#### Caraway

Caraway is the most important specialist crop in today's Lithuania. Caraway, as a medicinal plant, has been cultivated in Lithuania since olden times. The ether oil of caraway contains carvon, which is used in alcohol production, and limonen, which is used in soap and perfumery production.

**Table 5** Caraway area in Lithuania ('000 ha)

	1997	1998	1999	2000	2001	2002	2003
Caraway	-	0.6	0.9	0.8	2.4	4.8	6.5

Department of Statistics

The capacity of the domestic market for caraway can be estimated as 500 tonnes. The most active company in caraway production and trade is UAB Agrolitpa. This company contracts caraway with farmers providing them with seeds and purchasing production. Yield level of caraway is 1-1.5 t/ha UAB Agrolitpa has about 85% of the total caraway exports in Lithuania. The company's exports were 540 tonnes in 1997, 407 tonnes in 1998, 42 tonnes in 1999 and 373 tonnes in 2001. Because of the dry season, the company purchased only 500 t of caraway in 2003.

### **Thyme** (*Thymus* )

The raw material of thyme (absolutely dry) contains 0.12-0.27% of ether oil, 11% mineral materials, ascorbic acid, flavonoids, saponines etc. The raw material is used for perthusin production, which is used for the treatment of coughs and bronchitis. Ether oil is used for rheumatism etc. Ether oil of thyme is used in the pharmaceutical and perfumery industries. Production in Lithuania is several dozens tonnes (Švenčionių vaistažoles purchase 5-6 t of DM raw material per year).

### **Peppermint** (*Mentha x piperita L.*)

Peppermint is grown as a herb, medicinal and melliferous plant. Its' ether oil contains 32-61% of menthol. Ether oil is used in the food and perfumery industries. Its green material yield is 10-14 t/ha. Production in Lithuania is several dozen tonnes (Švenčionių vaistažoles purchase 10t of DM raw material per year).

### **Camomile**(*Chamomilla rcutita L.*)

Camomile contains ether oil, ascorbic acids, carotene bitter and other materials. Production in Lithuania is some dozens tonnes.

### **Sage** (*Salvia verticilatta*)

Lilac sage. It accumulates biologically active compounds-polyphenols (flavonols, phenol carboxylic acid, and tannins). Research showed that during flowering and even later (August) it is possible to prepare the utmost amount of good quality raw material, which has to comprise not less than 0.15% of flavonols and PCA and 4.6% of tannins. Production in Lithuania is several dozens tonnes (Švenčionių vaistažoles purchase 10t of DM raw material per year).

### **Lemon-balm** (*Melissa officinalis* L.)

Lemon balm is widely used in the pharmaceutical and food industries (as an additive). Its production in Lithuania is several dozen tonnes.

### **Valerian** (*Valeriana officinalis* L.)

The roots of valerian contain over 100 various chemical materials, which explains its wide use in scientific and folk medicine. The underground part of valerian contains ether oil, valerianic acid, alkaloids, mineral matter, resins, starch etc. This traditionally important plant today faces market stagnation.

### ***Echinacea purpurea***

*Echinacea purpurea* a medicinal ornamental, melliferous plant whose natural habitats are in North America. From the medicinal raw material immunomodulating preparations replacing synthetic ones are produced for prophylactics and treatment of allergic, autoimmune and oncological diseases. In Lithuania the growing of *E. purpurea* was started in the collection of Kaunas Botanical Gardens in 1960 and the biology and introduction of the species was investigated in 1991-1999. The above ground part of *E. purpurea* is prepared for the medicinal raw material from the second to the sixth year. The biggest mass of dry grass is obtained in the fourth - fifth years (1.1 - 1.8 kg/m<sup>2</sup>). The raw material is prepared in the second and third years of growth. In the medicinal raw material of *E. purpurea* the established content of cichoric acid was as follows: in grass – 3.84, inflorescences – 4.30: ligular florets – 5.80, disc florets – 2.2, stem side branches with inflorescences – 5.77, roots 2.65 %.

Phenological observations and qualitative and quantitative estimation of biological properties, growth development and productivity of the aboveground and underground parts and medicinal raw material proved that *E. purpurea* could be successfully cultivated in Lithuania and provide abundant medicinal raw material of good quality.

### **Research**

Kaunas Vytautas Magnus University's Botanical Gardens, Institute of Botany, Kaunas Medical University, Kaunas Technology University, Vilnius Pedagogical University are involved in the

research into the cultivation of various species of medicinal plants, as well as quality and quantity of raw material. Recommendations on 30 species of medicinal plants have been prepared.

**The Botanical Garden of Kaunas Vytautas Magnus University** holds the largest collection of medicinal plants in Baltic countries. Plants are divided into groups according to active matters (alcaloids, glycosides, polyphenols, polysaccharides, vitamins etc.). About 315 taxones, 175 genera, 232 species of 63 families 30 varieties are currently present in their collection. Accessions of different origin are collected; valuable forms are selected according to their resistance to unfavourable environment effects, productivity, and the quality of raw material. The investigation of pests and diseases of the plants in collections cultivated in the Botanical Gardens and plantings are carried out. Studies on the introduction of new medicinal plants, their biology and the quality of raw material are conducted.

**The Institute of Botany** holds a collection with approximately 100 species of medicinal plants (Achillea, Alcea, Allium, Angelica, Arctium, Astragalus, Bidens, Crataegus, Echinacea, Gentiana, Helichrysum, Hypericum, Leonurus, Malva, Matricaria, Mentha, Oenothera, Origanum, Plantago, Sanguisorba, Saponaria, Symphytum, Thymus, Valeriana, Verbascum, Viola etc.).

#### **Kaunas University of Technology (Department of Food Technology)**

The expertise covers isolation, fractionation, chemical (chromatography, mass spectrometry, nuclear magnetic resonance, etc.) analysis and technological investigations of natural chemicals from various plant materials. Several effective natural food additives have been isolated from some local plants and comprehensively tested on a laboratory scale. Close co-operation with local enterprises specialising in the production of the essential oils and natural extracts has also been established and is successfully developing. There is also close co-operation with the Lithuanian Institute of Horticulture and Kaunas Botanical Gardens carrying out research into agrotechnological and medicinal areas and providing various cultivars for the isolation and testing of biologically active materials.

## 1.2 Industry

The first of the two companies below rely totally on local raw material. This is only imported in times of shortage. The others buy material from local or foreign traders. Imports of the products prevail over exports. It can therefore be estimated that the larger part of high value plant-derived raw materials, such as essential oils, are imported. The large part of raw materials, like dried medicinal herbs, are produced domestically from local material. About 290 t of raw material is purchased in Lithuania per year.

**UAB “Švenčionių vaistažolės”** has good prospects for the development of medicinal plants and herbs business. Their advanced production facilities meet the standards of the world's pharmacy business. They have a great potential for the production of medicinal preparates and food additives. The current needs of the raw material of cultivated medicinal plants are over 100 tonnes of DM.

**TUB 'META'** manufactures essential oils with distillation techniques. The enterprise currently produces nearly 12 tonnes of essential oils and 200 tonnes of water extracts annually. Today four technological lines are at work: 1. A line for the production of water extracts. 2. A line for the production of alcoholic and fatty extracts. 3. A drying room for raw herbs and spices. 4. A line for the production of spices. Also produces dry herb and spices: caraway, mustard, lemon balm, thyme, coriander, etc.

**SPAB 'Stumbras'** possesses a CO<sub>2</sub> plant with 4 small size extractors, which is a very good technique for the extraction of medicinal and aromatic herbs.

**UAB 'BIOK'** produces hair and body care products: shampoos, conditioners, shower gels etc, Skin care products: facial creams, vitamin-enriched cosmetic milk etc.

95 - 97% of the ingredients are natural plant materials, including medicinal plants and herbs: Calendula, caraway, linseed, sage, hops, tutsan etc.

**UAB 'REKIN'** produces: Feet and hand care products, body, face, hair care and other cosmetics. The following plant material is used: calendula, camomile, sea buckthorn, cucumber, quickthorn, rowan, peppermint, thyme, aloe, lavender.

**UAB 'HIGĖJA'** produces feet and hand care products from different plant material as well as professional detergents and disinfectants and household chemistry products.

**UAB 'INECO'** produces cosmetics: lipsticks, skin balsams with calendula, camomile, and sea buckthorn.

**AB 'Bakteriniai preparatai'** produces extracts - liquid extract of quick thorn *Etractum Crataegi fluidum*;

**AB 'Vilniaus farmacijos fabrikas'** - *Tinctura Leonuri subtilissimus, tinctura Menthae piperitae, tinctura Valerianae*

**AB 'Sanitas'** produces heart drops *tinctura Valerianae* etc.

**UAB 'KOSLITA'** produces shampoos, chemical detergents and disinfectants, containing plant ingredients.

**UAB 'Camelia'** produces a large variety of herb teas, purchasing plant material also from local farmers with the help of the UAB Acorus Calamus.

### **1.3 Markets**

There is still a shortage of medicinal plants and herbs in the domestic market, which is covered by the imports.

### **1.4 Environment**

Increase in the biodiversity of plants provides favourable conditions for the spread of beneficial insects.

Medicinal herbs are the only plants that are allowed to be cultivated in the most environmentally sensitive active Karst zone (4th) in Northern Lithuania.

Part of medicinal plant material (about 85 t) is picked up in the natural habitats. This part should account for a smaller share of the total market of medicinal plants and herbs.

## **2 Barriers to Progress**

### **2.1 Scientific, Technical and Economic**

- There is little information on the marketing of medicinal plants and herbs. Growers and producers underestimate the relevance of know-how and innovations.
- Breeding and seed production is being developed too slowly.
- Comprehensive statistics on the production and markets of specialist crops are scarce in Lithuania. Lithuanian farmers find it difficult to market their production.

Also, limited investment capacities of small producers; small and marginal production; out-of-date production facilities etc.

### **2.2 Legislative**

There is no specific legislative barriers for specialist crops cultivation and use in medicine or cosmetics with the exception of a few species, such as poppy.

## **3 Prioritisation**

Special crops have a large potential of development in economic terms. A variety of species grown in Lithuania have medicinal and aromatic properties and potentially can be of interest for the domestic and foreign markets. Caraway is a major crop in the specialist crop group and will probably hold this position in the near future. Camomile, Calendula cultivation is well established for use in the pharmaceutical and cosmetics industries. Development of these sectors is and in the nearest future will remain limited by the capacities of local primary processors. However, joining EU can have a positive effect.

## ANNEX 1

## Crop area in all farms 1994-2003 (ha)

Crop	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Winter wheat	263.3	250.5	318.9	314.9	293.0	233.3	285.5	269.7	266.7	283.4
Winter triticale	27.5	22.5	34.1	40.6	36.9	25.9	21.1	41.6	40.5	66.2
Winter rye	203.5	134.7	152.2	158.7	174.3	134.8	133.1	110.5	74.6	59.9
Winter barley	3.9	2.7	3.6	1.9	2.7	0.9	1.2	2.8	6.9	12.9
Spring wheat	6.7	10.1	28.8	60.7	66.6	100.4	84.9	68.1	68.4	53.3
Spring barley	616.0	541.8	470.2	501.1	460.2	420.3	352.0	328.5	358.1	295.7
Spring triticale					-	19.1	21.7	18.0	15.5	11.9
Oats	54.5	47.4	51.6	56.1	49.6	51.2	44.3	47.6	55.0	48.3
Buckwheat	1.2	1.0	1.9	4.4	8.3	15.1	16.6	16.9	17.0	16.3
Mixed cereals	17.9	16.0	17.6	23.4	15.9	11.6	11.0	11.1	12.4	14.2
Grain maize									2.9	2.2
Other cereals					-	0.1	0.2	0.4	-	-
Peas							25.2	20.3	18.4	7.8
Beans							1.4	2.2	3.2	1.8
Vetches							10.0	9.5	9.9	2.1
Lupines							1.9	1.5	1.6	2.0
Other legumes							1.3	1.2	3.1	7.2
Linseed									0.2	0.4
Flax	9.8	13.2	5.6	6.1	6.2	8.8	8.6	4.2	9.3	9.0
Sugar beet (for industry)	16.6	24.3	31.2	35.2	30.0	30.6	27.7	26.5	29.2	25.9
Winter rape			0.9	0.3	1.2	3.0	5.4	10.0	21.0	8.1
Spring rape	12.0	13.9	10.9	21.8	37.4	80.8	50.1	26.4	39.0	58.7
Other oil seed crops										0.2
Caraways					0.6	0.9	0.8	2.4	4.8	6.5
Medicinal herbs					0.1	0.0	0.0	0.3	0.1	
Etheric and aromatic					0.1	0.0	0.1	0.3	0.3	0.5
Other technical crops					0.1	0.0	0.0	0.0	0.0	0.0
Strawberry					-	0.7	0.8	1.1	1.1	1.5
Potatoes	116.5	124.5	125.3	121.2	136.3	121.1	109.3	102.2	99.2	93.2
Cabbages					7.6	6.1	5.7	5.7	6.1	
Cucumbers					2.2	1.6	1.2	1.2	1.1	
Tomatoes					1.4	0.9	0.9	0.8	0.6	
Beets					5.5	4.8	4.1	3.9	4.0	
Carrots					4.6	4.3	4.3	4.0	3.8	
Onions					3.3	3.6	2.6	2.6	2.5	
Other vegetables					3.5	3.6	3.1	2.9	2.6	
Fodder root-crops, including sugar beet for fodder			54.0	51.3	58.3	46.8	39.1	37.3	36.0	27.0
Maize for silage and green fodder			4.3	3.5	6.2	6.3	10.3	11.6	13.8	13.9
Other silage crops			10.1	9.8	8.1	5.5	5.5	3.5	2.9	1.8
Seed of perennial and annual grasses					3.4	5.5	2.4	4.0	3.2	-

Lithuanian Department of statistics, Žemės ūkio augalų pasėliai, derlius derlingumas (Vilnius, 1996, 1998, 2000, 2002, 2003)

## ANNEX 2

### Total crop yield ('000 tonnes) in all farms 1980-2002

Crop	1980	1990	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Winter wheat	405.7	1176.3	537.2	611.7	850.2	962.5	858.0	665.0	1015.3	896.4	1024.5	1023.1
Winter triticale			50.6	46.6	77.6	114.1	94.9	55.3	80.7	107.1	114.4	181.5
Winter rye	327.6	470.2	313.0	239.3	286.8	348.2	348.7	260.9	311.4	231.1	170.2	147.1
Winter barley	-		6.6	4.4	7.7	4.2	5.9	1.5	2.7	7.4	20.7	34.7
Spring wheat	0	1196.5	12.2	25.6	86.0	164.9	173.0	205.9	222.3	179.9	193.1	181.0
Spring barley	914.6		1083.9	884.0	1168.9	1189.3	1098.4	740.1	856.9	768.8	850.4	865.1
Spring triticale	-						-	29.8	50.2	36.7	30.9	32.7
Oats	168.6	195.7	69.0	66.7	101.6	111.7	97.2	67.1	82.9	84.3	97.5	114.6
Buckwheat			0.2	0.6	1.5	3.5	8.0	8.6	14.7	12.7	10.6	14.7
Cereal mixtures	20.0		25.5	24.5	34.8	46.9	32.7	14.2	19.8	19.8	18.5	28.6
Grain maize											8.3	
Other cereals							-	0.2	0.8	1.1	-	
Peas	33.1	113.5							49.7	30.0	37.0	
Beans	2.3	4.6							2.7	4.1	4.0	
Vetches and mixtures	56.4	65.2							16.8	14.3	15.3	
Lupines	2.3	1.8							1.6	1.5	1.7	
Other legumes									2.2	2.3	4.9	
Linseed											0.2	0.5
Flax fibre	8.1	10.1	4.4	9.4	6.2	5.0	5.6	4.3	7.2	4.0	6.2	9.9
Flax seed	5.8	10.2	3.5	6.5	3.2	2.9	2.7	3.7	2.7	0.9	2.5	2.2
Sugar beet (for industry)	559.0	912.4	461.5	692.4	795.5	1001.9	949.2	869.9	881.6	880.4	1052.4	977.4
Winter rape					1.7	0.8	2.3	4.8	11.9	22.4	43.9	13.9
Spring rape		24.3	13.2	18.9	20.9	36.4	69.6	110.3	69.1	42.4	61.7	105.6
Strawberry							-	1.7	1.4	2.4	2.0	3.0
Potatoes	1178.4	1573.1	1096.4	1593.5	2044.3	1829.8	1849.2	1708.1	1791.6	1054.4	1531.3	1445.2
Cabbages		44.4	116.5	152.1	201.5	172.5	171.9	119.6	125.7	121.3	98.4	230.2
Cucumbers		1.2	6.5	2.5	12.1	17.5	17.9	14.2	8.6	8.0	8.3	
Tomatoes		0.0	3.1	1.5	8.0	9.6	9.4	6.8	5.1	4.4	4.4	
Beets		24.2	67.1	98.8	99.9	95.0	90.2	71.0	64.8	64.2	63.2	118.4
Carrots		20.6	46.1	83.8	67.4	61.3	64.9	47.4	65.3	61.6	48.9	131.9

Onions		2.6	5.2	4.0	18.9	19.4	28.4	23.1	20.3	22.7	22.7	30.0
Other vegetables		3.6	24.8	18.7	17.2	23.6	25.2	16.2	15.0	14.5	15.1	
Fodder beets	1362.0	2678.8	1323.9	2188.9	1718.4	1829.7	2026.0	1573.3	1399.4	1382.9	1136.2	944.7
Maize for silage	2195.8	2171.2	78.7	107.7	88.8	91.7	162.0	163.5	288.5	277.9	298.1	388.9
Other silage crops	1543.3	1347.0	235.3	178.5	161.6	147.9	126.6	59.9	85.4	56.9	41.6	28.8

Lithuanian Department of statistics, Žemės ūkio augalų pasėliai, derlius derlingumas (Vilnius, 1982, 1991, 1996, 1998, 2000, 2002, 2003)

## ANNEX 3

### Areas and yields of current industrial crops 1980-2003

		1980	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fibre flax	Area ('000 ha)			13.2	5.6	6.1	6.2	8.8	8.6	4.2	9.3	9.0
	Fibre ('000 t)	8.1	10.1	9.4	6.2	5.0	5.6	4.3	7.2	4.0	6.2	9.9
	Seeds ('000 t)	5.8	10.2	6.5	3.2	2.9	2.7	3.7	2.7	0.9	2.5	2.2
Linseed	Area ('000 ha)								0.1*	0.2*	0.2	0.4
	Yield ('000 t)										0.2	0.5
Sugar beet**	Area ('000 ha)			24.3	31.2	35.2	30.0	30.6	27.7	26.5	29.2	25.9
	Yield ('000 t)	559	913	692	796	1002	949	870	882	880	1052	977
Caraways	Area ('000 ha)						0.6	0.9	0.8	2.4	4.8	6.5
Medicinal crops	Area ('000 ha)						0.1	0.0	0.0	0.3	0.1	0.5
Etheric and aromatic crops	Area ('000 ha)						0.1	0.0	0.1	0.3	0.3	
Other technical crops	Area ('000 ha)						0.1	0.0	0.0	0.0	0.0	0.0

\*-area contracted by UAB "Aletovis"

\*\*for sugar production

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