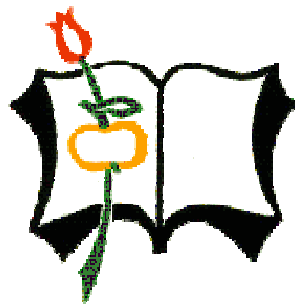


Feedstock Resources for Industrial Biotechnology

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Lithuanian Institute of Horticulture



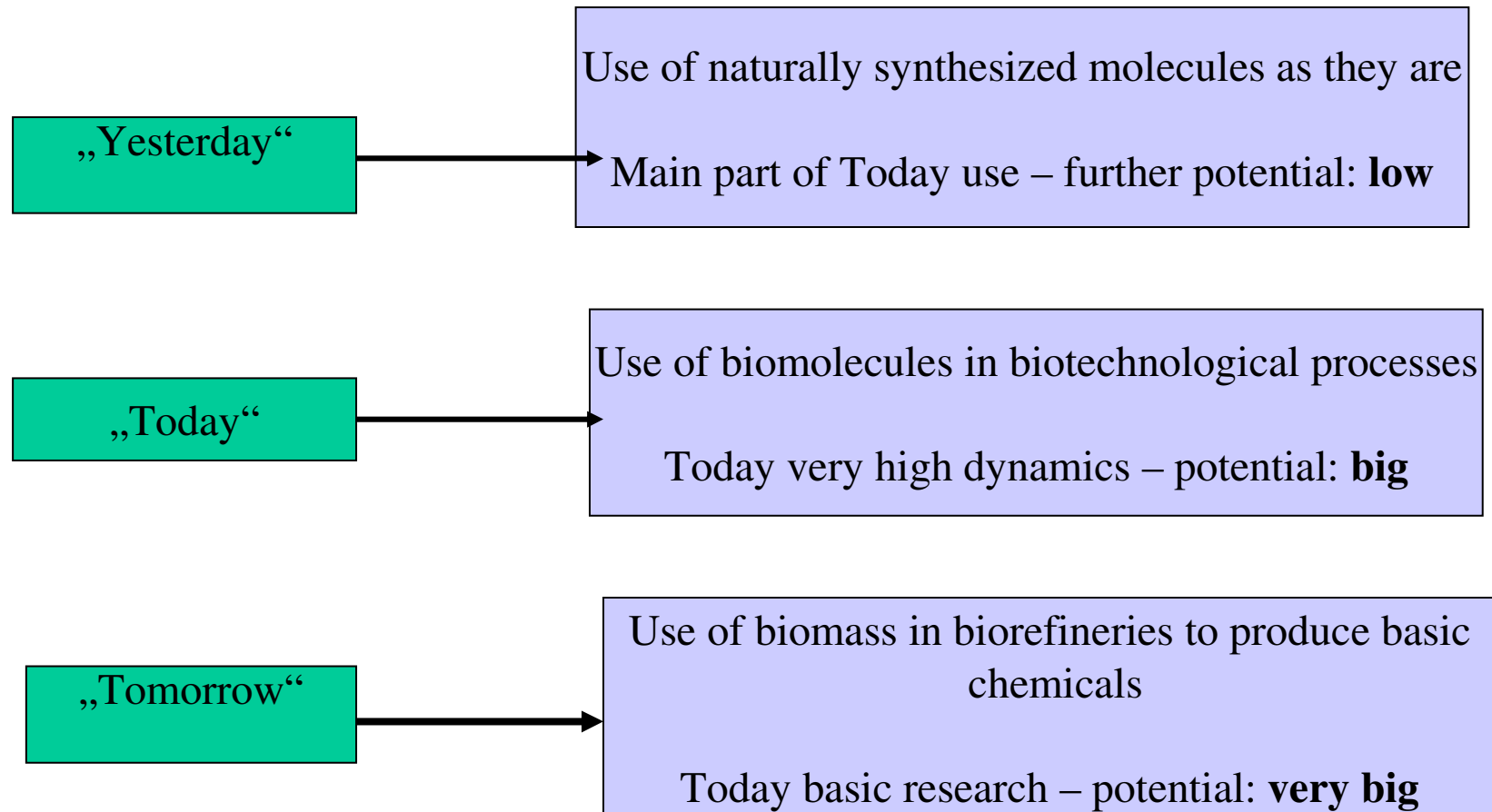


About 350,000 species of plants are defined as seed plants

**There are over 20,000 species of edible plants in the world;
yet fewer than 20 species now provide 90% of our food.**

- **Plants also provide us with fibres for making cloth, rope, paper etc.**
- **There are numerous dyes obtained from plants.**
- **Many plants have oil-rich seeds and these oils can be extracted.**
- **Many of them can also be used as lubricants, fuel, for lighting, in paints and varnishes, as wood preservatives, for waterproofing etc.**

Three „Generations“ of Biomass Usage in the Chemical Industry



Motivation for the Use of Renewable Raw Materials

■ **Competitiveness:**

- Economical advantages: raw materials with more competitive prices
- Technical advantages: improves processes and products
- Sustainability (ecological, economical and social aspects)

■ **Innovation:** new products

■ **Security of supply:** fossil feedstock is limited, biomass seems unlimited

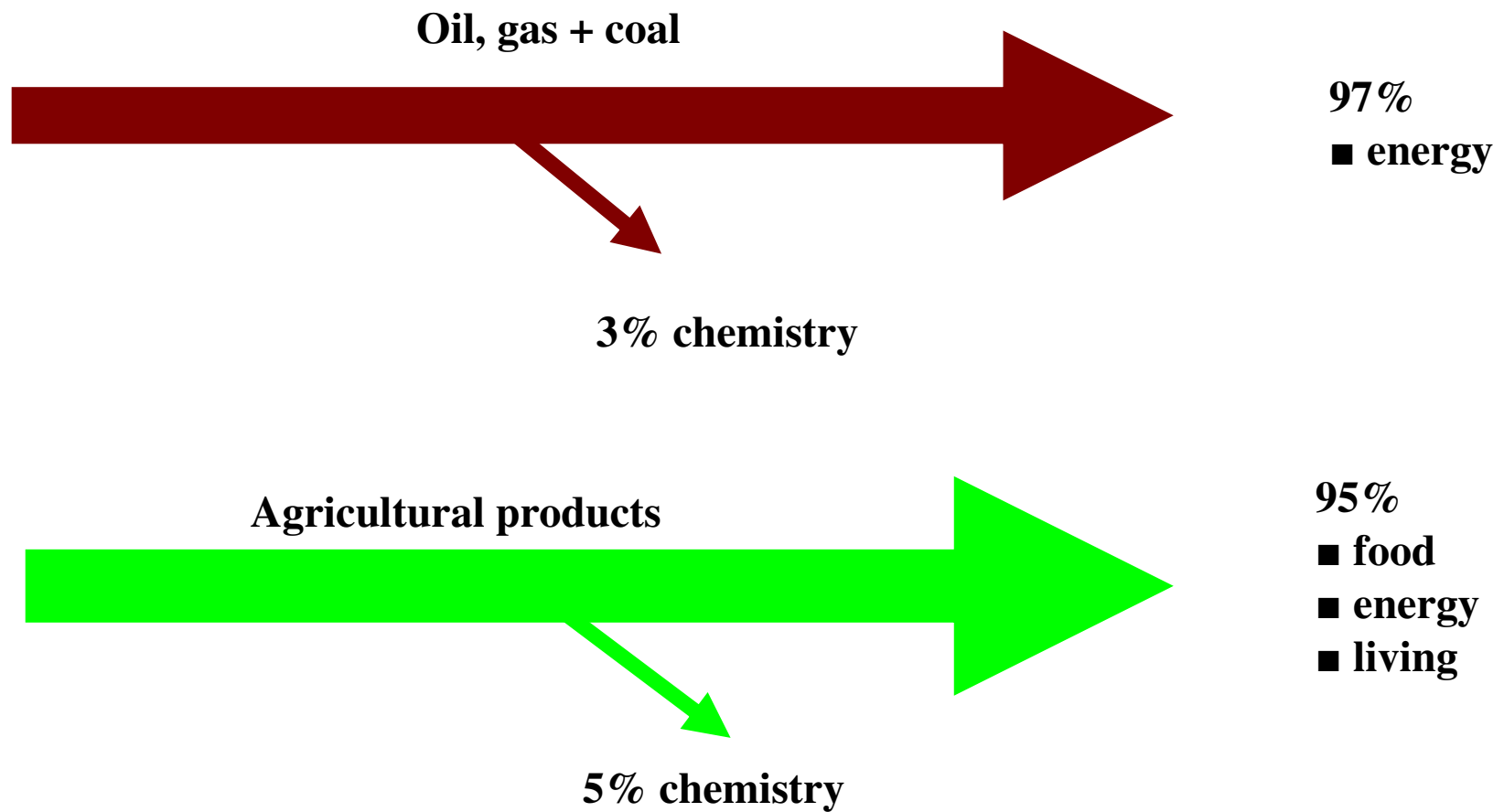
■ **Climate change:** biomass is considered as „CO₂-neutral“ (biomass based products may have a better carbon footprint)

Raw material prices have been fluctuating a lot due to multiple influences, e.g. weather, climate change, rising demands for food, feed and fiber, regional programs, ...

Changes of wheat price:

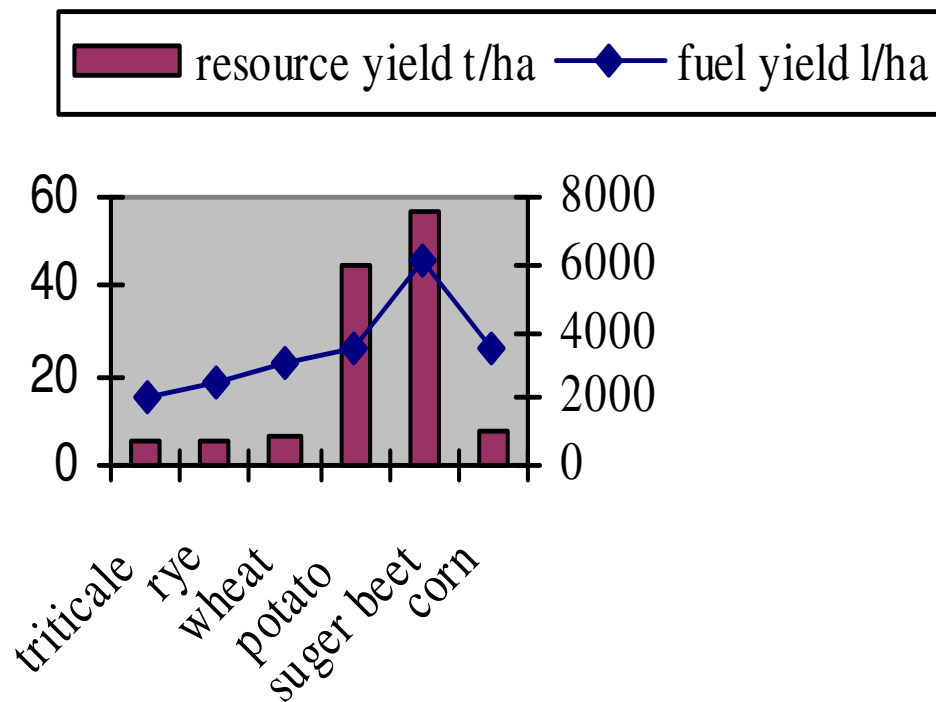


Worldwide Material Streams



Being suitable as feedstock for production of chemicals does not automatically mean that a specific renewable resource is economically feasible

Yields for various renewables used as feedstock in Bioethanol production:

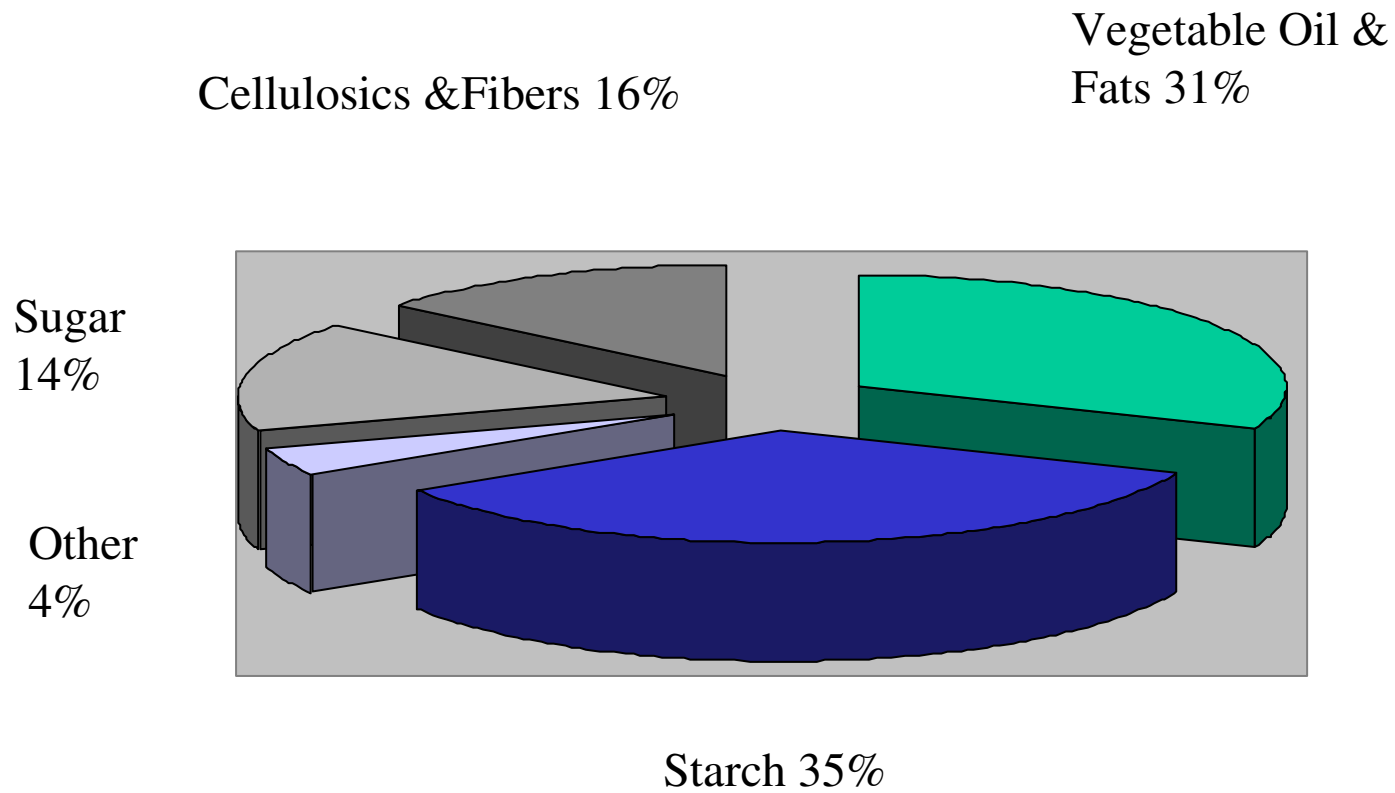


- Efficiency of renewable resources for chemical production varies significantly
- Availability of resources may change due to different price strategies and possible alternative land use opportunities
- Biodiversity aspects need to be considered

- **Chemical Industry in Europe has been using a variety of biobased renewable raw materials since a long time**
- **8 to 10% of feedstock for the organic production of the European chemical industry is biobased**



Total industrial use of RRM



Estimations based on data from: EU, IENICA, EHGA, CIRFS, EIHA, EuropaBio, AAF, Röper, Kaup, EurObserv'ER, FAO

■ **55% of the biomass in 2050 will be harvested in South of Sahara, Caribbean and South America and in the former Soviet Union.**

In East Europe will be harvested 3%

In West Europe will be harvested 4%

■ **Only 10 to 16% of the expected primary energy consumption in Europe will be covered by biomass produced in Europe**

Survey of Lithuanian plant division

Agricultural land, suitable for agricultural production, is 3,47 million ha (53% of Lithuania).

30% of Lithuanian population lives in a country;

13% of employable Lithuanian people works in agricultural sector.

14 research institutions with their departments may participate in biomass research. 387 researchers works in these institutions.

Prognoses:

11,5 thousand ha of energetic plants will be grown until 2013

230 thousand ha of rape will be grown in the year of 2015

Area of fruits and vegetables will be doubled

Area of flax will be expanded

Area of sugar-beet and potato will remain the same

20 million tons of biomass (as dry substance) is formed on Lithuanian territory per year by the process of photosynthesis.

2.5 – 3.0 million tons of oil products per year are used in Lithuania at the present time.

Biomass of agricultural plants in Lithuania

The main agricultural products (thousands tons per year)

	Average of 2001-2004	2006	2010	2015
Grain	2649	1893	3030	3580
Rape seed	124	170	546	690
Sugar-beet	954	717	1117	1102

Potential feedstock for industrial biotechnology in 2010 may reach 1-2 mln. tons of grain ,
0.5 – 0.6 mln. tons of rape seed.

Biomass of agricultural plants in Lithuania

Secondary agricultural production (thousands tons per year)

	Average of 2001-2004	2006	2010	2015
Straw	2702	1949	3000	3600
Rape straw	163	224	737	930
Sugar-beet	572	430	670	661

Potential feedstock for industrial biotechnology in 2010 may reach 2 – 2.5 mln tons of lignocellulosic biomass.

General characteristics of Lithuanian forests

Parameter	1998	2004	2005
Forest land area, thousands ha	1978	2069	2091
Of which plantations, thousands ha	424	464	463
Total growing stock volume, millions m³	347.6	387.9	393.2
Mean volume per ha, m³	184	197	198
Total volume of mature stands, millions m³	59.4	79.6	81.5
Gross annual increment, millions m³	11.6	12.5	12.8
Forest coverage, %	30.3	31.7	32.0

Total amount of forestry residues which may be used as fuel or raw materials for industrial biotechnology equals 1.70 mln m³ per year (approx. 0.85 million tons). It is expected that short rotation tree plantations will add much to this amount in the future.

Ambitious research agenda (2005-2025)

Through well-targeted research into plant genomics and its biotechnological applications, it is possible to:

- Improve understanding of plant metabolisms*
- Secure a healthy, high quality food/feed supply*
- Improve plant yield potential and security*
- Increase the amount of useful plant matter*
- Develop renewable materials*

This can be achieved by developing plant types that can be grown as sources of renewable materials. This will help cut down on the fossil energy used and waste currently generated in producing them.

*Projects on Development of the Industrial Biotechnology in
Lithuania 2007-2010 targeted research into plant biomass*

There are 7 projects

Project - **Wheat for special - purpose polymer production**

Participants:

- Lithuanian Institute of Agriculture ■ Institute of Biotechnology
- Company 'Malsena' ■ Company 'Dotnuvos projektai'

Main results expected:

- **Identification of genes controlling starch granules type A and type B synthesis in wheat endosperm and evaluation of their expression pattern**
- **Accomplishment of amylopectic starch wheat genome, grain quality and biopotential analysis**
- **2 new competitive wheat varieties with high biopotential, high starch production and optimal starch granule proportion (granule > 10 μ m in size content 65-74%) will be created**
- **25 new amylopectic and large-granule starch wheat genotypes will be created**

Project - **Quality improvement of raw material of medicinal plants using plant biotechnologies**

Participants:

■ Institute of Botany ■ Vytautas Magnus University ■ Kaunas Botanical Garden of Vytautas Magnus University ■ Company “Švenčionių vaistažolės” ■ Company “Herbitum Balticum”

Main results expected:

To develop polyploid forms of annual medicinal plants with enhanced biosynthesis of biologically active secondary metabolites and higher quality of raw material using plant tissue and cell engineering methods.

Project-Detection and elimination of viroids and phytoplasmas from horticultural crops used in industrial biotechnology

Participants:

- Institute of Biotechnology ■ Molecular Plant Pathology laboratory (Baltimore) ■ Institute of Botany
- Lithuanian Institute of Horticulture ■ MBI „Agrochema“

Main results expected:

- Viroid and mollicute (phytoplasmas and acholeplasmas) species that are spread out in Lithuania will be detected, identified and characterized
- Damage made will be identified
- Molecular pathogen detection methods by creating new PCR primer groups will be developed and tested
- Possibilities of growing-up viroid- and phytoplasma-free plants by evaluating efficiency of thermo-, cryo- and chemotherapy in *in vitro* system will be evaluated

Project - **Biotechnological approaches to improve plant cold tolerance**

Participants:

■Institute of Biotechnology ■Lithuanian Institute of Horticulture ■Lithuanian University of Agriculture ■Company „Agrochema“

Main results expected:

- Cloning of genes, responsible for cold resistance, cold acclimation, vernalization and promoters regulated by temperature, photoperiod, phytohormones. Construction of vectors with these combinations.
- *In vitro* and *in vivo* studies of biochemical, physical factors on cold hardiness and cold acclimation regulating genes expression in rape, *Miscantus* and horticultural plants.
- Plant transformation with genes: *HOS1*, *ICE1*, *CBF3*, *MYB15*, *COR15*, *COR47*. Gene expression studies *in vitro* and *in vivo*, choice of valuable plant forms for further selection.

Project - Plant biomass energy value enhancement by biotechnology methods

Participants:

■Lithuanian Institute of Agriculture ■Lithuanian University of Agriculture ■ Company „Vyrybalt“

Main results expected:

- New genotypes of herbaceous plants with high energy value will be developed.
- Cultivation technology of valuable biomass producers will be prepared.
- Technology for the use of by-products of biogas production (processed biomass) for fertilization of perennial grasses
- Major genes controlling lignin biosynthesis, their nucleotide sequences in herbaceous plants will be identified. SNP markers will be identified of these genes.

Project - Fruit plants as producents of natural anthocyanins

Participants:

■ Lithuanian Institute of Horticulture ■ Institute of Biotechnology ■ Institute of Botany ■ Kaunas University of Medicine ■ Institute of Biomedical Research ■ Company „Agrochema“

Main results expected:

- The main project goal – to evaluate variation of anthocyanin qualitative composition and quantity in fruits of different plants during ripening,
- To study their bioactivity in heart fibre and mitochondria, also in plant cell culture *in vitro* systems,
- To construct different constructions for regulation of structural and regulatory genes expression in plants,
- To create plants producents of stable and valuable to human health anthocyanins, and technologies for production of food dyes.

Project - Management of oil crops' productivity and pathogenic resistance

Participants:

- Institute of Botany
- Lithuanian Agriculture Institute
- Lithuanian University of Agriculture
- Kaunas Vytautas Magnus University

Main results expected:

- New technological means for creation of *Phoma lingam* and *Sclerotinia sclerotiorum* resistant/tolerant rape genotypes will be uncovered;
- Thermostable proteins, responsible for winter hardiness would be identified and characterized by biochemical-molecular means;
- Specific antibodies would be used for rape winter hardiness screening and evaluation;
- Rape cultivation technologies will be modified in order to optimize seed weight per plant, seed lipid content;
- Potential of using unconventional oil-bearing plants (*Crambe*, *Camelina*) for bio-fuel and bio-lubricants processing will be evaluated;
- Genetic pool of Lithuanian oil-bearing plants will be enriched by spontaneous species;

Thank You For Your Attention

