CONSIDERATIONS REGARDING THE DEVELOPMENT OF NEW EQUIPMENT USED FOR HEMP HARVESTING

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ABSTRACT

The important potential of cultivating hemp for fiber and cannabidiol extraction for medicinal use, makes this plant return to the attention of agronomists and medical researchers. Another strength of this plant is the potential of produced fibers to contribute to the decrease in the use of plastic in the near future, helping to reduce dependence on fossil fuels. In addition, hemp could be a more economically attractive alternative for ethanol generation or even for the production of high-strength construction materials. The paper aims to present several technologies used for hemp harvesting.

INTRODUCTION

Climate change is already affecting food security through increasing temperatures, changing precipitation patterns, and increasing the frequency of some extreme events. In the current changing conditions, research is needed on the development of various crops, that are having superior adaptive capacities and are less affected by climate stress (Nenciu, F., et al. 2021; Vlăduţ V., et. al. 2020).

Hemp has always been a better natural resource than trees. Because hemp has not been legal in most of the world for the past 80 years, it has never had a chance to compete on an equal footing with wood or other natural fibers. In terms of quality and performance, hemp fiber has some advantages, being probably the strongest and most durable fiber in nature. Hemp is not only 10 times stronger than wood fiber, but also four times stronger than cotton.

Industrial hemp is lighter and cheaper to process than wood. By establishing hemp crops for 40 years can obtain 400% more usable fiber than planting the same area with trees for 40 years. Hemp is the most efficient biomass resource in the world. In less than 91 days, the plant can generate stem up to the stage when the fibers have reached their full CO_2 content and are ready to be processed properly. An increasing number of scientific publications highlight the other important properties of hemp: high absorption characteristics, has protection against IR and UV radiation and naturally low flammability. Other promising new tests also indicate natural antibacterial properties of hemp fiber, which are the result of alkaloids, cannabinoids and other bioactive or phenolic compounds, (Amaducci, S. and Gusovius, H. 2010; Desanlis, F. Cerruti, N. and Warner, P. 2013; Dun, A. and Declerck, S., 2009; Gusovius, H.-J., 2002)

Hemp also provides an attractive investment opportunity for companies that are looking for an efficient way to make their products "decarbonised" - decreasing their carbon emissions. Due to hemp strong carbon storage capacity, based on the high biomass content and the low level of water requirements, hemp is probably the most durable fiber of all.

Hemp plants have an exceptional absorption capacity for CO2, even higher than the trees. According to several scientific articles, one hectare of a common hemp variety can absorb 8.88 tons of CO2 annually, while one hectare of forest captures about 2.5 tons of CO2 annually.

Research has shown that hemp varieties grown for fiber generally produce up to five times the biomass of the remaining "seed" strain - up to 42 tones - and that CO2 displacement when hemp is replaced by traditional raw materials in end products such as plastic, textiles, steel, construction and other materials could reduce CO2 emissions by up to 200 tones.

Although plant produces oxygen in the atmosphere through photosynthesis, this natural process diminishes with the aging. It seems logical that large trees with a significant leaf area would generate more oxygen, especially since they live much longer than a hemp plant, but this is not always correct. While the ability of larger trees to produce oxygen decreases in time,

hemp is a fast-growing plant that is harvested after only 12 weeks.

Industrial hemp fiber may also be suitable for paper production, cellulose being the main chemical that strengthens paper and other composite products. With a concentration of cellulose of 72%, hemp has a higher concentration than wood, which provides only 42%. The more cellulose a plant contains, the less chemicals it takes to make paper. Hemp peel has the highest cellulose content compared to any other known plant, (Pari, L., Baraniecki, P. Kaniewski, R., et al, 2015; Placet, V., Day, A., Beaugrand, J. 2017).

Fig. 1 Industrial hemp cultivation, (https://agrobiznes.md/otilia-cotuna-este-momentul-canepa-sa-revina-in-gama-de-culturi-agricole-ale-romaniei.html)

In addition to growing much faster than trees, its high cellulose content allows for lower conversion costs and does not require significant amounts of toxic chemicals for processing. Wood pulp requires the use of pollutants such as sulfuric acid, bleach and chlorine to remove the mass of non-cellulosic fibers during the pulping process. Hemp fiber, on the other hand, can be bleached with hydrogen peroxide, which is not chemically harmful. In addition, paper made from hemp fiber, compared to its wood pulp counterpart, is resistant to decomposition and does not turn yellow or brown with age.

Hemp fiber can play a vital role in trade and economic development. One interesting feature of the "hemp business

model" is that collaborations with existing industrial capacities are practically unlimited.

Hemp oil is also rich in protein, vitamins and minerals, while the protein is complete, being rich in nutritionally important essential amino acids (Wirtschafter, 1997). For this reason, there is a real chance that hemp seed powders will be part of the food ratios of animals in the future, being able to successfully replace soybean crops (Callway J. C., 1998). Compared to soybean crops, hemp proteins are much easier to digest.

Hemp is made up of to three parts that can be used: The seeds can be used in the preparation of various foods, oils and medicinal products. The fibers have several industrial uses (from clothing to machines) - they form the middle layer of the stem and are covered by a thin protective layer. The wood core left after the fibers have been extracted is the part used for construction sector (Brückner, T. and Steger J., 2013; Budde, J., Gusovius, H., Hoffmann, T. et al, 2014; Grotenhermen, F., and K. Müller-Vahl., 2016).

The seeds and stems do not mature together - they are (or at least should be) harvested at different times. Both seeds and fibers have different optimal harvesting periods. The seeds do not mature at once, since they tend to mature in two cycles. The best time to harvest seeds is when it is believed that most seeds can be harvested (when some of the seeds may be spoiled), (Thouminout , C., 2015; 20https: // bhudeva .org / ro / 2010/12/17 / recoltatu-canepei-parte-1 /).

Hemp was once cultivated in Romania on large areas, especially for obtaining textile fiber, until 1990, being the third country in the world to produce hemp.

It is very important that the hemp varieties that can be grown in Romania have applications in various industries.

The hemp cultivation process is natural and environmentally friendly, without excess of using pesticides, insecticides or fungicides. After harvesting the hemp crop, the stalks are left in the field to separate the fibers from the woody part of the stem. Harvested hemp seeds are conditioned and used in the food industry, and the leaves are dried and used for tea blends, but also for the extraction of CBD-rich oil and used in the composition of nutritional or dermato-cosmetic supplements (Gusovius, H., 2011).

Beyond the impediment to authorization and monitoring, hemp cultivation brings more than profitable gains to those who invest in it. It is grown for its relatively high natural fiber content and for its seeds rich in drying oil. Hemp fibers are longer than flax, very durable and quite resistant. They are used in the manufacture of a wide range of resistant textiles, even in under water employment. Short fibers (tows) are used in the manufacture of mattresses as well as an insulating material.

By-products - such as oils, or ash are generally obtained by applying chemical-thermal treatments, and use as an organic fertilizer rich in phosphorus and potassium. Applications in medicine include productions of sedatives, diuretic, vomiting, deworming and other products prepared from the tips of the inflorescences of female plants and from seeds, (Hempflax, 2017).

On the other hand, hemp oil resulting from cold pressing of seeds is used as a natural supplement to fight cancer, diabetes or arthritis. Due to the fact that it has so many uses ranging from the cosmetics or textiles industry to construction, hemp has gained a special interest lately for Romanian farmers, who have started to be interested again in the cultivation of this plant.

MATERIAL AND METHOD

Hemp is a strong plant and requires powerful harvesting equipment. The fibers are very strong and therefore the stem is difficult to cut, tangling in the knives - which involves the use of high quality materials. Hemp is a tall plant (much taller than wheat) - and this involve special harvesting equipment in order to reach the top. When the stem is cut, it is advisable to cut it in such a way that it is easy to gather in bales. Stems should be cut as long as possible - long fibers are generally better and more useful than short ones. Stems and seeds may be harvested together. The seeds are usually harvested first, then using a well sharpened and fast cutting system the stems are harvested as well, leaving the long fibers intact.

The time of harvesting the hemp seed is when in the lower third of the inflorescence have acquired the characteristic color and are no longer covered by bracts. The fruits in the middle third of the inflorescence have the characteristic color, but are still covered, and those at the top have a yellowish color, maturing later. Manual

harvesting (rarely practiced), consists in cutting the stems, in bundles and placing them in pyramids for drying, for 6-8 days, after which they are beaten by hand and blown on the spot. The mechanical harvesting can be done in a single phase with special combine harvesters for hemp crop or possibly with a usual harvesting equipment modified for this purpose. Preliminary defoliation is mandatory and is done with the substances recommended by agronomists, when the first seeds acquire the characteristic color (about 10-12 days before harvest). Harvesting in two phases consists of cutting with a combine harvester, drying for 5-6 days and threshing with a thresher specially modified for this operation.

It is recommended to harvest the male plants separately after shaking the pollen. Thus, a very good fiber production is obtained, and the seed production increases, making the harvesting easier. In order to be preserved, the seeds must be completely cleaned of the inflorescence residues and green seeds. The seeds are kept in a thin layer, of 15-20 cm until the humidity reach 9%. Only then can they be stored in layers up to 100 cm or, preferably, in bags.

Depending on how the hemp is harvested, appropriate equipment has to be used. The "HempCut" machine system, with a working width of 3.0 or 4.5 m respectively, has been developed since the 1990s in the Netherlands. It is currently considered the most widely used system for hemp harvesting. The system is manufactured and distributed by the company Wittrock (Rhede Brual). It is based on a lawn mower in combination with a modified shredder drum and equipped with a single knife.

The Claas 492/493 harvester is commonly used as a load-bearing vehicle, if the original cutter is replaced with the said module. The variable drum drive control allows the cutting of the fiber harvesting stems in lengths from 150 to 600 mm. The load-bearing vehicle remains practically in its original state and can be used in all harvesting operations for other field crops, carrying out many hours of work annually, thus reducing harvesting costs.

Fig.2 Machine system „HempCut“,
(http://multihemp.eu/media/2018/07/Deliverables_D_4-3_D_10-1_Report.pdf)

Kranemann's "Blücher" system (Klocksin - Blücherhof) is based on a completely different concept. Mowing is performed by additional cutting Long pieces up to 80 cm with vertically installed cutting discs, in the original vertical position of hemp plants (Amaducci S., Gusovius H., 2010). Both subprocesses are performed simultaneously before the eccentrically conveyor elements transport the biomass behind the cutter head. The supports having a width of 80 to 110 mm are deposited in the field by both harvesting systems. Given the comparatively high yield of hemp biomass, operations are required one to several times to allow uniform drying in the field.

Fig.3 Machine system „Blücher“,
(http://multihemp.eu/media/2018/07/Deliverables_D_4-3_D_10-1_Report.pdf)

Another technological approach focuses on the application of the scissor principle for hemp harvesting, as is known from cutting fodder or cereals. A vertical arrangement on two or four levels of cutting bars allows the required shortening of hemp stems. In 2007, the Czech company Tebeco launched a three-tier harvesting system based on double-fingered steel bar cutting. The demand for such mowers increased especially in the first decade after the cultivation of hemp in Germany.

Fig.4 Three-level cutting equipment, (http://multihemp.eu/media/2018/07/Deliverables_D_4-3_D_10-1_Report.pdf)

Hemp harvesting with a Claas Xerion 4000 VC. The machine separates the protein-rich leaves from the stem and collects them in a hopper in the back of the machine. It is usually used as animal feed. Fiber-rich stems remain dry to rot, they are pressed into packages and then processed into composite materials, such as car door panels or insulating material.

Fig. 5 Claas Xerion with Hemp-Stripper, (https://horsepowersonline.com/video/harvesting-fiber-hemp-claas-xerion-4000-dunagro/)

A hemp harvesting equipment created through a cooperation between HempFlax and GroeNoord., has more than 25 years of experience in hemp cultivation. GroeNoord company also covers the technical, production and commercial parts. With this technology can separate the three elements: fibers, seeds and the flower / leaf of the hemp plant. The quality of the raw materials is very good. Two machines in the series can be offered: the DoubleCut version and the SingleCut version. Both series can be combined with a flower collection system. The equipment can be installed on the John Deere W6 series or T6 Walker combine MY16, while the reconfiguring in a conventional combine can be done with little effort.

Two systems have been developed for collecting flowers / leaves. A blower (TFB10) and a trailer (TFT10). The blower system is mounted on the left rear of the combine, while the trailer system is towed by the combine.

a)

b) ***c)***

Fig. 6 a), b), c) Double-Cut-Combine, (https://budsfeed.com/product/hempflax-modified-john-deere-t660i-double-cut-combine--1568553920792x253278131975094270)

This machine separates the tips and leaves form the fiber-rich stems in a single pass. Countertops and leaves are processed and dried and can be used, for example, for the preparation of CBD oil or hemp tea. When the growing conditions are correct, the combine can also be used for threshing hemp seeds from the tops. The stems are left on the ground and then are baled and processed and can be used in the textile industry or for composite materials. The John Deere T660i combine is transformed by Dutch distributor John Deere GroeNoord, using a 4.5-meter-wide header. Below it is mounted a cutting head from the JD 8000 series. They cut the stems 60 cm long and leave them directly on the ground to be later baled. https://www.hemp.com/ro/hemp-university/growing-hemp/harvesting-hemp-for-fiber.

For textile applications, hemp is cut at the beginning of flowering or while the pollen is shed, but before the seed sets. The fibers cut after seed harvesting will lignify considerably and are only usable in some non-woven industrial fiber applications.

(https://www.hempflax.com/wp-content/uploads/HempFlax-Groenoord -Double-Cut-Combine-Prospectus.pd).

CONCLUSIONS

The use of modern equipment in hemp harvesting technology ensures the following advantages: harvesting on the three components: seed, leaf and stem; higher seed yields; leaf harvesting capacity; better fiber processability; labor and fuel cost savings, CO2 emissions reduced to 2.5 per Ha; increased operator comfort.

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