

Cultivation, Processing and Utilization of Industrial Hemp in Poland

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Introduction

The world trends towards the industrial utilization of the renewable raw material based on natural polymers, including hemp and flax fibre and shives.

Hemp-annual plant, produce in its life cycle enormous amounts of biomass, environmentally friendly. The biomass could be used for the production of textile and textile technical products as well as non-textile once.

The scope of hemp application is very large and includes production of textile products, textile technical products, production of pulp (cellulose) and paper, composite materials, cosmetics, as well as food and pharmaceutical products.



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The renaissance of interest in hemp and intensification of hemp growing is noticed; mainly according to the issues of ecological production and usage of alternative raw materials by the industry.

The hemp provides important alternative for food crops production in agriculture. The renewed production of hemp fibre as well as its development for technical purposes will allow for the development of rural areas and the stimulation of solving of Polish agriculture problems. It could be achieved thanks to creating addition sources of income for farmers as well as work places in niche production and processing.



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Cultivation of hemp in Poland

Polish hemp varieties

In Poland three monoecious hemp varieties are registered:

* Białobrzeskie

* Beniko

* Silesia



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All three varieties have been bred at the Institute of Natural Fibres in Poznań.

Highly monoecious, stabilized level of monoecism.

Those fibrous varieties belong to central European cultivars, with the vegetation period adjusted to soil and weather conditions of this region.

Δ9THC below 0,2% (cultivation is absolutely safe and does not cause any drug threats)

No need of plant protection media application.

The soil of very good structure after hemp cultivation.

Cultivated on heavy metals polluted zones, contributing to their recultivation.

The yields: 8-9 tones straw/ha guarantee every year high output of the renewable biomass

Hemp 2000 kg of CO₂ from the atmosphere.



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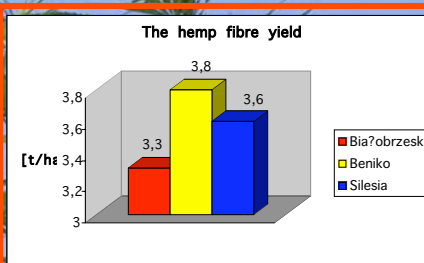
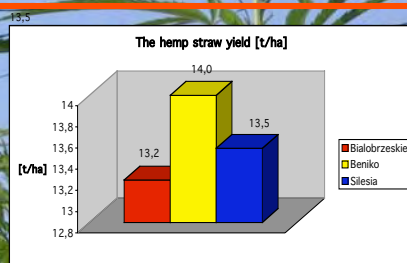


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Hemp yields

Parameters of Polish hemp cultivars' yields obtained in comparative trials

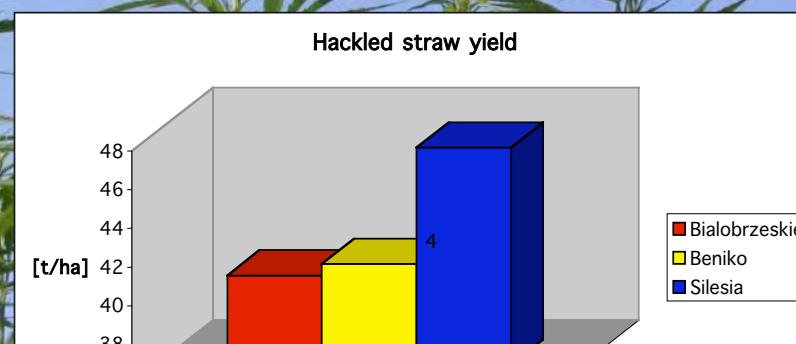


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Parameters of Polish hemp cultivars' yields obtained in comparative trials

47,2 Silesia 47,2



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Polish hemp varieties data

Polish varieties provide high and stabile seed yield between 300-1000kg/ha, depending on the cultivation purposes.

Straw yield 8-9t/ha

Fibre content 27-30%.

The seed yields of Bialobrzeskie are high (500-1000kg/ha).

Beniko provides the highest output of the fibre from 1ha.

Silesia presents high coefficient and efficiency of good quality hackled (combed) fibre.

Bialobrzeskie, Beniko and Silesia are registered on the list of qualified varieties according to OECD. The low content of Δ^9 THC, as well as high economic value were the parameters, which allowed for the official registration in Austria and on the list of varieties eligible for European Commission subsidies. Those varieties are allowed for cultivation in the EU countries.

The registration trials of the new Polish hemp variety Silesia started in 2001.



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The registration on the EU lists- followed by increase of the qualified sowing material selling mainly for markets of Germany, Finland, Czech Republic and UK.

The high demand for sowing seed required the extension of sowing seed areas and plantations in Poland. In 2003 the official agreements to produce qualified sowing material on 100ha have been signed. The sowing area of industrial hemp cultivation for diversified industrial purposes amounted at approximately 300ha.

Harvesting and primary processing of hemp

The harvesting technology of hemp

The harvesting technology of hemp depends on hemp destination.

Hemp from seed plantations is harvested with a help of mowers of Russian production ZK-1,9.



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Mower ZK-1,9

The ZK-1,9 mower collaborates with the trailer and cuts stems on 10cm. It cleans the straw from impurities e.g. tow, weeds as well as not suitable plants and then sheafs.

The capacity of his harvester is 0,5-0,8 ha/hour. The cut and the sheaf are standing on the field to dry.



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The MLK-4,5A deseeding machine



When the moisture of the raw material is below 18%, the deseeding is conducted on the MLK-4,5A.

The deseeding of the panicles (tops) is conducted between two pairs of drums, equipped with the fingers. The capacity of this machine allows for deseeding of 3,5-4,0 tons of hemp straw. The deseeded hemp straw is applied for industrial fibre processing.



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The hemp harvest on seed plantations



Machines adapted by the INF, which are devoted generally to harvest green forage.

The typical Polish agricultural practices mobile mowers have been adapted to the hemp harvest after modification of the construction of knives, as well as devices, which keep plants and supplies the raw material.



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The hemp harvest on seed plantations



The technology allows for total mechanization of hemp harvest.

Capacity of the harvesters of the Institute of Natural Fibres are up to 1,5ha/h, the cut hemp straw is laid in rows on the field and is picked up by baling presses used in Polish agriculture when the moisture is lower than 18%.

This technology guarantees quick and effective harvest of hemp biomass.



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New technology of hemp fibre extraction

The INF elaborated new, highly effective technology of decorticated fibre production/extraction from bast fibrous plants.

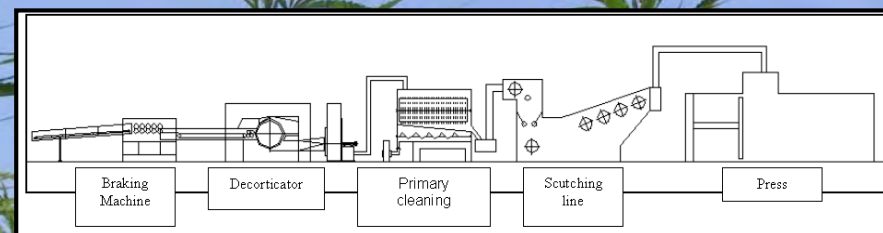
The new technology and the applied devices, allow for significant simplification of the processing methods, better production economy, through the limitation of energy and labor consumption of the fibre extraction process.



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The scheme of decortication line



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New technology of hemp fibre extraction

The proposed processing of the raw material eliminates:

- * labor and cost consuming processes (braking, shaking and scutching)
- * natural retting, which is depended on weather conditions
- * the need of the straw drying before extraction (the raw straw with natural moisture up to 18%).

It is not necessary to conduct the retting of the straw on the plantation.



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Decorticator

The new decortication line is able to process approximately 1500kg of the raw hemp straw, and obtain ca 25-30% of fibre, which could be cleaned up to the 5% of impurities.



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New technology of hemp fibre extraction



The produced fibre is appropriate for technical applications such as:

- * pulp and paper mass
- * composite materials
- * nonwoven fabrics etc.

The technological solutions allow for the decrease of decorticated fibre production costs in comparison with the raw material obtained with traditional hemp processing.



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The utilization of hemp fibre

The scope of textile utilization of hemp in Poland is not large and is at the level of 200t of fibre per year.

The production of flax fibre and modified hemp fibre (cottonin) is implemented and launched at the INF's experimental linen mill.

The technology allows for obtaining the thin fibre, shortened and very clean, which is suitable for blending with cotton, wool, viscose and other types of man made fibres.



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The utilization of hemp fibre

The features of modified fibre are suitable for the cotton system spinning, and are presented in table.

Quality feature	Linen cottonin	Hemp cottonin
Fineness of fibre	below 1,5 tex	1,5-1,9 tex
Fibre impurities	below 1,0%	below 1,0%
Mean linear mass	30-35 mm	20-50 mm



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The utilization of hemp fibre

The features of modified fibres allow for application of cottonin in mixtures (blends) with cotton.

The features of blended yarns are appropriate for their utilization for the production of knitting apparels and socks.



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Non-textile application of hemp in Poland

Biomass for pulp and paper

High content of cellulose in the hemp fibre appropriate for pulp and paper industry.

Hemp- an alternative source of cellulose for pulp and paper.

The quality of this cellulose is very high due to the appropriate length of the fibre.

Up to now this cellulose has been applied for the production of valuable papers and cigarette tissue paper.

The eco-friendly technology elaborated by INF in Poznań in co-operation with Pulp and Paper Institute in Lodz provides bleached fibrous mass from polluted areas (metallurgy industry).



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The degree of whiteness: between 75-85% and fulfills all requirements for long fibre cellulose mass (pulp) for the production of paper for special applications e.g. cartographic paper, Xerox paper, valuable paper, thin condenser tissue papers, paper appropriate to print Bible, cigarette tissue papers etc.



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Non-textile application of hemp in Poland

Biomass for pulp and paper

In Poland there is no functioning paper-mills, based on annual raw material. There is a preparation procedure going on to launch in 2004 the cellulose paper mill, which is supposed to produce pulp from hemp raw material. Its capacity should reach 20 thous. tones of cellulose mass per year in 2003-2008.



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Lignin derived from hemp

There is an increasing utilization of lignin, derived from the cellulose production. Lignin appeared to be an important raw material for the production of phenolic- and formaldehyde resins applied for composite production.

This natural polymer is more and more often applied for the production of agrochemicals, packaging laminates, frictional materials, wood composites (plywood, shive particleboards), moulding elements, and antioxidants.



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Composite materials

Biocomposites, based on binding media and resins of natural origin reinforced with natural fibres.

The main advantages of lignocellulosic composites: biodegradability, especially if the natural resins are applied.

Fields of application: for furniture, building, and automotive industries.



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Features of biocomposites reinforced with fibres for automotive industry:

1. high tenacity, similar to this of glass fibres
2. more resistant in case of the car crash in comparison to glass fibres.
3. do not break easily, are able to absorb energy, due to comparable tenacity and higher elasticity.
4. much lighter compare to composites reinforced with glass fibres; therefore their usage reduces the fuel consumption.



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Particleboards

The production of MDF (Medium Density Fibre Boards), based on annual plants is applied in Poland in furniture and decorative panels production as well as in building industry.

They are characterized by highly homogenous structure, smooth surfaces, and dimension stability. They are easy to dye (color); they have got higher tenacity towards bending, and towards elongation.

MDF boards production does not require conditioning, and it is possible to apply the same finishing techniques, as in the case of wood boards.



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Insulation materials

The panels made of entire hemp plants are applied as insulation material and as inner, non-construction walls in building. The production technology of such panels is very simple and the equipment is not complicated.

The research of the INF showed, that most suitable is the straw from the final vegetation period phase, when the stems are enough woody and fully developed.

The empty space created inside the stems, enhances the insulating properties of hemp panels and such stems are light.



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The utilization of shives (hurds)

Bedding materials e.g. for horse, swine and poultry. The shives are very valuable because:

- *absorb the smell and urine
- *could be the source of agro-chemicals.

Trials at INF to utilize hemp hurds as the medium for cultivation of consumption mushrooms (*Pleurotus columbinus*). The first part of their maturity was observed after 42 days. The yield of obtained edible mushrooms was approximately 0,65kg from 1 kg of dry mass of the culture medium.



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The utilization of shives (hurds)

The hurds - an excellent raw material for briquettes or pellets.

For: energy providing material

The energetic value of hemp shives (hurds) in pellets is about 18MJ/kg (while for wood 16MJ/kg).

Note: no need to dry the shives before briquette production process, which decreases the costs of the pellet production.



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