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Hemp Club

Competent and Connected Clusters Unfold the Hemp Industry Potential for the European Bioeconomy

European Cluster Excellence Programme with ClusterXchange scheme connecting ecosystem and cities

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Overview of the different existing and potential hemp-related value chains

The HempClub Project

The **Competent and Connected Clusters Unfold the Hemp Industry Potential for the European Bioeconomy (HempCluB)** project is an EU COSME project coordinated by the Lombardy Green Chemistry Association bringing together **7 clusters and associations** from Italy, Czech Republic, Romania, Austria and Portugal.

Acknowledging the fact that, with its unique chemical properties, environmental benefits, high yield and wide range of applications, hemp is a valuable crop for the bioeconomy, contributing to achieving climate neutrality, the HempClub project works to **unlock the potential of hemp** by creating EU value chains for biobased applications and new business opportunities for primary producers and chemical companies. As a European Strategic Cluster Partnership, HempCluB promotes collaboration, synchronised strategies, and encourages innovative interregional investments to enhance cluster excellence. Through mutual learning, and SMEs and other stakeholders' mobility, HempCluB aims to unlock the biomass exploitation potential supporting the ClusterXchange scheme's implementation.

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Executive Summary

This document aims at presenting an overview of the existing and potential value chains distinguishing between industrial hemp and medical cannabis, a sector of growing interest all over Europe, but with separate rules and techniques, since it deals with high content of controlled substances.
The overview is based on the following steps:

- The uncertain distinction between 'hemp' and 'cannabis' within a unique species, *Cannabis sativa L.*, and the restrictions imposed to this date by the UN Single Convention on Narcotic Drugs;
- the framework of the potential applications of the different parts of the plant *Cannabis sativa L.* and the framework of the industrial sectors involved;
- the current development of the hemp market, at global and European level, with a focus on the main existing applications and players in the following sectors: Textile, Construction, Biocomposites and Bioplastics, Paper, Food and Beverages, Feed, Innovative materials and energy storage;
- the UE hemp regulation framework, that recognizes hemp as a legitimate agricultural crop and industrial plant provided that its THC content doesn't exceed 0,2% (0,3% from January 1, 2023), but with no clarity about the use of its entire biomass, including flowers, leaves and resins and the patchwork of rules in the member states
- the fundamental sentence of the European ***Court of Justice against French legislation*** in the so-called '*Kanavape'* case
- Novel Food and Cosmetic rules on CBD and the forecasted THC limits for hempseed food derivates;
- analysis and mapping of the existing hemp value chains in the 5 HempClub countries: legislation - R&D support with a focus on genetics and machinery – trends of cultivated areas - main industrial applications and players for fiber, seeds and active substances extracts - medical cannabis state of the art.

The analysis shows substantial differences between the 5 countries, based on multiple factors, mainly on legislation. Moreover, generally speaking, hemp value chains are quite well developed in food and cosmetic sectors, but not in the manufacturing sectors. In fact, all the five countries have strong know-how in hemp use in sectors like composites, non-woven or construction, but suffer a lack of fiber processing facilities, representing the crucial link in all these chains.
On this basis, this document presents a final framework of strengths and weaknesses of hemp development in each country.

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1. Introduction

As part of task 2.2 "Development of a comprehensive scheme of hemp-related value chains and their relation to the EU Green Deal", this deliverable analyses the technological, environmental, social and economic aspects of EU hemp value chains in partners' countries, also focusing on the regulations and policies affecting the hemp sector. By providing an exhaustive overview of the different existing and potential hemp-related value chains in the partners' countries, this deliverable will be used, in the context of WP2, as input to implement specific services to support the development of such chains.

1.1 Clarification on terms: hemp and cannabis

Many national regulations usually distinguish between the terms "hemp" and "cannabis", although they are just two different names of the same botanical species: *Cannabis sativa L*. However, in regulatory papers and policies, the word 'hemp' generally identifies cannabis plants or strains with a low content of THC (tetrahydrocannabinol), the active principle responsible for hemp's psychotropic effects on human beings. On the contrary, the term "cannabis" is usually employed when referring to higher THC strains, used as drugs or in the pharmaceutical sectors. Generally, according to forensic toxicology and scientific literature, plant varieties with a THC content lower than 0,5% are not associated with such effects. In North America, USA and Canada, the legal limit for cultivation is 0.3%; in some countries as Switzerland and recently Czech Republic (since the 1st of January 2022) is even 1%. In the EU, the limit is currently more restrictive – 0.2% - although such limit will be increased to 0.3% in January 2023.[1]
This report will usually refer to industrial hemp, but with insight also in the medical cannabis sector (and thus high THC strains) due to its increasing interest in overall Europe.

1.2 The Single Convention on Narcotic Drugs

Before analyzing the existing and potential hemp value chains in Europe and the regional contexts of the HempClub partners, it is important to consider the international legal framework on controlled substances. Some severe legal limits in fact are still imposed on the use of *Cannabis sativa L.*, due to the presence in every hemp variety or strain of a psychoactive principle, called ∆9-Tetrahydrocannabinol (THC).
For this reason, 'Cannabis', intended as the flowering or fruiting tops of the *Cannabis sativa L.* plant, was listed as a drug in the so-called ***Single Convention on Narcotic Drugs***,[2] subscribed on the 30th of March 1961 in New York at the United Nations from 183 countries and still in force (amended by the Protocol of 25 March 1972 at Geneva), aiming to combat drug abuse by coordinated international action. For sixty years the tops of *Cannabis sativa L.* plant have been listed in Schedule 1 and 4, thus compared to heroin and other drugs with "particularly dangerous properties". However, "*This Convention shall not apply to the cultivation of the cannabis plant exclusively for industrial purposes (fiber and seed) or horticultural purposes*" (art.28, 2).
In the last decades, hundreds of active principles in the hemp flowering tops were discovered, many of them having important medical properties. Currently, about 150 molecules have been discovered within the phytocannabinoids family (the family of ∆9-THC), the majority of which are not psychoactive (with the exception of two new molecules recently discovered)[3], benefiting the human and animal health, such as Cannabidiol (CBD), the most abundant phytocannabinoid in hemp industrial varieties.
Only in December 2020, the UN decided to remove *Cannabis* from Schedule 4 while maintaining it under International Drug Control in Schedule 1 (that contains morphine for example), recognizing at least its medical properties. Two years before this decision, the ***World Health Organisation (WHO)*** commissionated to its *Expert Committee on Drug Dependence (ECDD)* to conduct a review of the cannabinoids dossier and their hazard profile. Following the final recommendation of ECCD's review, on the 24th of January 2019, the WHO's General Director sent a note to the General Secretary of the UN, Mr. António Guterres, with six recommendations, proposing also that "*Cannabidiol (CBD) should not be scheduled within the International Drug Control Conventions*", by simply adding the following footnote to cannabis scheduling *"Preparations*

[1] https://eiha.org/wp-content/uploads/2021/12/PR-CAP-VOTE-COUNCIL.pdf
[2] https://www.unodc.org/unodc/en/treaties/single-convention.html
[3] See chapter Hemp Value chains in Italy – R&D

containing predominantly Cannabidiol and not more than 0.2% of ∆9-Tetrahydrocannabinol are not under international control".
Unfortunately, the UN did not follow such recommendations, causing uncertainties in the use of the entire plant *Cannabis sativa L.*, with substantial regulation differences from country to country, outside and inside EU.

1.3 Industrial Hemp and Cannabis applications

The *Cannabis sativa L.* plant can be divided into several parts, all of which with many potential applications:

- Stems, containing
  - Fiber (17-27%)
  - Shives (70-75%), the lignocellulosic part of the stem
- Seeds
- Leaves
- Flowers and Resins
- Roots.

The following scheme shows the main potential and existing applications of the various parts of the plant.

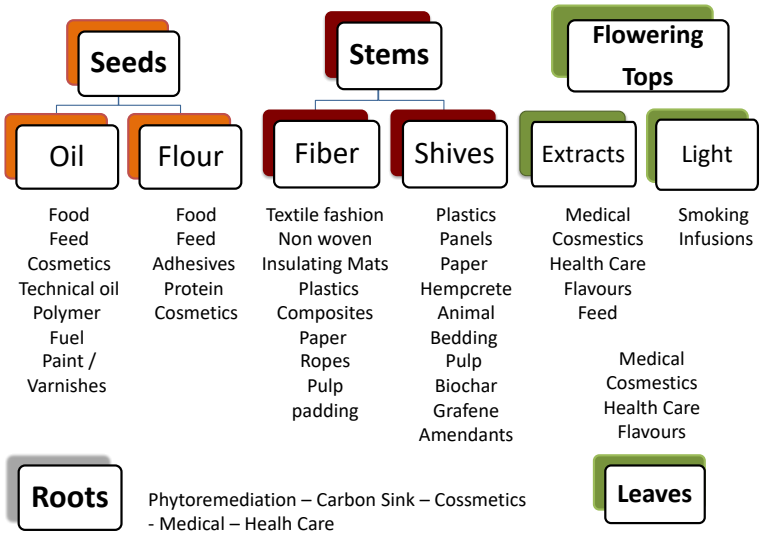


Figure 1. Parts of *Cannabis sativa L.* plant and their applications

Many industrial sectors take already users of the hemp potential and the applications of its different parts *(Figure 2)*. Beyond the final users, other business sectors are involved in the hemp supply chains, including:

- Genetics (new strains for innovative applications);
- Mechanics (harvesting, decorticating);
- Chemistry and Biochemistry (extraction techniques, retting, bioplastics production).

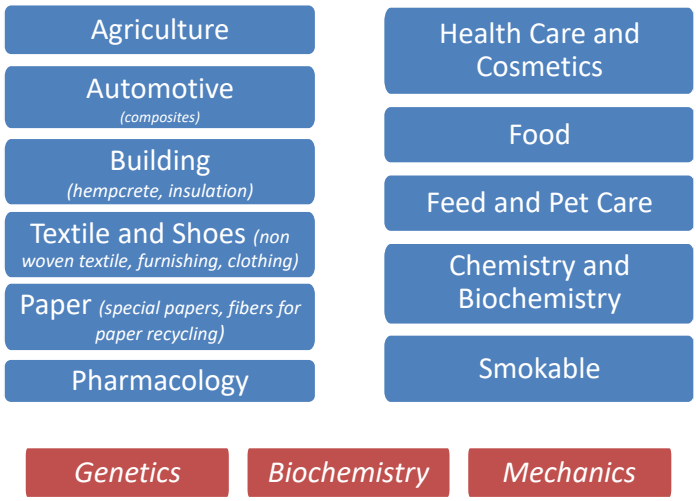


Figure 2. Industrial sectors using hemp

Moreover hemp has many environmental benefits[4]:

- **Carbon storage**: one hectare of hemp sequesters 9 to 15 tons of CO_2, similar to the amount sequestered by a young forest, but it only takes five months to grow – moreover the use of the plant in various products, like hempcrete or hemp fiber insulation in construction, reduces energy consumption and carbon emissions;
- **Breaking the cycle of diseases**: hemp helps to break the cycle of diseases when used in crop rotation. In addition, weeds are not able to grow due to the fast growth and shading capacity of hemp plants;
- **Soil erosion prevention**: dense leaves of hemp become a natural soil cover, reducing water loss and protecting against soil erosion. Hemp covers the ground just three weeks after germination;
- **Biodiversity**: flowering cycle usually occurs between July and September, coinciding with a lack of pollen production from other crops. Hemp produces large amounts of pollen. It also provides shelter for birds and hemp seeds are food for animals;
- **Low or no use of pesticides**: hemp is susceptible to few pests because of the lack of natural predators, which means that the use of insecticides, herbicides, and fungicides can be avoided in most cases;
- **Organic cultivation:** hemp can be grown with organic fertilizers such as manure or digestate, thus representing a promising crop to support the transition from conventional to organic farming.

The positive impact of the hemp industry on the environment also brings economical benefits, especially in the form of Carbon Credits or other financial instruments dedicated to carbon-neutral technologies and products.

1.4 The Market: World and Europe[5]

According to *TechNavio* and *GrandviewResearch*, industrial hemp global market in 2019 reached 4,1 billion $, with a global harvested area of 375,000 hectares and it is projected to grow at a CAGR of 16% by 2025.[6] The global hemp harvested area 2019: Asia Pacific countries (mainly China) account for 40% of the global hemp market, followed by North America (26%) and Europe (18%). The main market segment is historically textile (47%), followed by personal care (18%), CBD (12%), and food and derivatives (10% - *see Figure 3*).

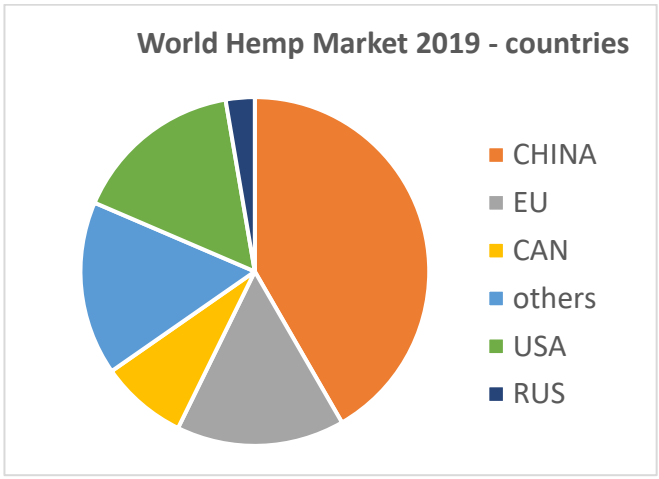
[4] https://ec.europa.eu/info/food-farming-fisheries/plants-and-plant-products/plant-products/hemp_en

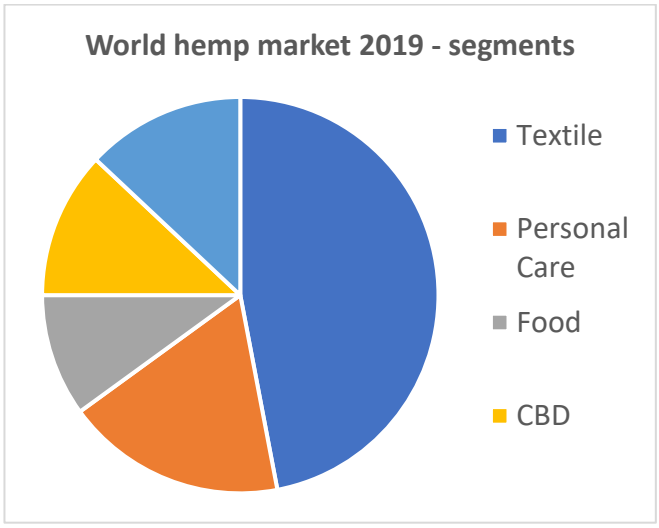
[5] UNCTAD recently published a document ("Commodities at a glance – special issue on industrial hemp" UN 2022) with a large overview of hemp international trade and prices, according to official data from FAO and UNComtrade. But these data are largely incomplete and also UNCTAD suggests that better information can be obtained from national data or private entities as those we refer to in this study

[6] Technavio, "Global Industrial Hemp Market 2019-2023" – GrandviewResearch "Industrial Hemp Market Size, Share & Trends Analysis Report 2020-2030"

In the EU the area dedicated to industrial hemp cultivation in recent years has almost tripled from 19,970 ha in 2015 to 56,196 ha in 2019. In the same period, the production of hemp increased from 94,120 tons to 152,820 tons (a 62.4% increase).[7]
According to EIHA (European Industrial Hemp Association), European hemp transformers source 90% of their raw material within Europe. More than half of flowers and leaves traded in Europe are used for the production of food supplements, including CBD extracts. However, textile production represents a niche market because of the relatively high raw material prices, the lack of fiber supply and the scarcity of manufacturing facilities. Before WWII, the production of hemp textile fiber was more advanced in Europe, with Russia cultivating almost 700,000 hectares, providing for 40% of Europe's hemp needs, followed by Italy and Yugoslavia with more than 100,000 hectares each.

Figure 3. World Hemp Market





Source: our elaboration on data Technavio

Although Europe has not unlocked the full potential of hemp, the industry is rapidly growing. France today is the first hemp producer (17,900 ha in 2020), accounting for one-third of the global EU hemp area, followed by Germany, Lithuania, Esthonia and the Netherlands. However, due to many relatively new markets like biocomposites, hemp food, CBD or CBG extracts, the area cultivated in each country can change dramatically from year to year (Table 1).

[7] https://ec.europa.eu/info/food-farming-fisheries/plants-and-plant-products/plant-products/hemp_en

In terms of production (MMT - Million Metric Tons), France accounts for almost 40% of EU hemp production, followed by the Netherlands (10%), while the Dutch cultivated area is quite limited. Indeed, Dutch hemp producers are contracting hemp farmers both in Denmark and Germany to be able to meet the production needs.

Table 1. Hemp cultivation in some EU countries *

country	*hectars*		
	2018	2019	2020
France	16,458	14,546	17,900
Germany	3,114	4,508	5,507
Lithuania	\	9,182	5,000
Esthonia	\	4,455	\
Italy *	*4,000*	*3,100*	*2.200*
Austria	1,583	2,005	2,166
Romania	3,147	2,231	1,334
Netherlands	3,833	1,877	\
Poland	1,300	3,000	\
EU global	**50,081**	**56,196**	

Source: Data from USDA FAS (Foreign Agricultural Service) and other various sources
** estimates*

Textile

The textile and fashion application leads the hemp market, generating over €1.5 trillion in global revenue. Hemp for 'textile' applications means not only fashion, but also technical fabrics and non-woven for building, furniture and horticulture applications. Hemp textiles are created using bast fibers once they have been separated from hemp hurd through the process of decortication, resulting in durable, breathable and antibacterial fabrics, while being also resistant to mold and ultraviolet light, features that make the hemp fibers very appreciated in the hemp market. Furthermore, hemp cultivation is associated with a reduction of inputs and GHG emissions, thus making its derived fibers and fabrics more sustainable. This could represent a solution to the "environmental and social emergency" of the fashion industry, as it was defined by the *UN Alliance on Sustainable Fashion* established in 2018 by 10 UN countries[8]. Indeed, the industry is responsible for almost 20% of global wastewater and 10% of global greenhouse gas emissions, as well as using more than 25% of all chemicals produced globally. Moreover, it has significant social costs such as dangerous working conditions and the use of hazardous chemicals during production.
In recent years, leading brands such as ***Levi's, IKEA, H&M*** and ***Patagonia*** have included hemp in their collections. For example, Swedish fast fashion company *H&M* includes hemp as part of various eco-friendly clothing lines; *IKEA* has included hemp as a material for various pillow covers, table runners and other furniture.
Nonetheless, hemp is still a very small proportion of global textile production, with an estimated volume of 60,657 tons versus 111 million tons of textile produced in 2019.[9]
Moreover, the suppliers of hemp fiber textiles on the European market are mainly based in China. Indeed, China is not only the biggest producer of hemp fiber but is notably improving in the automation of hemp scutching. The Heilongjiang province, in the far northeast of the country, produces alone almost half of hemp fiber world volume and the R&D in the automation processes, including spinning and weaving, is supported by the Central Government with the cooperation of ***National Hemp Industry Technology System*** and the ***Qinggang Agricultural Center***. The main global producers are ***Shanxi Greenland Textile, Ningbo YAK Technology*** fabrics supplier for Chinese army***, Shenyangbeijiang, Kingdom*** and ***Hemp Fortex Industries Ltd***,

[8] UNECE https://unece.org/forestry/news/fashion-environmental-and-social-emergency-can-also-drive-progress-towards
[9] see Prohibition Partners, *Industrial Hemp*, The Impact Series, November 2021

a leading supplier of organically grown hemp, now a vertically integrated manufacturer and a global enterprise with a design studio in Seattle, Washington, and supplier of famous brands including *Patagonia*.[10]
A more advanced case of circular economy applied to hemp is proposed by ***Circular Systems S.P.C.*** (Social Purpose Corporation), a US materials science company, which has developed *Agraloop™ BioFiber™*, a technology which allows to transform leftovers from agricultural crops into textile-grade fiber for the fashion industry. Two of the primary sources are crop leftovers from oilseed and CBD hemp production. *BioFiber™* is now being incorporated into *H&M*'s fashion collections aiming to use 100% recycled or sustainably sourced materials by 2030.
Flax industry in cooperation with Belgium partners created in 2021 a new Hyler machine[11] which can harvest hemp stems similar as flax providing the opportunity to process them on the scutching lines for long textile quality fibres same as flax. This is big step for hemp industry and further processing of textile hemp in Europe. The French Flax and hemp organization (Linetchanvrebio.org) [12] organised in June 2022 event on French / Belgium border with 300 experts interested in hemp production for textile, aiming at launching again this industry in Europe.
Research is also committed to find novel uses of hemp in the textile industry, to be used, for example, as a feedstock for man-made cellulosic fibers (like viscose or lyocell) and bio-based leather alternatives. In particular, a German research project at ***TITK Rudolstadt*** has shown promising results in developing sustainable lyocell fibers using hemp as a feedstock, called *Lyo-hemp®*. This produces extremely fine fibers in the range of the nest cotton with more environmentally-friendly processing.[13]

Construction

The green building sector is one of the biobased sectors in constant growth with new sustainable-by-design polymers driving the green transition of the sector. In this context, hemp is a versatile material that in the form of hempcrete bricks/blocks, prefabricated panels and hempcrete spray can be used for construction and insulation. Hemp, indeed, has insulation and transpiration properties that allow a huge energy saving in building, thus reducing the GHG emissions of buildings that are responsible for 38% of all greenhouse gas emissions worldwide. Three-quarters of these emissions are, indeed, related to their ongoing energy use and the remaining quarter are embodied emissions during their construction.[14]
Hemp panels can be obtained mainly from hurd or whole stem, such as hemp wood material. Traditionally seen as a less valuable by-product of bast fiber, hurd's potential as a building material has enlarged the biorefinery concept for this plant. Hurd can be turned into a range of construction products such as roofing tiles, insulation, fiberboard and more recently hempcrete blocks. First developed in France in the 1990s, hempcrete is the popular name for construction blocks made from mixing hemp hurds with a lime-based binder and water, which is then used for walling and insulation. The resultant material is a lightweight (7 times less than concrete, breathable and durable replacement for conventional concrete, although the lower compressive strength properties. Also, it can be easily recycled into new buildings material.
Hemp fibers or stems can also be used to produce insulation material as a natural replacement for glass fiber insulation insulation when mixing with only 10% PPL[15] or PLA, or even used as 100% natural material for insulations[16]. Being fire- and mold-resistant, it provides insulation properties similar to fiberglass but with a better thermal mass. Moreover, it contains no harmful substances and does not cause irritation to the skin or lungs like fiberglass.
The leading European manufacturer of hemp blocks is Belgian ***IsoHemp***, which has doubled its turnover, each year, since its foundation in 2012, and opened a second plant in France in 2022. Another leader in the EU is the Dutch ***HempFlax***, which produces a range of insulating materials and other biocomposites used for

[10] "We source the best and most environmental fibers, spin the highest quality yarn and knit and weave fabrics that are both fashion right and eco-friendly" www.hempfortex.com
[11] https://hemptoday.net/new-harvester-yields-hemp-fiber-suitable-for-flax-processing-lines/
[12] http://linetchanvrebio.org
[13] TITK https://www.titk.de/en/innovations/lyocell-/-lyohemp
[14] https://globalabc.org/news/launched-2020- global-status-report-buildings-and-construction
[15] https://www.kobe-cz.eu/en/vyroba/prirodni-vlakna/kobe-eco-hemp-flex/
[16] https://www.hanffaser.de/

automotive industry but also for construction, as well as precast hemp blocks made with water and lime binding. Hempcrete can be, in some projects, applied also by spraying which could speed up the process of applications. [17]

Biocomposites and Bioplastics

Bioplastics and biocomposites are expected to be an area of significant innovation and growth in the coming years. According to the *European Bioplastics,* the biopolymers volumes will triple in the next 5 years, from 2,4 million tons in 2021 to 7,6 million tons in 2026.[18] Asia is the main producer, accounting for 50% of the global, followed by Europe (25%).

Hemp biocomposites offer some mechanical advantages and a 25% weight reduction over glass fiber composites. Weight is important because, according to Euro 6 standard, the fiscal drag will be heavier for vehicles generating more than 98 g/km of CO2 emissions. It is easier for lighter vehicles to assure CO2 emissions below that limit.

Demand for biocomposites is rapidly growing, particularly in automotive industry. German car manufacturers - ***BMW, Volkswagen*** and ***Audi*** – were the first to use natural fiber composites, incorporating hemp in vehicle interiors, such as door panels. In 2021, two Italian composites producers, ***Bercella*** and ***Fibertech Group***, used hemp fiber for some components of the bodyshell of an electric racing vehicle, the *Alfa Romeo Giulia ETCR* by ***Romeo Ferraris***.[19]

Another example of the potential of hemp-based composites is the French ***Automotive Performance Materials***, a joint venture between the automotive components manufacturer, ***Faurecia*** - part of the FORVIA Group, a global automotive supplier - and a major French agricultural cooperative, ***Interval***. One of its flagship products, *NAFILean*, is a 20% hemp fiber reinforced polypropylene compound designed for automotive structural parts by injection process: panels, door panels, center consoles. It was first used in the manufacture of the *Peugeot 308* line in 2014, and is now being used in the models of at least five other vehicles.[20] Faurecia has been recognized in 2022 for the German Innovation Award and received the "Winner" award in the Automotive Technologies category. With their use of natural fibers, these materials set standards in recycling and contribute to weight reduction in vehicle interiors and thus to a reduced carbon footprint in automotive construction. The carbon footprint of different natural fibres for biocomposites and insulation material is well described in study conducted by the Nova Institute, providing data for the automotive and insulation industry[21].

Hemp biocomposites are also being used in consumer products, like suitcases, cosmetics packaging and mobile phones produced by a Swedish company, ***Triflon***.

Cellulose from hemp fibers can also be used to produce a non-toxic bioplastic 2.5 times stronger than polypropylene. It is also lighter and requires less energy to produce, according to some studies.[22] Moreover hemp plastic is both recyclable and 100% biodegradable, although it is still difficult to produce 100% hemp-based bioplastic.

Packaging is the biggest segment of the bioplastics market (1,2 million tons, 48% of the global volume). An interesting example of hemp-based packaging is US ***Sana Packaging***, Colorado, a sustainable packaging brand that designs and develops packaging made from 100% plant-based hemp plastic, 100% reclaimed ocean plastic or other innovative recycled materials.[23]

The Italian thermoplastics producer, ***LATI Industria Termoplastici*** (Lombardy), has made a recent agreement with another innovative Colorado company, ***The Hemp Plastic Company***, for the distribution in Europe of their hemp blended plastics.

[17] https://hemplimespray.co.uk/

[18] European Bioplastics, "Bioplastics Market - Development Update 2021" bioplastics.org/publications/EUBP_Facts_and_figures.pdf

[19] See chapter Hemp Value Chains in Italy

[20] Fontaine-lès-Dijon, France

[21] http://eiha.org/media/2019/08/19-08-06_Study-Natural-Fibre-Sustainability-Carbon-Footprint.pdf

[22] Modi, A.A., Shahid, R., Saeed, M.U.,& Younas, T.(2018) "Hemp is the Future of Plastics" In E3SWebofconferences (Vol. 51, p. 03002). EDP Sciences. https://www.e3s-conferences.org/articles/e3sconf/pdf/2018/26/e3sconf_icac- er2018_03002.pdf

[23] https://sanapackaging.com/

However, hemp plastic still struggles to compete with traditional plastic in terms of price and, for this reason, its usage is still limited. Paul Benhaim well describes the role of hemp plastic in the fight of climate change and its potential is well described in study written.[24]

Paper

The use of hemp in papermaking dates to the first paper made by the Chinese over two thousand years ago. Hemp paper can be made from both hurd, tow or bast fiber. Paper production using offcuts from textile fiber processing was widespread until the industrialisation of paper production, when commercial paper production was optimised for wood pulp. As a result, hemp paper became economically not competitive and, after II World War, it was dedicated only to small niche uses, such as cigarette paper (e.g. Delfort group in Czech Republic[25]) and banknotes, particularly in France. However, hemp paper offers some advantages compared to wood pulp. Dried hemp is rich in cellulose, the main ingredient of paper, averaging around 57% as compared to 40-50% in wood, and it has a lower lignin concentration, which needs to be removed chemically in the paper process.[26] Furthermore, hemp as raw material can be produced faster than wood (a few months versus 20 years). Additionally, hemp fiber paper can be recycled up to eight times, compared to just three times for wood pulp paper. As climate change and environmental concerns require more and more to recycle paper, papermakers need to dispose of strong fibers and show a renewed interest in hemp. However, at the moment, fiber extraction from hemp from the stalk has a yield of only 20-25% and the process is costly. The price and the amount of fiber obtained are, thus, still an obstacle to the development of hemp paper industry. An interesting example of hemp-paper industrial production is China's ***Shenzhen Datong***, which recently made headlines with an innovative hemp paper-based product line also including baby diapers and feminine hygiene products. In Europe, hemp paper is still confined to special papers production, more often at artisanal level, with excellent examples like "*Hempathy*" line of papers, hand-made creations of ***Sandro Tiberi*** from Fabriano, paper district since Middle Age. But there also bigger companies specialized in quality papers, like ***Büttenpapierfabrik Gmund*** (Gmund am Tegernsee - D) with its *Gmund Hanf* line, made from 100% European hemp. Another big German paper industry ***Hahnemuehle*** prepared in 2022 a special custom-made paper for a new edition of an encyclopedic book on industrial hemp ("H is for Hemp" by Maren Krings).[27]

Food and Beverages

Food and Beverages include hempseed-derived products but also, more recently, flowers and leaves extracts. Hemp food is a relatively new market, although its use in the kitchen is testified from the Middle Age. In Europe, the hemp food sector was unlocked in the second half of 1990s, becoming more and more relevant in the food sector, being classified today as a "superfood". Today Canadian companies were the first to unlock the potential market of hemp food. Since 2000, they were the unique suppliers of the huge US market, taking advantage of the fact that until 2018 hemp food could be sold but not produced inside the USA.
The food and beverages market holds great potential for hemp-based products looking to benefit from recent trends toward health and sustainable eating. The hemp-based edibles global market in 2020 was estimated at 2.6 billion $ (70% only in the US).[28]

Hempseed food. The main property of hemp seed oil is its exceptionally high levels of essential polyunsaturated fatty acids – linoleic acid (omega-6) and alpha-linoleic acid (omega-3) - in a ratio of about 3:1, considered an ideal ratio for human health.[29] Most plant-based oils in Western diets have much higher ratios of omega-6 to omega-3. A high level of omega- 6 consumption has been linked to chronic inflammatory

[24] https://www.academia.edu/44243119/Hemp_plastic_co
[25] https://delfortgroup.com/en/location/op-papirna-s-r-o/
[26] Malachowska, E., Przybysz, P., Dubowik, M., Kucner, M., & Buzala, K. (2015). Comparison of papermaking potential of wood and hemp cellulose pulps. Annals of Warsaw University of Life Sciences-SGGW. Forestry and Wood Technology, 91.
[27] https://blog.hahnemuehle.com/en/h-is-for-hemp-printed-on-hahnemuhle-hemp-paper/
[28] Prohibition Partners "Disrupting Food" The Impact Series 2021
[29] Rodriguez-Leyva, D., & Pierce, G. N. (2010). The cardiac and haemostatic effects of dietary hempseed. Nutrition & metabolism, 7(1), 1-9. https://link.springer.com/article/10.1186/1743-7075-7-32

diseases such as cardiovascular disease, rheumatoid arthritis and Alzheimer's disease.[30] Moreover, hempseed is a high-quality, easily digestible and sustainable protein source (edestin and albumin + high levels of arginine) and it also contains fibers, vitamins (notably tocopherol) and minerals.
Hulled hemp seed, hemp seed protein powder, and hemp seed oil were recognized as *Generally Recognised as Safe* (*GRAS*) by the *Food and Drug Administration* in December 2018, paving the way for the growth of the hemp food industry in the United States.
Hemp food has developed in Europe for many years with many smaller-scale hemp food companies which have so far been slow to expand. One of the biggest European hemp food producers is the German company ***Hempro Int.***

The largest European grower of hemp, France, produces over 11,500 tons of hemp grain per year. In 2016, 44% of the French hemp seed production was employed for animal feed, while 43% was employed for human consumption; 13% was dedicated to oil production. The largest French producer of hemp seed, ***La Chanvrière de l'Aube***, claims to supply 30-50% of Europe's hemp seed demand each year. The second European hempseed producer is the Lithuanian company ***Allive*** contracting organic farmers all around Europe for their BRC quality production of hemp food ingredients on more than 8000 ha.

Novel Food

Flowers and leaves of industrial hemp strains, rich in CBD and terpenes with a negligible amount of THC, can be used as flavorings for many beverages, like teas, beers or non alcoholic drinks, or as food supplements, in the form of CBD extracts or isolates or pure CBD. The global market is full of such products, also with the involvement of big companies like ***Constellation Brands*** (*Tweed Fizz™, Tweed Iced Tea™*) or ***Anheuser-Busch InBev*** which made an agreement with the biggest pharmaceutical cannabis company, ***Tilray***, to study cannabis-infused beverages for the Canadian market. Unlike many national legislations, the European Union from 1997 until 2019 hasn't forbidden hemp flowers and leaves extracts as food ingredients. However, in January 2019 the EC updated the *Novel Food Catalogue* with the entry for "*Cannabis sativa* L.". Only seed-derived products are now considered food while leaves and flower extracts are now considered Novel Food, which means "any food that was not used for human consumption to a significant degree within the Union before 15 May 1997".[31] According to the new Novel Food regulation, only the products authorized and enumerated in a Union List can be placed on the market. In 2021, European companies submitted about 50 novel foods applications for CBD products, but none of these has been authorized, also because of the remarks of EFSA in June 2022.[32] To get around this obstacle, the Danish company ***Royal Unibrew***, with its brand Ceres, announced in April 2022 *Hempiness*, a beer derived from hempseed and terpenes. The great world epicenter for CBD food and drinks authorizations is the UK. In July 2022 the UK's *Food and Standard Agency (FSA)* reached a "milestone" after **authorizing almost 12,000 cannabinoid (CBD) products** to its public list of items that can be marketed in England and Wales.

Cosmetics

Hemp-based products are already popular in Cosmetics, especially hemp seed oil and CBD oil ingredients, mainly used topically in skincare products. Hemp seed oil had been used for a long time as a nourishing and moisturizing ingredient. The British company ***The Body Shop***, for example, has been using hemp since 1992, and nowadays other famous brands such as ***Garnier*** (***L'Oréal***) or ***Estée Lauder*** offer hemp-based product lines. The European Cosmetic Ingredients database, *CosIng*, nowadays authorizes about twelve hemp-based ingredients, mostly derived from seed oil but also leaves, roots, sprouts and CBD and CBG (Cannabigerol), another non-psychoactive cannabinoid. CBD oil is a powerful anti-inflammatory, which helps treat acne, sensitive skin, eczema, psoriasis and rashes. Also if CosIng is not binding for member countries, its list of authorized ingredients has contributed to the rapid growth of the hemp-based cosmetics market. In

[30] DiNicolantonio JJ, O'Keefe JH. Importance of maintaining a low omega–6/ omega–3 ratio for reducing inflammation. *Open Heart* 2018
[31] Reg 2283/2015 on Novel Foods
[32] https://www.efsa.europa.eu/en/news/cannabidiol-novel-food-evaluations-hold-pending-new-data

particular, the CBD cosmetics market has seen a remarkable rise in recent years, reaching an estimated global turnover of 710 M$ in 2018, according to Prohibition Partners.[33] The CBD market is driven mainly from numerous indie brands. The major barrier to the further development of the industry, in its current state, is the lack of supply chain consistency.

Feed

Hemp seeds have long been used as supplemental animal feed (poultry and fish in particular). With the rise of the hemp seed oil market for human consumption, after hemp seeds have been cold-pressed to extract oil, the residue, called hemp seed cake, high in protein and with a similar amino acid profile to soybean meal, can be used to produce flour for bakery, in small amounts, but mostly for animal feed. Scientific studies show the benefits of hemp seed cake as feed, from increasing the nutritional value of cow milk to enriching the omega-3 content in egg yolks when fed to hens, without detectable cannabinoid residue in the eggs.[34] Hemp press cake is also well recognised as feed supplement for horses.

Other hemp by-products, such as sediment, hulls and pulp may also have the potential to be used as animal feed.

The European feed market is dominated by soybean meal as a source of protein, mostly imported from Latin America and mostly GM (Genetically Modified). In this context, hemp seed cake, derived from domestic crops, can be a valuable and safer alternative and an efficient way of maximising the value of using the whole plant. Already in Europe, hemp seed, hemp seed cake, hemp seed oil, hemp flour and hemp fiber are allowed as animal feed for livestock, with maximum diet incorporation rates for each species (e.g. 2-5% for pigs, 3-7% for poultry).

Innovative materials and energy storage

A 2014 research study showed how hemp bast fiber could be used to produce carbon nanosheets that work as supercapacitors.[35] This graphene-like material is stronger than diamond and more conductive than copper. Although it is less diverse in potential uses than conventional graphene, it works particularly well for energy storage applications and is, at least, equal to the performance of commercial graphene devices.

Electricity storage devices are of huge importance for the transition to a renewable energy system. The technology for hemp-based supercapacitors has passed the 'proof of concept' stage, and now the barriers it faces, before becoming commercially viable, centres around its potential for scalability. Although these storage devices are not being commercially produced, they have the potential to compete with lithium-ion batteries in applications such as electric vehicles and power tools.

2. Methodology

The present work was based on the analysis of different documents and sources of data, collected through general literature on hemp topics, websites research and through cooperation with the *HempClub* partners and their networks for each of the five countries involved and with *EIHA (European Industrial Hemp Association)* for the European framework.

In particular, for the different chapters of the survey, the main sources of data were the following:

- The framework of hemp and cannabis applications is based on the knowledge of Federcanapa and the literature collected over the years;
- The market analysis was conducted with the aid of *TechNavio*, *GrandviewResearch* and *Prohibition Partners* surveys, ones of the most outstanding market research companies. *Prohibition Partners* is

[33] Prohibition Partners "The Disrupting Beauty Report" The Impact Series 2021

[34] Karlsson, L., Finell, M.,& Martinsson, K.(2010) "Effects of increasing amounts of hemp seedcake in the diet of dairy cows on the production and composition of milk". *Animal*, 4(11), 1854-1860.

Rajasekhar Kasula, et al. 2021. Effect of increasing levels of dietary hemp seed cake on egg quality in commercial laying hens. Int. Journal of Poultry Science., 20: 48-58. https://docsdrive.com/pdfs/ansinet/ijps/2021/48-58.pdf

[35] Wang, H., Xu, Z., Kohandehghan, A., Li, Z., Cui, K., Tan, X., ... & Mitlin, D. (2013) "Interconnected carbon nanosheets derived from hemp for ultrafast supercapacitors with high energy" *ACS nano*

specifically focused on hemp and cannabis (medical and recreational) market analysis and their reports are rich in information about the European sectorial markets and players. Another important source for monitoring prices and trade of the hemp unfinished products (fiber, hurd, seeds, extracts) is the European *CanXChange* platform with its quarterly reports;

- The legislation analysis was based on official European and national documents about hemp and cannabis regulation and on critical papers and proposals from *EIHA* and from national associations;
- The survey and mapping of hemp value chains in the single countries was based partly on general intelligence source, as the *USDA FAS (Foreign Agricultural Service)* reports on industrial hemp market in various European countries, partly on information provided by each HempClub cluster with the aid of national hemp associations and mostly on web research about main public and private players and about main projects related to hemp.

3. Results

3.1 Hemp value-chains in Europe

EC Hemp regulation

In 1989, the EC Regulation 1164/89 introduced a financial support for fiber flax and hemp, recognizing the legitimacy to grow hemp for industrial purposes. The Common Agriculture Policy (CAP) support for hemp has been renewed also in the last CAP cycle (see CE Reg. n.1307/2013) including also the production of seed derivatives. The only constraint posed by the CAP is that hemp varieties must not exceed a THC content of 0.2% and be listed in the '*Common Catalogue of Varieties of Agricultural Plant Species*'.
Moreover, in the EC, the import export of hemp biomass is permitted within the CN code 5302, which specifies: *"True hemp (Cannabis sativa L.), raw or processed but not spun; tow and waste of true hemp (including yarn waste and garnetted stock)"*.[36]

Therefore, EU legislation recognizes hemp as legitimate agricultural crop and industrial plant, provided that its THC content doesn't exceed 0.2%. This limit will be increased up to 0.3% from January 1, 2023. Moreover, the EU legislation affirms that cultivation of hemp cannot be prohibited by any individual Member State as long as it fulfils the EU conditions.

However, a crucial point for the development of the hemp sector in Europe is the industrial use of the entire plant *Cannabis sativa L.*, including its flowering or fruiting tops, which are still listed (excluded seeds) under Single Convention on Narcotic Drugs. An example in this context is the Lithuanian regulation: since November 2021 Lithuanian producers can use the whole hemp plant in their products and Lithuania is now one of the main hemp producers in Europe.

The EU regulation, on the contrary, hasn't clarified this point yet, although hemp extracts are not formally forbidden by Europe. An important step forward is represented by a sentence of the ***Court of Justice of European Union (CJEU)*** in November 2020, in the so-called 'Kanavape' case.[37] This sentence originates from the marketing by a French company of electronic cigarettes which contained cannabidiol ('CBD'), imported from the Czech Republic, where extraction from the entire hemp plant, including leaves and flowers, is allowed. According to this sentence, "*the **CBD** at issue in the main proceedings **is not a drug** within the meaning of the Single Convention*" and *"the prohibition on marketing CBD lawfully produced in another Member State – when it is **extracted** from the Cannabis sativa plant in its **entirety and not solely from its fiber and seeds** – constitutes a measure having equivalent effect to quantitative restrictions within the*

[36] "Notice on import and export licences for agricultural products n. 278/34" published in the *EU Official Journal* 30 July 2016
[37] CJEU, n. C-663/18 – 19 November 2020 – art.76 and 82

meaning of Article 34 TFEU[38]*"*. In other words, a Member State may not prohibit the marketing of CBD lawfully produced in another Member State.

The European Commission hasn't yet expressed its position on the exploitation of the entire hemp plant for industrial extract, but recognized in December 2020 that CBD is not a drug and, besides e-cigarettes or medical uses, opened two other important dossiers for CBD industrial use:

- *Novel Food*: after the CJEU judgement, the European Commission readmitted CBD as eligible Novel Food ingredient and has resumed its examination of around 50 applications waiting for approval. However, in June 2022 *EFSA (European Food Safety Agency)* holded the approval, declaring that there are no sufficient evidence about the safety of CBD. Note that in the same period, July 2022, the *Food and Standard Agency (FSA)* in UK has authorised an official list of almost 12,000 cannabinoid (CBD) products;
- *Cosmetics*: after the CJEU judgement, the European Cosmetic Ingredient database (CosIng) in 2021 included in its list hemp leaves and natural CBD as authorized ingredients, until then forbidden as falling under the Single Convention scheme. Natural CBD is now classified as "*Cannabidiol - Derived from Extract or Tincture or Resin of Cannabis"* citing four functions: 'anti-sebum, antioxidant, skin conditioning, skin protecting'. Another cannabinoid – cannabigerol (CBG) – has been admitted in CosIng with the function "skin conditioning". At the same time "Cannabis sativa extract" is still restricted in "Narcotics" list and CosIng refers that "*Cannabinoids as such are not listed in the Schedules of the 1961 Single Convention on Narcotic Drugs. However, these shall be prohibited from use in cosmetic products (II/306), if prepared from a substance controlled in Schedule I of the 1961 Single Convention on Narcotic Drugs*."
  In conclusion, currently Cosing admits leaf extracts, seed extracts, callus extracts, root extracts, sprout extracts from Cannabis sativa plant, but not flower extracts. It is important to note that the CosIng list is not binding for the Member States.

Various hemp products are on the contrary admitted as pet food, including also 'hemp oil'. However, it is not clear if this designation includes also 'CBD oil' or just ''hempseed oil'.

THC limits in hemp food. Until 2022, as regards ∆9-THC limit in food, every EU country had its own national rules or no rules at all. But in August 2022 CE introduced new Regulation No 1393/2022, amending Regulation (EC) No 1881/2006 ('maximum levels for certain contaminants in foodstuffs') and setting a maximum of THC levels of **3.0 mg/kg** for dry products such as flour, proteins, seeds, snacks and **7.5 mg/kg** for hemp seed oil. [39] The new limits apply in overall EU states from 1 January 2023.
The industry is benefiting from having certainly around-limit allowances, because the new limits will be mandatory for all Member States (allowing in certain cases higher limits than national regulations).

CAP 2021-27 and Carbon sequestration. Hemp production in Europe could benefit not only from the Green Deal and the new R&D EU programs, but also from the revamped CAP. The CAP program is being reviewed and updated for the 2021-27 period, and in 2019 EU agriculture ministers called for funding and incentives to support carbon-sequestering crops under the CAP—a policy hemp farmers would strongly benefit from, as hemp as excellent sequestration properties[40]. The EC answered with the *Communication on Sustainable Carbon Cycles* in December 2021, which promotes carbon farming as a green business model which should contribute to the increase by 42 Mt CO2eq of the land sink that is required to meet the objective of 310 Mt CO2eq net removals by 2030 and forecasts to support the upscaling of carbon farming by the CAP and other EU programs, like LIFE, the cohesion funds, Horizon Europe.[41]

Table 2. Main EU rules on Industrial Hemp

[38] Treaty on the Functioning of the European Union, art.34: "*Quantitative restrictions on imports and all measures having equivalent effect shall be **prohibited** between Member States*"
[39] the maximum level refers to the sum of Δ9-THC and Δ9-THC acid (Δ9-THCA). A factor of 0,877 is applied to the level of Δ9-THCA and the maximum level refers to the sum of Δ9-THC + 0,877 x Δ9
[40] EIHA: https://ec.europa.eu/environment/forests/pdf/respondents-additional-inputs/European%20Industrial%20Hemp%20Association%20(EIHA).pdf
[41] "Sustainable Carbon Cycles" 15.12.2021 EC COM(2021) 800 final

	from 2023-2024
THC limit on field	0.3% *(from Jan 2023)*
THC limit on import export	0.3%
CAP aid	new CAP Reg
THC limit on food	Oil 7,5 ppm – Dry food 3 ppm *(from Jan 2023)*
CBD in food supplements	Under Novel Food: ongoing but alert EFSA
CBD and CBG as cosmetic ingredients	YES
Cannabis extracts as cosmetic ingredients	YES leaf extracts, seed extracts, callus extracts, root extracts, sprout extracts NO flower extracts
Cannabinoids *(other than CBD and CBG)*	Forbidden in CosIng

In conclusion, nowadays hemp EU regulation is extremely fragmented, without a clear legal framework. In the absence of this framework, as said before, every country follows its own rules. Many EU countries still prohibit or have unclear regulations about the use and marketing of flowers and leaves, considered under the Single Convention even if the THC level is below the established thresholds in the EU regulation for industrial hemp. However, to make hemp a profitable crop, farmers should be allowed to maximize their income through the use of the entire plant, especially the flowers and leaves, in a ***"whole plant" approach*** as promoted by the European Industrial Hemp Association (disseminated on social media with the hashtag *#unlockthepotential*).

Table 3. Hemp cultivation and transformation main rules in HempClub countries

with less restriction **partially restricted** **restricted** **forbidden**

	Austria	Czech Rep.	Italy	Portugal	Romania
Authorisation requested for cultivation under THC limit	NO but obligation to notify	No, but obligation to notify	NO	YES, from DGAV *	YES, from MARD *
Industrial contract requested for cultivation	NO	NO	NO	NO	YES
THC limit in field	0.3%	1%	0.2%-0.6%	0.2%	0.2%
THC limit in food	NA	NA	Seedoil: 5 ppm Flour and other: 2 ppm	NA	Any product with THC, regardless of the concentration, is illegal as THC is a prohibited substance
Entire biomass usability (inflorescences included)	YES but with important exceptions	YES	contentious	flowers not allowed to be transported outside the farm	YES but with no THC
CBD extracts edible	under Novel Food authorisation	under Novel Food authorisation and with no THC	under Novel Food authorisation	under Novel Food authorisation	NO, **but** commercialization of them produced in other State Members is allowed under Novel Food authorization

CBD for cosmetics	not allowed	allowed	allowed	authorisation from INFARMED *	YES with no THC
Smokes	not allowed	NO herbal – YES e-cigarettes with no THC	not allowed	not allowed	not allowed
Medical Cannabis (high THC content) permit of cultivation	only national agency AGES	under license from Health Ministry	under license from Health Ministry	authorisation from INFARMED *	NO (negative opinion from Government on Romanian Agency of Cannabis

- *DGAV: Direção Geral de Alimentação e Veterinária*
  INFARMED: National Authority of Medicines and Health Products
  MARD: County Directorate for Agriculture and Rural Development

In this context, the strongest intervention in recent years remains the already mentioned CJEU sentence in November 2020. It should be noted that after this sentence, the French government modified its regulation on hemp and presented a new decree in December 2021 which allows the use of hemp leaves and flowers for the production of hemp extracts and anticipates the next common resolution on THC limit, fixing the THC limit for industrial hemp at 0.3% (instead of 0.2%).[42] At the same time, the decree prohibits any other use of leaves and flowers, such as selling to the public fresh or dry leaves and flowers (the so-called 'cannabis light').

Hemp value chains

The ground for sustainable bio-based products is the quality of their vegetal raw materials and the way of their selection, production and supply, starting from genetic improvement and breeding. Other two pillars for the development of good hemp product chains are:

- *Harvesting and post-harvesting technologies* (agricultural machinery);
- the *technologies of first processing*: decortication or scutching for stalks - oil extraction and/or dehulling for seeds – CBD and other active principles extraction for inflorescences.

R&D: Genetics and breeding

The *Common Catalogue of Varieties of Vegetal Species* published in August 2022 includes 96 varieties of industrial hemp with low THC content that can be legally cultivated in the EU. Most of these varieties are strains historically selected and employed for fiber production: the most famous are the Italian *Carmagnola, Fibranova, Eletta Campana*, the Hungarian *Kompolti, Tiborszallasi* or the Polish *Bialobrzeskie* strains, all generally dioecious. Although being suitable for fiber production, these strains scarcely fit the needs of competing with US or Swiss strains on innovative markets, demanding high seed productivity or high non-psychotropic cannabinoid content. Above all, they scarcely fit the need for a double or triple product (fiber+seed+green threshing residues), despite the paradigm of the circular economy. Only recently, innovative strains designed for innovative uses or to improve the quality of raw materials have been included in the Common Catalogue, such as the Dutch *Enectarol* strain for CBG production or the Estonian *Estica* strain for big seeds production.

Genetic research and breeding are crucial for the innovation of European hemp strains. The research can have many targets, like the production of pathogen & virus-free young plants (e.g. the Czech Biotech Company ***Genetia BioScience***), increase of yield and quality, resistance to parasites, psychoactive potency or THC-free strains.

In this context, France is not only the main hemp producer in Europe but also a global supplier of hemp seeds, thanks to the cooperative ***HEMP-it***, created in 1965. In past decades, it has developed monoecious strains for pulp aiming to a further reduction of THC content – the most famous are *Futura 75, Felina 32* or *Fedora 17* – appreciated because they guarantee easier harvest technique, low price and high germinability. Moreover, they can be cultivated for straw or feed. HEMP-it's breeding activity relies on a network of 155

[42] JORF n°0304 du 31 décembre 2021

propagator farmers and its catalogue is in continuous enrichment with new strains. In 2019 *HEMP-it* and the *FNPC* (Fédération National de Producteurs de Chanvre) created ***HEMP-it ADN,*** a business unit dedicated to innovation and varietal creation. The strength of the French model relies on 3 pillars:

- Cooperative model between farmers, helping joint investments in machinery and transformation technologies;
- Strong national associations, like *FNPC* (farmers) and *Interchanvre* (industrial sector)
- Continuous public support to R&D since 1935: France, perhaps unique in western Europe, has never abandoned the hemp sector.

Besides France, nowadays Netherlands and some countries in Eastern Europe (such as Poland) are strongly committed to R&D of new varieties. In 2021 Poland, for example, launched *Henola*, a strain for high volume of seed production, while Romania launched *Secuieni Jubileu* and *Zeni*.
The development of new strains is often conducted by universities, like ***Wageningen University & Research*** or public institutes, such as in Poland with Krakow's ***Institute of Natural Fibers and Medicinal Plants*** or in Italy with ***CREA*** *(Council for the Research in Agriculture and the Analysis of the Agrarian Economy)*. There are also many private companies or cooperatives involved in the development of new strains and breeding, such as the Romanian ***SCDA Secuieni*** or the Estonian ***EOPC,*** usually conducting R&D collaboration with public institutes.

Agricultural Machinery

The way of harvesting hemp crops has a strong influence on the quality and the cost of raw materials. For almost 50 years, since hemp was banned in the second half of the last century, any technical knowledge in hemp processing was lost or put aside in the Western world, except for France growing, breeding and processing hemp since 1932 with the support of the Government and the ***Fédération Nationale des Producteurs de Chanvre (FNPC)***. On the contrary, Eastern countries grew and used hemp since the 1980s, also developing harvesting machinery. It is also worth mentioning that the industrial demand for hemp grains and non-psychotropic cannabinoids arose only at the beginning of this century. However, without adequate technology, the majority of hemp farmers are employing non-specialized machines, fitted for harvesting and collecting single parts of the crop (usually, a wheat combine for seeds and a cutting bar for stalks).

In this context, the new technology development for hemp machinery in recent years focuses on two main targets:

- *Multipurpose machines* for double or even triple harvest (seeds + stalks + green residual biomass, still rich in CBD and other active principles). These machines could offer a way to maximise the value of biomass and the farm income. Examples of multipurpose machines are the 'double cut' machines developed firstly in the Netherlands by the collaboration between ***John Deere*** and ***Hempflax*** (Figure 4) and between ***Claas*** and ***Dunagro***. Hempflax uses these machines for its cultivation in the Netherlands and Romania. It is an example of triple harvest and its performances are very impressive: it cuts the stalks at 60 cm leaving them between the wheels and separates seeds from the green parts of the tops (flowers, leaves, resins). Another innovative machine is *Multi-Combine HC 3400* owned by Germany's ***Hanf Farm GmbH***, designed for gently stripping the hemp tops (inflorescences and seeds);
- *Specialised machines for the textile value chain*, allowing an ordered collection of stalks, as requested for textile fiber processing, following the linen model. In this context, a new performing machine, *Sativa 200* (Figure 5), has been developed by the Belgian constructor ***Hyler BV***. It can cut stalks of more than 3 meters in two or three parts, leaving them ordered in parallel on the field. It was recently tested by the cooperative ***Linière du Nord de Caën*** and publicly shown during a demonstration day at the end of August with very impressive performances.

However, in both examples, the price for this innovative machineries is very high: more than 400,000 € for the Sativa 2000 and even more for the 'double-cut' *Hempflax-John Deere*. Moreover, they are very huge. This means that these technologies are not fitted for little farms and hilly areas as in the main territories of countries such Austria, Czech Republic, Italy or Portugal.

Figure 4. the 'double cut' machine by John Deere/Hempflax

Figure 5. Hyler Sativa 200A harvester

First Processing of fibers and shives

Fibers can be separated from hurd by decortication and scutching:

- *Decortication* is simpler and it consists of the breaking of hemp stalks to separate the bast fiber from the hurd. In this way, two main products can be obtained: a pile of hurd and a bundle of unfinished fiber;
- *Scutching*, after breaking stalks, is the mechanical removal of remaining hurd bits from the fiber. In this way, three products can be obtained: hurd, long fiber and short fiber.

The choice between the two systems depends on the main targeted market. Decortication is suitable for markets like buildings, woody panels, paper (cellulose), non woven or animal bedding (in some cases hurd becomes the main product and fiber the by-product). Scutching instead is crucial if the target is a good quality fiber, especially for the textile market (fashion and furniture), but also for biocomposites, requiring fibers free of impurities.

The decortication system is also in general less costly, but it depends on the specific requirements of the final product (cleanliness, strength etc.); the textile fiber processing instead is the most complex and costly, but it can give the widest range of products.

To obtain a fiber fitted for spinning, besides scutching, two other processes are indeed required:

- *Retting* (or degumming) is the natural or biochemical removal of pectins binding together the fibers. In Northern countries, such as in the linen process, retting simply consists of leaving the stalks for some days on the field, but in Southern countries with a drier climate, this system with the conventional strains

usually doesn't work. Until the last century farmers used to collect stalks and plunge them in tanks for two or three weeks, a process today too much labor-expensive. The new method consists of a controlled retting system with bacteria or enzymes, usually after scutching;

- *Hackling* is the process of separating/combing the bast into individual fibers, to make them suitable for spinning.

Due to the complexity and the costs of automation, a proven system for textile hemp fiber processing has not been developed in Europe yet. An exception is represented by a plant opened in 2021 in Tuscany (Italy), ***Canapafiliera srl***, for quality fiber production. It is a decorticating system followed by a huge controlled retting system in anaerobic conditions, as in biogas production. However, it is too early to evaluate the efficiency of this process. There are also prototypes in France and Italy that could offer a cheaper way of obtaining high-quality fibers. However, for all these reasons, hemp-based textile production is dominated by the Chinese industry, not only for cheaper labor costs but also for huge public investments in automation. More than 90% of hemp fibers are provided by Chinese companies such as *Shanxi Greenland Textile, Ningbo YAK Technology* provider for the Chinese Army, *Shenyangbeijiang* (2,500-3,000 ton fiber/year), *Tianyouhemp, Kingdom* or *Hemp Fortex.*

The development of decortication technology in Europe is quite different. Currently in Europe are active **11 decortication facilities**, according to EIHA: France (6); Netherlands (2); Poland (1); Romania (1); Lithuania (1). The main markets of these facilities are:

- fiber: composites for automotive, non-woven fabrics, insulants for construction;
- shives: hempcrete for construction, animal bedding, plastics.

Hempcrete and biocomposites are today the main markets for European hemp.

3.2 Hemp value chains in Austria

General Framework

Industrial hemp production was reintroduced in the country in 1995. It can be legally grown provided that it contains no more than 0.3% THC, before, during and after the production process and that only original seeds approved for cultivation according to the *AMA* hemp variety list (updated every year) are used. They can therefore be produced and distributed without obtaining a permit within the framework of the addictive drug, but their commercialization is limited by other legal constraints, such as the rules applicable to food or cosmetics. Furthermore, it is required that new hemp cultivation is notified t the authorities. The reproduction of hemp is prohibited. Since 2020, hemp is no longer on the list of general exemptions of the ***Austrian Agency of Health and Food Safety*** (AGES), therefore, when using conventional, unpollinated seeds, an application must be submitted to the relevant eco-certification body before purchasing".[43]

In Austria the laws for controlled substances include:

1. *the Narcotic Substances Act (Suchtmittelgesetz – SMG),* in force since 1998*,* the content of which is governed by the Single Convention on Narcotic Drugs of New York;
2. *the Narcotic Drugs Ordinance* of the Ministry of Health, which regulates exceptions and additions: the Ordinance is a consequence of the *Addiction Prevention Strategy*, adopted in 2016. It considers addiction as a disease, supports the principle of treatment over that punishment and aims for a society as free from addiction as possible.[44] In this context, only the AGES is permitted to cultivate cannabis plants above 0.3% for the purpose of manufacturing pharmaceuticals as well as for related scientific purposes.

Annex 1 of the Drug Act (SNG) regulates some exceptions related to the industrial hemp plant. The exceptions include:

- the inflorescences or fruiting spikes of those varieties of hemp which are listed in the Common Catalogue of Varieties of Agricultural Plant Species or in the Austrian List of Varieties, whose tetrahydrocannabinol content does not exceed 0.3%

[43] Chamber of Agriculture Upper Austria, Status: 02-2021 https://ooe.lko.at/bio-hanf+2400+3413504

[44] https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10011053

- products from commercial hemp varieties listed in the first indent provided that the THC content does not exceed 0.3% before, during and after the production process and that no narcotic drug in a concentration or quantity suitable for abuse can be easily or economically profitably obtained therefrom
- the seeds and leaves of plants belonging to the genus Cannabis, not mixed with inflorescences or fruiting bodies.

On the other hand, the THC-containing flower and fruit stalks may only be used for medical or scientific purposes under the conditions of the Narcotic Substances Act or processed by tradesmen with a license to produce medicinal products and poisons and to engage in wholesale trade in medicinal products and poisons.[45]

Although appearing less restrictive in allowing the use of the entire hemp biomass than many EU countries such as Italy, there are some sectorial constraints:

- *Food sector:* in October 2018, the Austrian government applied the Novel Food and banned all CBD food and cosmetic products. Only authorized and registered novel food can be placed on the market and no CBD extracts have been yet authorized;
- *Cosmetic sector*: according to the same Opinion of the Federal Ministry for Health, cannabis and its extracts are considered to be narcotics and thus cosmetics containing such extracts may not be placed on the market. However, as noted before, the European Commission has recently added naturally extracted CBD and CBG to the CosIng database, also if it is not binding for the Member States;
- *Feed sector*: AGES excluded hemp flowers and leaves: "*For livestock, especially ruminants, but also for pets, the focus is on the whole plant, or the hemp oil extracted from the seed. According to current knowledge and ongoing discussion between EU member states, it is largely undisputed that hemp flowers and buds may not be used as feed. Hemp leaves are viewed differently due to their CBD content, but here too an exclusion from the feed chain is emerging due to negative findings from feeding trials with dairy cows that were given hemp silage. Accordingly,* ***only the seeds or the oil obtained from them and the stalks or the hemp meal obtained from them remain as plant parts as usable individual feed components***"

Since the new laws have been established, CBD products have been regulated in a framework of uncertainty. The new laws indeed do not prohibit CBD in essential oils or raw plant extracts, so retailers have been selling CBD labeled as aroma products. Citizens can also legally purchase CBD hemp flower, extracts, teas, and hashish as long as the THC content is 0.3% or less.

Cultivation

Hemp cultivation in Austria has gradually grown from 2015 to 2020 (Figure 6).[46] Until 2014 less than 1,000 ha of hemp were cultivated in only 4 regions: Lower Austria, Upper Austria, Carinthia and Styria. Currently, Lower Austria has the largest crop area with 947 ha in 2018, which corresponds to about 60% of Austria's hemp cultivation area.

In 2021 since hemp in Austria is predominantly grown for oil extraction purposes (about 90% of the cultivated area), a separation in hemp land census was made into "hemp for oil extraction" and "hemp for fiber extraction". For the extraction of hemp straw, 188 ha were identified in 2021 and about 1,696 ha were used for hemp for oil extraction.[47]

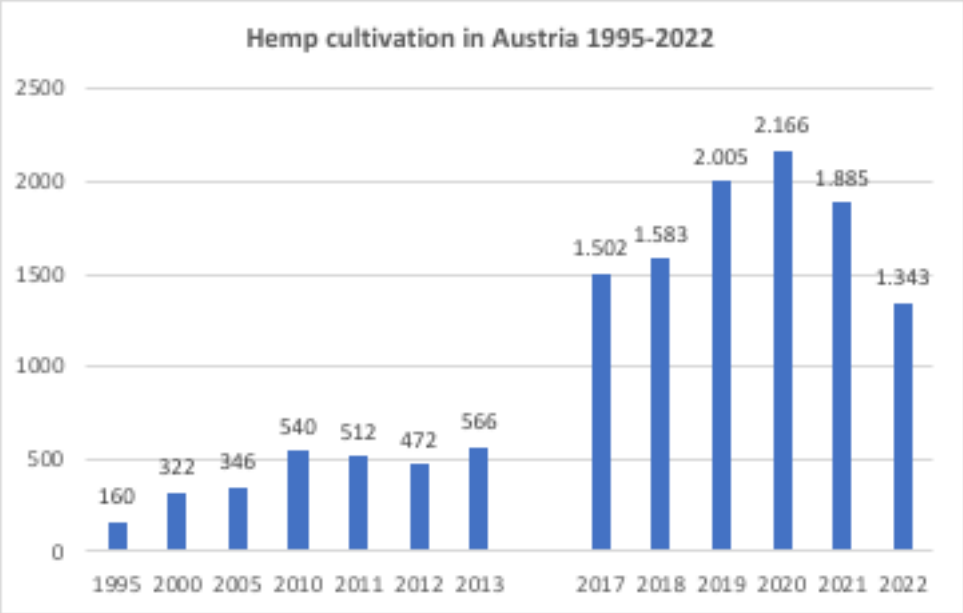
In 2021 and 2022, land areas dedicated to hemp cultivation are decreasing. One reason for such decreasing may be the end of the CBD boom that occurred in Europe and USA. Some Austrian companies in fact invested heavily in this sector. It is the case of ***Deep Nature Project GmbH***, from Gols (Burgerland), making CBD and CBG dietary supplements, cosmetics, hemp foods and animal feed supplements under the *Medihemp, Sativa Beauty* and *Vetrihemp* brands. In the summer of 2022, it was announced that creditors owed a total of €9.6 million by Austria-based CBD company, that declared insolvency. It should receive 20% of the money under a recently announced restructuring plan, according to Austria's *Credit Protection Association (KSV)* and the *Alpine Association of Creditors (AKV)*.

[45] pursuant to Section 94 item 32 of the Industrial Code 1994, GewO 1994, Federal Law Gazette No. 194/1994 as amended
[46] https://www.statistik.at/fileadmin/publications/Anbau_auf_dem_Ackerland_2020.pdf
[47] https://www.statistik.at/fileadmin/publications/SB_1-16_Anbau_Ackerland-2021.pdf

Table 4. Crop Area in hectares 2022 *(preliminary data)*[48]

Hemp	Austria		Burgen-land	Carinthia	Lower Austria	Upper Austria	Salzburg	Styria	Tyrol	Vor-arlberg
	2021	2022								
Total	1,885	1,343	70	30	969	194	2	63	16	3

Figure 6. Hemp cultivation in Austria *(hectares)*



Due to its versatile uses (seeds, fibers, flowers) and to the increasing interest in hemp in recent years and the comparatively moderate level of information about it, the ***Federal Institute of Agricultural Economics, Rural and Mountain Research (BAB)*** initiated a project focused on economic issues of hemp cultivation. The primary aim is to investigate which parts of the hemp plant can be marketed (seeds, fibers, blossoms) and which marketing channels already exist for them. Furthermore, research is carried out into which varieties are suitable for the corresponding types of use and which production processes can be used to cultivate them on agricultural land. In addition, the possibility of producing hemp organically should be highlighted. The research data should help to program its own production processes for hemp within the framework of the online application "Internet Contribution Margins" of the BAB.[49]

Industrial hemp applications

As shown by the huge amount of hemp area dedicate to oil extraction (90%), Austria hemp sector is driven by farms/companies transforming and selling hemp food and cosmetics. In some cases they created real hemp value chains, such as ***Medihemp*** which develops organic hemp extracts and food in close collaboration with organic farmers in the region around Lake Neusiedl, declaring around 200 hectares of hemp cultivation. ***Hanfland*** operates in the historical Hanfthal (NiederOsterreich), cultivating, processing and trading organic unhulled hempseed-derived food. They currently process around 150 tons of hemp seeds yearly and they are one of the first companies worldwide to develop a hemp hulling machine, very useful for obtaining a sweeter taste. In the cosmetic sector, ***BioBlum*** in Apetion grows 110 hectares of certified organic hemp in the area of Lake Neusiedl. The dried hemp plants are extracted in a multi-certified special laboratory using CO_2 extraction.

[48] https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjzxr2q_cj6AhVB_7sIHb0OCP0QFnoECBMQAQ&url=https%3A%2F%2Fwww.statistik.at%2Ffileadmin%2Fpages%2F127%2FFeldfr2022vorl.ods&usg=AOvVaw3vHT2ytCzxmXwlCa2UBVpY

[49] https://bab.gv.at/index.php?option=com_content&view=article&id=2134:bab-053-22-sektoranalyse-hanf&catid=110&Itemid=215&lang=de

For fiber and hurd, on the contrary, there are no decortication facilities in Austria and consequently, there are no value chains. As a recent development in this context, the "***Alpine hemp project - ARGE ALP Alpenhanf 360°***" in Tyrol was initiated as a measure on the *KEK Platform (Klima, Energie und Kreislaufwirtschaft)*, funded by the EU REACT Fund. The project stimulates innovations in hemp cultivation as well as in the utilization of the entire plant, its fibers and extracts. Due to the successful development of the project, the revitalization of hemp as a useful plant was included in the catalogue of measures of the state of Tyrol. Accordingly, funds will be available over the next few years. However, hemp cultivation in Tyrol is still limited with about 16 hectares in 2022 divided among 4 farmers/companies.

Table 5, Alpine Hanf Project "Alpenhanf 360°" – Austrian Network Partners

Company	*Products*
Alois Bauer	AlpinHanfHarvester
Michael Halbfurter	Harvester and food
Hempions	Food
Tiroler Berghanf	CBD and hemp products
Sand'l Hof	Manufactory refining various oil fruits into different products
Fohlenhof Astner	Food
Profanter	Bio-Bakery and 0km house
UIBK (Universiy of Innsbruck)	Research
Troi	Composite components - Ski - and trekking pole
Spurtart	Ski
Gärtnerei Seidemann	Sheep wool hemp mats as a breeding ground for sprouting vegetables
Gottstein	Natural slippers producer
Whisperwool	Sustainable design alternative for room acoustic solutions
Regensburger Schaafwollzentrum	Sheep wool manufactory
Tirol Shop	Beanies
Zanier	Gloves

In the next few years, however, the **hemp bio-composites** market could become an Austrian excellence. Indeed, ***Alpex Technologies*** ('Hulk' project about hemp fiber as material for biocomposites) is a technology leader focused on high-quality tooling for the aerospace, automotive and many other industries, while the ***Kompetenzzentrum Holz GmbH*** (Linz A) aims at the development, characterization and optimization of natural fiber reinforced polymers (NFRP) made from continuous plant fiber reinforcement (flax or hemp) for structural component applications. ***Innsbruck University*** moreover has focused its R&D on biotechnology processes for biobased, natural fiber composites.

Austria also invented and produced for the first time the so-called '*Hempstone'*, a hard material today produced in Germany, Australia and other countries. The inventor is Martin Ernegg an Austrian materials science engineer, able to produce in 1989 a small quantity of a wood-like, mouldable material obtained from cellulose fiber and water, called *Zelfo*. The process to obtain such material was later patented in 2000. The range of cellulose fiber biomasses for Zelfo is very large, but hemp is the most suitable one because of the form of its fiber cells. While still wet, Zelfo can be textured, patterned, stamped or coloured. According to its creator, Zelfo has the greatest tensile strength of any known vegetal-derived material, ranging between five thousand and ten thousand megapascals. It is currently used by ***Drumparam*** for the production of clarinets or other musical instruments.

Another outstanding use of hemp fiber in Austria is ***Naporo Klima Dämmstoff GmbH*** for building materials. Naporo from the Upper Austrian town of Perg has developed for more than ten years the first certified and technically mature hemp insulation board for facades, developing two systems of hemp insulation (*NAPOROwall* and *Q-flex*). Roofs, walls and whole facades can be insulated with it as a replacement for EPS products (expanded polystyrene). In addition to hemp, Naporo makes use of another natural raw material, cattail (lat. Typha), a versatile wild plant with massive stocks to be found in wetlands.

We can cite also Austrian companies producing and using hempcrete (in this case hurd and not fiber) for building, like ***Hempstatic*** in Wien and ***Hanfdaemmung***.

A peculiarity of Austrian hemp sector is the market of Cannabis clones and seedlings, allowed by the law as long as it excluded any use of inflorescences. The market was launched by the company ***Bushplanet***, which since 1996 clones feminized plants starting from cuttings of selected mother plants. They have a huge shop in the middle of Vienna, Margaretenstrasse, and a large warehouse, called Plant City, located in the surroundings of Vienna in Brunn am Gebirge/Vösenorf, where they grow and offer to the public more than 20 different varieties of cannabis. This market attracts people from all over Europe. According to Toni Straka, chief of the Vienna's Hanf Institut, promoting cannabis legalization, they sell more than 300,000 seedlings or clones every month

There are also annual fairs in Austria dedicated to hemp, like ***Wiener Hanfmesse***, usually held in April in Vienna, showcasing some of the cannabis industry's most innovative products, and ***Cultiva Hanfmesse***, a three-day event in Vienna, which focuses on the role of cannabis in medicinal practice.

Hemp Value Chains in Austria: Weakness and Strengths

Strengths	Weakness
LAW: use of entire biomass generally allowed	hemp extracts not allowed in cosmetics and feed
Hempseed oil for food and cosmetics (90% cultivated)	Lack of R&D on strains
Biocomposites (***Alpex Technol. - Kompetenzzentrum Holz – Innsbruck Universiy)***	Lack of fiber processing facilities
National & regional support (***BAB Project: "Sector analysis hemp"*** – ***Alpine hemp project***	Medical cannabis cultivation only AGES
Cannabis clones and seedless production&trade	

3.3 Hemp value chains in Czech Republic

General Framework

Czech hemp regulation is the most advanced in the EU. From 1 January 2022, thanks to an extensive amendment to the Act on addictive substances, cannabis that contains a maximum of 1% of THC is permitted for industrial, technical and horticoltural purposes, including sales. However, the growth of industrial cannabis on more than 100 m^2 of land must be notified to the competent authority and the violation of this obligation may be subject to a very heavy administrative fine (up to CZK 1,000,000, approx. EUR 40,800). The allowed varieties are those registered in the EU catalog (under 100 m2 of land you can grow also not registered varieties).

The rules about CBD and other cannabinoid extracts are still unclear because of the EU regulation. CBD extracts sold as food supplements, food, veterinary supplements are planned to be recalled from the market because of non-existing novel food registration. Other products in the form of massage oils or aroma oils may be able to stay on market but without any information about daily intakes or health claims. Under Regulation (EU) 2015/2283 (Novel Foods) and the Council of 25 November 2015, CBD is considered in fact a "novel food" and, after the authorisation under the above Regulation and without any THC content, can be marketed. However, the Czech State Agriculture and Food Inspection Authority are of the opinion that products from hemp leaves or seeds that naturally contain CBD are not considered "novel food" and they can be sold without authorization. As regards CBD smoking, Czech rules distinguish between herbal cigarettes

(not allowed) and e-cigarettes, allowed provided that they don't contain THC at all; consequently, dry flowers as smokable, in other words 'cannabis light', are not allowed. Despite the EU regulation, both technical hemp dry flowers and extracts from technical hemp are being traded and sold to consumers under the Products Common Safety Act (mostly as collectibles or aromatic substances) without any quality product information. Growing cannabis for medical use is allowed upon obtaining a license to plant cannabis and permission to dispose of addictive substances and products related to medical cannabis. The license is issued for a maximum period of 5 years and can be prolonged. Also importing cannabis for medical use requires permission from the Ministry of Health and it is issued for a maximum of 3 months. Patients can have access to cannabis for medical use upon electronic prescription from healthcare professionals, only if they are almost 18 years old and only for certain symptoms. The amount is limited to up to 180g in total of dry cannabis per person per month.

Cultivation and R&D

Hemp market in Czech Republic is one of the most developed in EU, thanks to some critical factors, as the hemp regulation and thanks to many R&D centers focusing hemp and cannabis and to the existence of the first hemp-related Cluster, ***Czechemp***. Medical cannabis is rapidly growing with sales increasing year after year (+63% in 2021) and the recent opening of a legal market to private growers.

- As concerns industrial hemp, its cultivation is still small in extension, under 500 hectars, with only two Czech varieties included in the European Catalogue, all registered under ***UKZUZ*** (Central Institute for Supervising and Testing in Agriculture) although not originally bred here or even maintained.

- Despite this, there are many R&D activities on hemp and cannabis, firstly established under the ***Czech University of Life Sciences (ČZU)*** in Prague where research on medical cannabis dates since September 2014. The ***International Cannabis and Cannabinoid Institute (ICCI)*** at St. Anne's University Hospital ***(FNUSA)*** is a scientific research institution with its own department working on research and production of medicinal cannabis, medicinal cannabis plant material testing in the standardised conditions, external factors testing for plant production and technological equipment including their standardised growth facility with external conditions management. The ICRC organises annually a one-day conference called Cannabis & Science.

- Another interesting R&D project is ***The Institute of Social Investigative Studies*** of the *Cannafamily* company. It is a non-profit organization founded by a group of experts from various scientific fields. Their mission is to centralize global research into the therapeutic effects of cannabinoids. They work with patients on detailed research of cannabis preparations, which is necessary for the most effective treatment of the disease, educating the professional public in the field of cannabis and working on the creation of applicable and functional legislation in this sector.
- ***Mendel University Brno*** rapidly expanding its exploration of industrial hemp in its broader cannabis research program focused on phytoremediation (in cooperation with Agritec Šumperk) and nutrition aspects of feed for animals.

- The private sector is also vibrant in the fields related to hemp genetics and biotechnologies, with ***Genetia BioScience***, a biotech company specialized in plant tissue culture, ***Grow City***, a seller of somaclones and pre-grown young plants for the Czech and Slovak market, ***Shieer Bio Systems*** (biotech products), ***Agritec,*** engaged in the research of genetic resources of legumes, flax and hemp.

- Hemp cultivation for seeds or flowers has significantly improved in these years. ***Hemp production*** is one of the early companies processing grain and further food products, including their harvesting services for other farmers since they owned special *Deutz-Fahr* combined with hemp harvesting. Many farms and companies are operating in cannabinoids extraction for food, cosmetics and medical (***CB21 Pharma***), with interesting cases of product chain integration like ***Hempoint***, a pioneer of hemp in Europe that covers the hemp value chain for food and feed from farming to processing and developing of final products, or ***Havacan***, with the ambition to integrate different segments on the hemp including CBD products, cosmetics and food.

Industrial hemp applications

In **innovative food production**, it is important to cite ***DBH Technologies*** specialized in micronization and nanonization technologies for new food formulations. DBH has developed unique Carbon Dioxide Assisted Spray Nebulization Drying (CASND) Technology, which is particularly suitable for drying, encapsulation or entrapment of biological and thermolabile materials. Other specialists in CBD food ingredients are ***BioVita Group, Cannafamily*** and ***CBDepot*** (partner of *CB21 Pharma*) which obtained from the EC in February 2022 a Novel Food application for isolated trans-Cannabidiol as valid.

Czech companies are considered leaders in hemp beauty and cosmetic market with bioactive principles, hemp oil and other hemp products. A pioneer in the cosmetic sector is ***Cannaderm*** entering the market in 2002 as the first company in the Czech Republic, manufacturing recipes for skin care products that featured hemp oil as a key ingredient. Since 2014 it goes on to produce autonomously in Czech Republic but its brand is managed by the *Simply You Pharmaceuticals*. Other famous Czech cosmetic hemp companies active in many foreign countries are ***Annabis*** located in Olomouc, closely working with the Canadian company *Canopygrow* on the distribution of medical cannabis in Czech Republic. Another famous brand is ***CutisHelp*****,** produced by ***Parenteral***, a company located in Prague**.** Besides those mentioned, there are many more cosmetics companies on the market and even hemp brands selling food or CBD having their own branded balms or creams.

Czech companies are also one of the few producers of CBD e-cigarettes (allowed in Czechia with zero THC). ***Kanavape*** created in 2014 the first CBD Vape Pen in Europe, becoming famous all over Europe after the 2020 sentence of the European Court of Justice against the French Government (*see European Legislation paragraph*) declaring that CBD is not a narcotic and that it is legal to be sold. Besides Vape Pens, Kanavape today sells cartridges and CBD e-liquid bottles.

Thanks to the advanced legislative framework, the production and trade of distillates and isolates of CBD and other active principles are rapidly improving in Czechia. Among the actors, we can cite again **CBDepot.**

Only a small R&D decortication facility in ***Agritec Šumperk*** is dedicated to hemp fiber first processing at the moment. There were two facilities in the first decade of this century: ***Lenka Kácov***, ***Josef Benedict*** and ***Canabia Group***, but they were sold outside the EU. Between 2003-2010, a famous Czech machine manufacturer, ***Tebeco***, developed a special hemp harvester still in use in some parts of Europe but they do not produce the machines anymore. Another Czech company ***JK Machinery*** currently produces machines for cleaning and processing hemp seeds.

Despite this, Czech companies still have some competencies in textile hemp. For example, ***Inotex*** is active in the R&D of the enzymatic separation of fiber for textile use and developer of products for retting (*TEXAZYM SER, TEXAZYM BRF, DLG*). ***Vub a.s.***, or the ***Cotton Research Institute***, are specialized in yarns also of bast fibers, declaring a production of hemp thread on a special order basis.

The demand for industrial hemp fiber supply is quite high – 7,500 tons annually according to Czechemp - which shows clearly the importance of building a decortication unit that will support the local supply of fiber products.

The hemp building sector is still underestimated, few companies as ***Mabeko*** or ***NORICUM*** are able to support individuals in their efforts in building with hempcrete but in general, there is not any hemp building company producing bricks or blocks from hempcrete or any big construction company looking at that direction. There are also two hemp insulation companies ***Kobe-CZ*** and ***Ecoinsul***.

Hemp Value Chains in Czech Republic: Weakness and Strengths

Strengths	Weakness
THC limit 1%	Lack of national strains
Cosmetics (hemp seed and CBD extracts)	Lack of fiber processing facilities

CBD e-cigarettes	Small cultivated area
Cannabis and hemp R&D	

3.4 Hemp value chains in Italy

General framework

Industrial hemp cultivation has a long history in Italy. In the last decades of the Nineteenth century, the ***Linificio Canapificio Nazionale*** allowed the development of a strong national industry. In a few years, this company opened many facilities in Lombardy and other regions employing thousands of workers. It proposed also a social model for its workers by building the 'Crespi Village' along the Adda river, today recognized World Heritage Site by Unesco. In a few decades, Italy became the best fiber quality producer in the world and the area cultivated reached more than 100,000 hectares, second only to Russia, during the first half of the Twentieth Century.

Moreover, medical cannabis is also historically rooted in Italy. Indeed, Carlo Erba, founder of the homonymous pharmaceutical company, after experiencing hashish from Egypt on himself and his parents, in the mid-eighteenth century started to sell it in pills or candies in his drugstore in the center of Milan. Carlo Erba went on to sell cannabis preparations until 1923. Another physician in Naples, Raffaele Valieri, chief of the 'Ospedale degli Incurabili', in 1887 began to give cannabis preparations to relieve the pain of his poor, incurable patients.

After a long break during the second half of the Twentieth century, industrial hemp was gradually readmitted in Italy in 1997,[50] initially only for fiber production and in 2009 also for seeds. However, industrial hemp in the country was regulated only at the end of 2016 by a general law and not just by some occasional decrees. Currently, the hemp regulation follows two different regulations. The general law is the so-called "***Testo Unico Stupefacenti***" on controlled substances.[51] This law classifies cannabis leaves, flowers and resin as controlled substances and forbids cannabis cultivation without special authorization, with the exception of hemp grown for fiber or other industrial uses (art.26), although since 2013 it has recognized their medical properties and allows physicians and veterinary to prescribe cannabis.[52]

Since 2016 industrial hemp has been regulated also by ***Law n. 242/2016***.[53] Farmers can grow hemp without previous authorization, provided that they use varieties listed in the 'Common Catalogue of Varieties of Agricultural Plant Species' and they can exhibit seed tags and invoices. They are not even obliged to inform the authorities about their sowing decision. Although the absence of constraints may support Italian companies in cultivating industrial hemp, on the other side this makes very difficult to obtain solid statistical data about hemp cultivation in Italy. Official data comes only from AGEA, the Agency for Agricultural payments, and are related to the number of hectares declared for CAP payment requests. However, it is partial information as producers of hemp for flowers (extraction or cannabis light) rarely make such declaration.

Italian regulation has introduced a new THC tolerance level, assessing that "*until 0.6% the farmer cannot be held responsible*" (art.4). This rule and the absence in the text of any reference to some restriction in the use of the different parts of the plant generated in recent years the phenomena of the so-called 'cannabis light': dry flowers, rich in CBD and with THC sometimes exceeding far 0.2%, sold directly to the public by tobacconist-shops, cannabis-shops or automated distributors. This phenomenon resulted in many police

[50] Circular n. 794 of Ministry of Agriculture, 2 December 1997, published in GU 16 March 1998

[51] DPR 309 9 ottobre 1990: **"Testo unico delle leggi in materia di disciplina degli stupefacenti e sostanze psicotrope, prevenzione, cura e riabilitazione dei relativi stati di tossicodipendenza" in GU 255 31/10/1990**

[52] Health Ministry Decree 23 January 2013, in GU n.33 8 February 2o13

[53] Law n. 242 2 December 2016: "Disposizioni per la promozione della coltivazione e della filiera agroindustriale della Canapa" – in GU 304 30/12/2016

actions and prosecutors charges, confiscation of products and contradictory sentences. Indeed, for part of the judiciary if the law tolerates a THC limit of 0.6% in the field, it would be a paradox to prosecute the farmer for processing and selling hemp materials exceeding 0.2% but below 0.6%. On this matter also the Italian Supreme Court of Cassation in May 2019 intervened, declaring: "*The trade of Cannabis sativa leaves, flowers, oil and resin is not under the law n.242, 2016 (on Industrial Hemp)… so it constitutes a crime… **unless such products have not in practice dopant effect***".[54] Moreover, on the ground of the judgment, the Supreme Court observed correctly that the legislators never set the acceptable level of THC for human safety, although according to a lot of scientific and forensic studies, this limit should be considered 5%. After the judgement of the Supreme Court, from a legal point of view, nothing changed (how is it possible to prove if hemp has a dopant effect or not?) for small businesses, but it changed significantly for national and foreign investors risking being prosecuted for their business.

The ban on the use of industrial hemp flowers and leaves, without ministerial authorisation, was confirmed in May 2022 in a new inter-ministerial decree on officinal plants.[55] The Decree admits for the first time the species *Cannabis sativa L.* as an officinal plant; however, according to a comma of the Decree, only the production of seeds and seed derivates is covered by the industrial hemp law, while the production of leaves or flowers or active substances requires special authorization from the Ministry of Health. Various companies and hemp associations, including ***Federcanapa***, have appealed against the Ministries complaining that this interpretation contravenes the rules of the Italian and European regulations about industrial hemp, which recognize as legitimate the use of the entire biomass. At the initial hearing, in September 2022, the judge before delivering his sentence decided to ask the Ministry of Health to present scientific evidence on the negative effects on human health of these parts of the industrial varieties, following a statement of the Court of Justice of European Union (CJEU) in November 2020 in the already mentioned 'Kanavape' case.[56] Italy is also one of the few European countries, like Germany, Belgium and Switzerland, that has already adopted a measure establishing THC limits in hemp food.[57] The limits fixed for hemp food by the Ministry of Health - 5 ppm for hempseed oil, 2ppm for flour and other hempseed derivatives - are very strict and can be easily reached with accidental contamination by the surrounding resins, making the seeds exceed these limits. Luckily, the new limits foreseen by European legislation from 2023 are much more reasonable.

Cultivation and R&D

Between 2016 and 2018, the hemp hectares cultivated in Italy grew from about 150 to 4,000 ha. The ambiguous interpretation of the 0.6% limit and the use of flowers (not mentioned but not prohibited in the text of the law) paved the way, as said before, for the business of 'cannabis light' with many farmers, traders and investors expecting to earn up to 50-100,000 € from a single hectare of CBD-rich hemp strain. Dried flowers were sold for up to 12-15 €/gram (also today they are quoted online 8 €/gram and more), while biomasses for CBD extraction could be sold for up to 1,500 €/ton for every single CBD percentage point. This opportunity, mostly due to the CBD "boom" all over the world, attracted also many foreign investors, especially from Canada and UK, searching for land and facilities to install, particularly in Southern Italy. 'Cannabis light' encouraged also illegal cultivation of foreign strains, especially from Switzerland and USA, with a higher content of CBD (12-15% and more), and often with a THC content much higher than 0.2%. From a certain point of view, well argued in an economic study of three researchers from the University of York, selling 'cannabis light' in tobacco shops or grow shops also contrasted the mafia business on drugs.[58]

The overproduction of CBD worldwide and the intervention of some prosecutors, such as the already cited sentence of the Italian Supreme Court in July 2019, stopped the growth of this market.

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[54] Corte Suprema di Cassazione – Sezioni Unite, Informazione provvisoria n.15, 30 May 2019

[55] Ministerial Decree 21 January 2022 "List of species of Officinal Plants etc." in GU n. 115, 18 May 2022

[56] "it is for the national authorities which invoke it to demonstrate in each case, taking account of the results of international scientific research, that their legislation is necessary in order effectively to protect the interests referred to in that provision.." CJEU, n. C-663/18 – 19 November 2020 –art.87

[57] Decree of Health Ministery 4 November 2019 "Definition of maximum levels of Tetrahydrocannabinol in food" in GU n.11 15 January 2020

[58] V. Carrieri, L.Madio, F. Principe "Light cannabis and organized crime: Evidence from (unintended) liberalization in Italy" *European Economic Review* 113 (2019) 63–76 www.elsevier.com/locate/euroecorev

In the last three years 2020-22, hemp cultivation in Italy had indeed a progressive decline. There is no reliable statistical data, if not the partial data of CAP payments requests from AGEA, but it is possible to estimate that in the period 2018-2022 hemp area dropped from 4,000 to 2,000 hectares, less or more.

Table 6. Hemp cultivated area in Italy

		2018	2019	2020	2021
AGEA data on hemp CAP payment requests	ha	1774	1401	1134	1124
Global area estimates	ha	*4000*	*3100*	*2200*	*2100*

The main reasons of this decline are explained below:

1. Legal uncertainty about the use of the entire biomass and the reduction of CBD prices all over the world after 2020;
2. No real industrial value chains for fiber and hurd production in Italy. There are nationwide many hemp industrial users – construction, packaging, glasses, composites for automotive etc.; however, the semifinished materials come often from abroad, especially from France and China. The reason for this absence is more economical than technical. The big sectors like paper, construction, non-woven textile or automotive, are more and more interested in hemp products. However, the final industrial users require assurances of huge and regular supplies that small start-ups cannot offer. On the other hand, prices for hemp stalks rarely are satisfying for farmers and it is therefore difficult to achieve the critical mass of raw materials for the start of the company.

In conclusion, until now, hemp for fiber and hemp for extraction haven't offered good prospects for Italian farmers yet. The only profitable market is seed hemp for food, but in this field, there are many little producers and few industrial experiences.

Approximately **80% of Italian hemp production is destined for the food industry**. The remaining 20% is used for the green building, cosmetics, and nutraceutical sectors.

Since the end of the last century, many Italian universities and public research centres have turned their attention to hemp. The main public research center is ***CREA – Consiglio per la Ricerca in Agricoltura e l'analisi dell'Economia Agraria***. It owns the germoplasm of the historical Italian strains for fiber (*Carmagnola, CS, Fibranova, Eletta*), highly appreciated also today as dioecious varieties rich in CBD (2-4%). In the last 25 years, CREA developed also new varieties for fiber or cannabinoids (eg. *Fibrante, Asso, Fibrimor, Carmaleonte, Ermo*). In its two centers of Bologna and Rovigo, CREA has also seed banks with more than 30 Italian strains and 270 hemp strains from all over the world. CREA is responsible for maintaining the purity of the historical hemp germoplasm, but for the breeding it rents the seeds to private operators that can receive a license, exclusive or not, to breed and sell them on the market for 15 years. The last call for the 4 historical strains already mentioned was in April 2022 and the license was granted to a Canadian company and to ***Assocanapa srl***, which already got the license for the previous period of fifteen years and surely has the best experience in these strains.

Furthermore, in 2022 CREA has been commissioned by the Agriculture Ministry to coordinate new research funds for hemp of 1 Million € provided by a recent Decree. The research fields are three: novel strains, hemp mechanization and new fast THC control methods.[59]

Other research centers very active in the hemp sector are some universities – such as the ***Cattolica del Sacro Cuore di Piacenza***, coordinator of the European project *Multihemp* (2012-17) and partner in the European funded projects *HEMPSYS*, *SSUCHY*, *GRACE*, and the Universities of ***Udine, Modena e Reggio, Padova, Catania, "Federico II" Napoli, "Luigi Vanvitelli" of Campania, "La Sapienza" Roma, Politecnico di Torino*** (prog *ComBIOsites* on recyclable composite materials for packaging) – and some institutes of ***CNR-Consiglio Nazionale delle Ricerche***, especially on cannabinoids. The last project, *Unihemp*, conducted by ***CREA, CNR Nanotech*** and the ***Department of Life Sciences University of Modena and Reggio*** had as its main objective

[59] Decreto 24 dicembre 2021 che istituisce il Fondo per la tutela e il rilancio delle filiere minori, in GU n.38, 15 Febbraio 2022

the use of the hemp residual biomass for energy and new biochemicals production.[60] One of the main results of the project was the discovery of two new phytocannabinoids with a similar structure to Δ^9-THC. One of these, called (-)-*trans*-Δ^9-tetrahydrocannabiphorol (Δ^9-THCP), has demonstrated a higher activity on human receptors than Δ^9-THC.[61] These results can open new perspectives for medical cannabis applications.
Some private companies developed and registered in recent years new hemp strains rich in cannabinoids other than THC: ***Canapalife srl***, ***Canvasalus srl***, an innovative company that counts as partners some of the best European experts of cannabis, like Giovan Battista Appendino, from *Università del Piemonte Orientale*, and Etienne De Meijer, former professor in *Wageningen University* and affiliated to *GW Pharamaceuticals*, and ***Enecta***, an Italian-dutch company, based in Holland but with agricultural and breeding activity in Italy, Abruzzo, with the brand ***GreenValley srl***. Enecta developed the first two strains with high cannabinoids content – one CBD-rich, *Enectaliana*, and the other CBG-rich, *Enectarol* – officially enregistered in the European Catalogue.

Industrial Hemp applications

As far as concerns industrial hemp cultivation and processing, despite the strength of the Italian agricultural machinery national sector, there are no on the market specific solutions for hemp stalks and seeds harvesting. In the last years, some farms rented machines from abroad, such as the already mentioned ***Assocanapa srl***, or developed prototypes themselves, such as ***Next Farm srl*** (Crema, Lombardy).
However, the main limitation of industrial hemp development, as mentioned before, is the status of primary processing in the hemp supply chain. Unlike France, Germany or the Netherlands, Italy didn't have any decortication facilities for fiber and shives until the autumn of 2022y, with the exception of a very peculiar plant for quality fiber production, recently opened (end 2021) in Pisa province, Tuscany, by ***Canapafiliera srl***. Similar to a traditional decortication facility, the plant is equipped with a huge controlled retting system in anaerobic conditions, as in biogas production. The facility is still in a start-up phase and is too early for a technical or market evaluation. The first main problem for the company at the moment is to obtain a critical mass of hemp growers.
In addition to this plant, there are two other facilities that, however, are not currently in operations: one is property of ***Assocanapa srl*** in Carmagnola, Piemonte, an old little hammermill, fitted for shives rather than for fiber, that should be renewed next year; the other one, owned by ***Biohemptrade srl***, should reopen very soon, for supplies to the construction sector. There are also various prototypes, such as the one developed by ***Naturfibre srl*** in Veneto, a mobile plant that can be moved by train or by containers, and the one funded by the Rural Development Program of Marche region (***Rete Canapa*** project), aiming to produce long fiber.
The gap in hemp primary processing in Italy is a bit odd considering the long tradition in fiber processing. In the 1930s and 1940s, Italy had already developed advanced mechanization of this process, with small performant machines built in Emilia Romagna and Liguria. The mobile prototype of *Naturfiber* was inspired by one of these machines. Moreover, at the beginning of the 1920s, a big plant in Comacchio (Emilia Romagna) for scutching and worsting hemp textile fiber was built by ***Ecocanapa***. It received a huge amount of public funds and counted on prestigious industrial users like *Armani* for textiles (jeans) and *Fedrigoni* for quality paper in Fabriano. After a lot of modifications, the plant worked well, but its efficacy was limited by the cultivation phase. They attempted to replicate the flax model in Normandy, with plants no higher than one meter (thanks to the use of glyphosate) and naturally retted on the field. This resulted in poor quality fiber and low income for farmers, thus abandoning the project in two years. The facility after 10 years of inactivity was sold somewhere abroad.

[60] http://unihemp.dhitech.it/
[61] AAVV – "A novel phytocannabinoid isolated from *Cannabis sativa* L. with an *in vivo* cannabimimetic activity higher than Δ^9-tetrahydrocannabinol: Δ^9-Tetrahydrocannabiphorol" – *Scientific Reports 9* – 30 December 2019
https://www.nature.com/articles/s41598-019-56785-1
AAVV – "Isolation of a High-Affinity Cannabinoid for the Human CB1 Receptor from a Medicinal *Cannabis sativa* Variety: Δ^9-Tetrahydrocannabutol, the Butyl Homologue of Δ^9-Tetrahydrocannabinol" - *Nat. Prod. 2020, 83, 1, 88–98,* December 31, 2019
https://doi.org/10.1021/acs.jnatprod.9b00876

The spinning expertise of ***Linificio Canapificio Nazionale*** (Villa d'Almé, Lombardy) owned by Marzotto Group, is, on the contrary, still in operation: although the relocation of its production in Lithuania and Tunisia, a spinning facility for flax and hemp remained active in Lombardy. A high-quality hemp knitted fabric is proposed by ***Produce Sinapsi srl*** (Cardano al Campo, Lombardy), born twenty years ago as a small single-member artisan activity. An innovative material has been created by ***Napee srls*** (Pesaro, Marche), with the aim of developing a sustainable leather alternative to replace synthetic and animal leathers: it is a compostable coated fabric, called *Napee Vegan Leather*, made from 97% biopolymers using natural oils and up to 30% hemp. Their fabric has found interest within automotive, furniture and also sport shoes companies. They assure to use a technology based on water processing without the use of solvents.
Hemp fiber can also be used for other textile applications besides fashion and furniture. For example, ***Cormatex srl*** (Montemurlo, Tuscany) specialized in carding and spinning technologies for woolen yarn and in nonwovens production has developed an innovative airlay system also for bast fibers that allow the use of a hemp dirty fiber, with also 15-20% of hurd impurities, for panels or rolls or nonwoven applications. Hemp fiber in fact can gain today a good market position in these sectors, in addition to composites.
Another company, ***Maiano spa*** (Florence, Tuscany), specialized in processing textile fibers to make felts, wadding and other nonwoven fabrics, produces also hemp insulation mats, with fiber obtained from non-Italian providers. It experimented in a recent project with another Tuscany company, ***TecnoWall srl*** (Poggibonsi), a hemp-based composite for camper interiors, replacing glass fiber with hemp fiber, but the hemp fiber resulted absorbing too much humidity with the risk to deform the panels.[62]
Despite of the absence of local value chains, there are various industrial uses for hemp fiber and hurds in Italy, especially in the plastics and composites sector and in the construction sector.
Hemp-based plastic is produced for the European market by ***LATI Industria Termoplastici***, in Vedano Olona (Lombardy), after signing in 2021 an agreement with the US ***The Hemp Plastic Company***, which since 2018 has produced ecological hemp blended plastics.
A special hemp fiber composite, called "canapa raso turco", for some parts of the first fully electric racing car, *Alfa Romeo Giulia ETCR* by ***Romeo Ferraris srl*** (Opera, Lombardy), has been realized by ***Fibertech Group*** (Mornago, Lombardy) in collaboration with ***Bercella srl*** (Parma, Emilia Romagna), specialized in composites and light alloy.
Novamont spa (Novara, Piemonte), a European leader in bioplastics, experimented in the European *GRACE* project the use of hempseed oil to obtain a chemical intermediary, the azelaic acid, for bioplastics.
In the same sector, ***The Eyes Republic srl*** (Longarone, Veneto) produces hemp plastic glasses with the claim of "the new bioplastic obtained from alpine hemp".
In the construction sector, there are various experiences, from Norther Italy to Sicily, among which notably two companies: ***Tecnocanapa Bioedilizia by Senini Group*** (Montichiari, Lombardy) and ***Pedone Working srl*** (Bisceglie, Puglia). Both companies propose hemp and lime biocomposites (*Bio Beton®* and *Biomattone®* respectively) that combine properties of insulation and thermal mass. They propose hemp and lime blocks and plasters.
An innovative application for interior design is proposed by ***Mogu srl*** (Inarzo, Lombardy) with its mycelium-based panels for walls or floors. It was implemented in the already mentioned GRACE European project from miscanthus chopped and hemp shives. The mycelium grows on these biomasses until it is completely covered with mycelial biomass. At this stage, the panels are dried, pressed and thereby sterilized.
An excellent case of hemp paper, at artisanal level, is "*Hempathy*" line, hand-made creation of ***Sandro Tiberi*** from Fabriano, a historical paper district since Middle Age.

On the contrary, the food sector is characterized by many product chains, from the field to final product, although stil at small scale. It is not known at the moment any industrial production of hempseed oil. The main Italian trader of organic cold-pressed oils, ***Joe&Co srl*** (Camisano Vicentino, Veneto), exporting most of its production in Northern Europe, declares to import hemp seeds from abroad, because Italian producers don't guarantee continuous and quality standard supply.
Nonetheless, Italy is the **first European country that defined technical requirements to certificate hemp-based cold-pressed oil**, representing indeed the first model for every kind of cold-pressed oil. The

[62] "COBRAF - Co-products from biorefineries" project funded by RDP 2014-2020 Regione Toscana

cooperation between ***Federcanapa***, ***University of Bologna*** and ***UNI***, the Italian certification body for industrial products (the equivalent of *CEN* in Europe), carried out this achievement in the spring of 2022.
High-quality products have been promoted by a national contest for the best hempseed oil (*"Premio Canapa è")* that have been organized for five years by ***Fracta Sativa Unicanapa*** (Fratta Maggiore, Campania) with a panel test and the support of experts from the Universities ***"Federico II" of Naples*** and ***"Luigi Vanvitelli" of Campania***. Between the best practices of local value chains from field to final products it is worth citing:

- ***Molino Crisafulli*** (Caltagirone, Sicily), a sixty-year-old mill transforming ancient Sicilian grains and for 7 years also hemp seeds for oil and flour. Their oil won several prizes.
- ***Ares Farm*** by Marzio Fiore (Termoli, Molise)
- ***Canapa Sativa Caserta*** (Campania), an association with a wide catalogue of oils, pasta and flours.
- In the north, on the Dolomites, ***Colle Elisa Farm*** grows hemp since 2015 and makes an appreciated hemp-based oil.

In cosmetics, one of the main Italian players is ***Verdesativa srl***, producing for almost ten years near Rome (Pomezia, Lazio) vegan, natural cosmetics based on organic hemp oil. ***La Saponaria srl*** (Pesaro, Marche) operates in the natural cosmetic sector producing an organic hemp-derived oil for skin grown by a local farmer, ***Allegro con Bio*** (Petriolo, Marche).

The extraction of active principles from hemp could also represent a potential market for Italy, although as already mentioned the actual regulation and the position of the Ministry of Health do not foster the companies of this sector. The biggest investment was made 4 years ago by the Canadian ***CanapaR Corp.*** (a subsidiary of *Canopy Growth*), building a facility in Ragusa, Sicily, with the ambitious plan of 1,000 hectares of hemp cultivation in Southern regions. However, regulatory problems, poor harvest and the disproportionate investment in the plant prevented the takeoff of the company. Now CanapaR has invested in *Hempoland* and decided to move elsewhere its production.
The Italian companies still active in the sector make different products with different technologies: ***Canax srl*** (Milan) is specialized in supercritical CO_2 extraction for distillates, extracts and vegetal intermediates from various species (eg myrra, vanilla, lycopenes etc); ***RSM laboratories*** by the pharma group ***Inalco*** (Milan) produce in Tuscany CBD crystal from ethanol solvent; in Siena, Tuscany, inside the incubator of Toscana Life Sciences, ***Ambra srl*** produces ash and rosin from hemp biomass cultivated in their fields in Maremma. They offer also extraction and analysis services and cooperate with the training of the police force on correct THC controls. An innovative extraction solution is proposed by another Tuscan start-up, ***Herbolea srl*** (Sesto Fiorentino, near Florence). It's a solvent-free system, based on water and enzymes, that can process also fresh biomass. Its patented technologies were already sold to various companies in the world, from the UK to Canada, Colombia and Switzerland (**Swiss Bioceuticals AG**) and has been adopted by another Italian company, ***Eusphera srl*** (Ariccia, Lazio), operating in the cosmetics and pharma sectors; ***Canapalife srl*** (Padua, Veneto) produces extracts for the foreign market using new solvent-free technology.

Medical Cannabis

As far as concerns medical cannabis production, until 2022 the unique authorized producer and distributor has been the ***Stabilimento Chimico Farmaceutico Militare (SCFM)*** in Florence, which began to grow cannabis in 2014 and has distributed it since 2017. It produces two hemp varieties developed by *CREA*: the first, *FM1*, at high THC content (13-20%) but very low CBD content (<1%) and the other one, *FM2*, at high THC and CBD content (respectively 5-8% and 7,5-12%). The products provided by SCFM are considered of very good quality although the amount produced is completely inadequate compared to national demand. As a consequence, in the past years, the Ministry of Health authorized imports of cannabis from abroad, especially Germany, to meet partially the internal demand for pain treatment. Finally, the Government decided to give other authorizations to grow cannabis in Italy and the Ministry of Defense launched a call to business operators in April 2022. The requirements are very strict. The results of the call haven't been published yet and it's impossible to know how many licenses will be released.

Figure 7. National consumption of medical Cannabis 2014-2021 *(grams)*

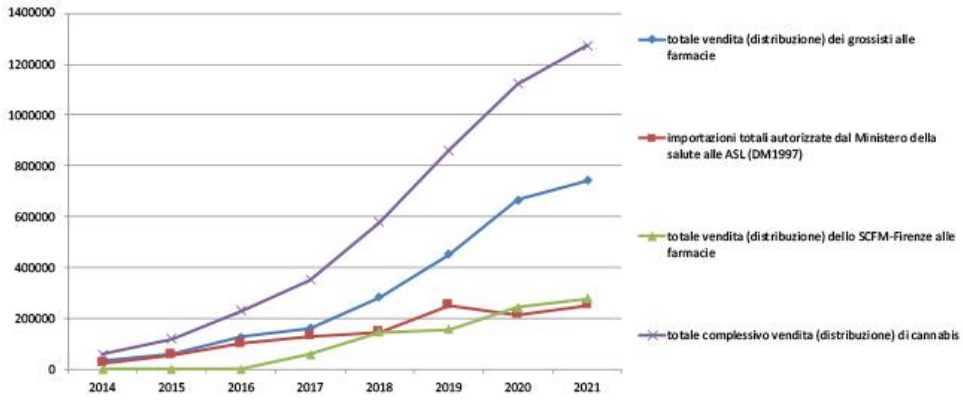


Table 7. National consumption of medical Cannabis 2014-2021 *(grams)*

Anno	Vendita (distribuzione) dei grossisti delle farmacie	Importazioni totali autorizzate dal Ministero della Salute alle ASL (DM 1997)	Totale vendita (distribuzione) dello SCFM-Firenze alle farmacie	Totale complessivo vendita (distribuzione) di cannabis
2014	33,315	25,275		58,590
2015	61,900	56,725		118,625
2016	127,305	102,410		229,715
2017	162,475	129,265	59,745	351,485
2018	284,290	147,265	146,905	578,460
2019	451,025	252.,85	157,165	860,675
2020	664,940	215,255	242,600	1,122,795
2021	742,500	251,460	277,515	1,271,475

Source: Ministry of Health

Hemp Value Chains in Italy: Weakness and Strengths

Strengths	Weakness
Safeguard for hemp farmers – THC limit in field of 0.2-0-6%	Regulations not favorable to the use of the entire biomass
Advanced research on cannabis and hemp – First UNI for hempseed oil	Lack of fiber processing facilities
Know-how in hemp fibers, plastics, composites and panels	Lack of novel strains and breeding expertise
Medical cannabis development	Lack of harvesting technologies

3.5 Hemp value chains in Portugal

General Framework

Industrial hemp farming in Portugal has been a legal activity since 1994, having first been transposed into national law by an amendment to Regulatory Decree 61/94, establishing rules for the control of the licit market in narcotic drugs and psychotropic substances.

However, a recent Ministerial Decree (14/2022 of 5 January) has introduced severe restrictions for hemp farmers, aiming to avoid any confusion in cannabis cultivation for industrial and other purposes. Indeed, cultivating hemp in Portugal for industrial purposes must be authorized by the ***Direção Geral de Alimentação e Veterinária (DGAV)*** and is limited to the purpose of obtaining "fibre and seeds (not intended for seeding), including for food or animal feed use or for the manufacture of compound feedingstuffs or feedingstuffs for animals, or for experimental purposes for the same purposes".[63] It establishes that hemp can only be cultivated outdoors in an area of at least 0,5 hectares; transplanting of plants is not allowed and the density of sowing cannot be less than 30 kg/ha. It is also forbidden to transport flowering plant juices outside the farm and rules have also been established on the reuse of opened seed packages.

Under the Law no. 33/2018, of July 18th and the Decree-Law no. 8/2019 of January 15th, the use of cannabis for medical purposes is admissible in Portugal, provided the necessary requirements and the mandatory licenses are obtained from ***INFARMED*** (National Authority of Medicines and Health Products).

As regards CBD, trade in CBD extracts is considered to be an activity prohibited to date as CBD, as a substance extracted from the flowers and leaves of the cannabis plant, must be treated as a controlled substance. Consequently, if the purpose is the extraction of CBD or any other substance, the plant may only be cultivated and traded in accordance with the specific rules for the cultivation and trading of controlled substances (i.e. essentially for medicinal purposes).

Cultivation

There are no official data on industrial hemp cultivation in Portugal. In 2021, it was estimated that in Portugal were cultivated 70 ha of hemp, from around 20 growers, mainly for the production of hemp flowers, given the limited extensions and the favorable climate conditions, destined to export. However, the recent Ministerial Order (14/2022 of 5 January), with its severe restrictions for hemp growers, risks further reducing industrial hemp production. In fact, by prohibiting the transportation of hemp flowers outside the farm where they are grown, the new decree essentially bans their trade, prohibits hemp growing in indoor and greenhouse facilities, requires growers to put in at least 0.5 hectares, and set restrictions on the use and handling of cultivation seeds. The various hemp associations – ***CannaCasa, Lusicanna, ACCIP*** – are demonstrating against this Order.

Industrial hemp applications

After all there are no facilities for hemp-based industrial production such as fibers or shives. Consequently, with the considerable exception of medical cannabis, there are no real industrial hemp value chains in Portugal to this date, but only fragmented know-how. And yet hemp in Portugal has a long history beginning around the fourteenth century until 1971, when became illegal. The raw material was used for the preparation of ropes and plugs for the Portuguese ships. Portugal has also used its colonies to ensure its supply of hemp, notably in parts of Brazil. In order to recover the ailing Portuguese naval fleet after the Restoration of Independence in 1640, King D. João IV put a renewed emphasis on the growing of hemp. He ordered the creation of the *Royal Linen and Hemp Factory* in the town of Torre de Moncorvo to increase production and support the effort.

Despite the strong limitations, there are two remarkable best practices of Portuguese manufacturers using hemp in their products. ***Louropel,*** in Vila de Famalicão, is the world's largest button factory producing all sorts of buttons and buckles for all types of clothing, including technical and military clothing. It produces 12

[63] The procedures for the authorisation of cultivation are described at: https://www.dgav.pt/wp-content/uploads/2021/06/Procedimento_-Cs_v5.pdf

million buttons/day, 25% of which are made from recycled material and vegetal fibres, mainly hemp. Hemp buttons represent 15% of their revenues, although hemp is entirely imported from Italy, where Louropel has a strong partnership with the Lombard factory Tecnozeta Louropel.
Tearfil (Moreira de Cónegos, Guimarães) is a spinning factory specialized in processing short ecological fibers, from organic cotton and hemp, lyocell and modal, to develop recycled polyester and bio-based PLA (Poly Lactic Acid). Tearfil offers a large portfolio of fiber blends and they have used hemp fiber since 2009, consuming about 30 tons a year of hemp entirely imported from Lithuania.

Medical cannabis

Medical cannabis in Portugal represents an example of a complete value chain, from cultivation to production and trading. There are two companies licensed to *"Manufacture of preparations and substances based on the cannabis plant*" given by INFARMED and 20 growers authorized for *'Cultivation of Controlled Substances/Cannabis'*.
Tilray Portugal is the most notable European subsidiary of the global leading Canadian company *Tilray* in the production and research of medicinal cannabis. The GMP-certified production facility in Cantanhede (investment of $ 22 million) is considered among the most advanced in the world.
Holigen Holding Ltd (Sintra) is also involved in medical cannabis development in Portugal. Holigen, initially a subsidiary of another Canadian company, *FlowR Corp.*, and sold in May 2022 to another Canadian company, *Akanda Corp.*, is cultivating a 72-hectare area in the Alentejo region aiming to produce more than 500,000 kilograms of medicinal cannabis per year. It has invested € 40 million in building its GMP facility in Sintra.
LEF *Laboratório de Estudos Farmacêuticos* is a GMP (Good Manufacturing Practices) and GLP (Good Laboratory Practices) compliant Contract Research Organization and Contract Manufacturer Organization, founded in 1992, providing a wide range of services for the pharmaceutical sector, as well as for other sectors, such as the Food Supplements and Cosmetics and Medical Devices, with a strong focus on Medicinal Cannabis. It offers also consultancy and training services.
It is worth citing also ***Smart Nature*** (Paço de Arcos) which is marketing in Portugal a wide range of both pharmaceuticals and cosmetic products with CBD.
An interesting case of training and consulting services on various clinical aspects, with a special focus on cannabis, is ***Wise Healthcare Solutions***[64] (Porto), which organizes a post-graduate course on medicinal cannabis**.**

Hemp Value Chains in Portugal: Weakness and Strengths

Strengths	Weakness
Complete value chain on medical cannabis	New law restrictions in force since January 2022
Services and training on medical cannabis	Lack of fiber processing facilities
Know-how in hemp short fibers for textile and buttons	CBD considered a controlled substance
	Lack of hemp cultivations

[64] https://wisehs.eu/pt/cannabis-medicinal-curso-pos-graduado

3.6 Hemp value chains in Romania

General Framework

The Law no. 339/2005, issued on November 29th, concerns the cultivation and preparation of psychotropic substances, thus also regulating the cultivation, selling and trading of cannabis. Furthermore, the Law 339/2005, under Government Decision 1915/2006, establishes the authorization process for hemp cultivation: hemp growers must be authorized by the ***Ministry of Agriculture and Rural Development (MARD)*** through County Agricultural Directorates before planting industrial hemp for stems or seeds. Only varieties registered in the Common Catalog or in Romania's Official Catalog of Cultivated Plant Varieties and Hybrids are allowed for cultivation.

Agricultural producers applying for hemp cultivation authorization **must have a production capitalization contract** and must verify the THC content of the crop in question.

Production, manufacturing, storage, commercialization, intermediation, possession and distribution of hemp-based plants and preparations need authorization from the ***Ministry of Health*** (MH), limited to industrial use or seed production or medical, scientific and technical use.

According to Law 339/2005, republished, Tab. I "*Plants, substances and preparations with prohibited psychotropic and narcotic substances, lacking recognized interest in medicine*", THC is at position 31, which means that any activity with THC is prohibited, unless has authorization issued by the Ministry of Health. As a consequence, Romanian law does not allow any sale or distribution of general hemp products (e.g. oil, flour, or food supplements) containing THC, regardless of the concentration. In January 2021, the Romanian ***Directorate for Investigating Organized Crime and Terrorism (DIOCT)*** clarified that the maximum THC content authorized (0.2%) is referred to the cannabis plant (in the cultivation phase), not to the final product. Romania regulations do not set a maximum level of THC and CBD for food products, creating several disputes between *DIOCT* and operators/consumers, many of which accused of trafficking in prohibited substances, although the THC content was very low and the products were imported from EU member states, where they were legally sold (and had entered the Romanian market through mutual recognition, according to EU Reg. no. 515/2019).

Currently, CBD products (oils, soap, creams, balms, etc.) without any THC content are legal and commercialized directly to consumers in Romania. However, CBD edibles and flowers are not available as they contain THC.

For scientific/research and medical purposes, however, hemp leaves, exempted from the definitions of Law 339/2005, and especially shoots with immature inflorescences (aerial part from cultivated varieties with less than 0.2% THC), from which, after dehydration/drying, the stems and seeds are removed, can be processed to obtain various vegetable extracts. Among them, the isolated CBD obtained through fractional distillation is of great interest, because it dissolves easily in hemp seed oil and can be formulated as a food supplement. Its commercialization is legal for example in Poland with over 350 such CBD oil products that, by mutual recognition, can also be commercialized in Romania. However, neither ***NSMAPBP - National Service for Medicinal, Aromatic Plants and Beehive Products*** nor the notifying institutions of the Ministry of Health involved in the legal marketing of food supplements that issue Notification Notices/Certificates allow CBD to enter the market without authorization from the EC, as it is considered a **novel food**.

Electronic cigarettes are considered medical devices and enter the market after being authorized by the ***NAMMSR - National Agency of Medicines and Medical Devices in Romania***. Their content ("vaping liquid") is regulated according to the Tobacco Directive (EC) no. 2014/40 and the national legislation). However, there are no specific provisions for CBD oil in e-cigarettes.

Law 339/2005 also provides that the growth, import and sale of cannabis for medical use is allowed in Romania, but under strict Government supervision.[65] Patients may be prescribed cannabis for medical use in the form of pharmaceutical products only. However, in practice, no doctor currently issues in the country a medical prescription based on cannabis, and Romanian pharmacies still do not sell substances containing

[65] Tab. II of Law 339/2005 (updated 2022) contains a list of plants and substances of interest in medicine, which are under strict control. Item 18: "Cannabis, resin, extracts and tinctures of Cannabis"

cannabis. Furthermore, the use of cannabis in Veterinary Medicine needs authorization as well as a strict control and supervision by ***NSVFSA - National Sanitary Veterinary and Food Safety Authority***.

Cultivation and R&D

Thirty years ago Romania was the Europe's largest hemp producer, reaching a cultivation area of 16000 hectares in 1990. However, lower demand, strict government regulations and old processing facilities led to a decline in this market. Since 2015, hemp area has started to increase again, reaching 3,147 hectares in 2018, slowly decreasing in the following years (tab 7). According to the *USDA's Foreign Agriculture Service* Romania is among the top five European Union member states cultivating hemp—mainly for fiber, oil, seed or grain.[66] Industrial hemp production (seeds and fiber) reached 3,161 tons in 2019.

Table 8. Data on the evolution of areas and production of hemp in Romania

Year	Surface (ha) *(In brackets: hemp for fiber only)*	Average production(kg/ha)	Total production (t)
2015	405	4719	1911
2016	650	5651	3673
2017	1688	1546	2610
2018	3147 *(1454)*	1900	2763
2019	2231 *(1433)*	2205	3161
2020	1334 *(1191)*	2506	2985

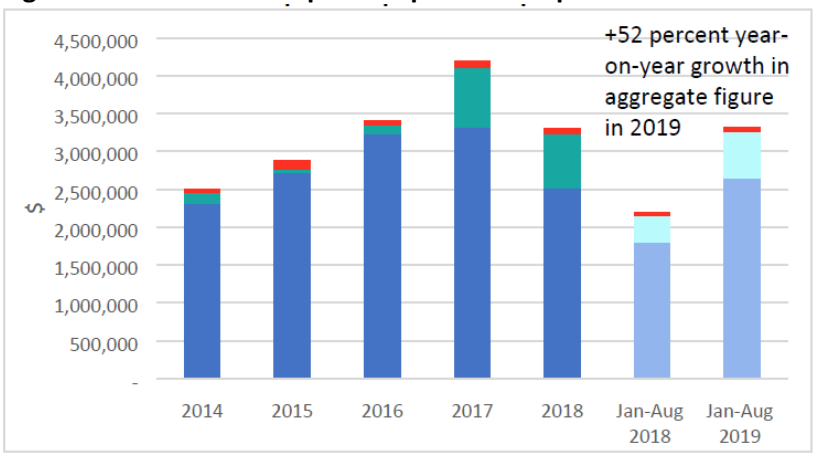
Source: Data from the National Statistics Institute - Tempo online
https://www.madr.ro/culturi-de-camp/plante-tehnice/culturile-de-in-si-canepa-pentru-fibra.html

Romania is a net importer of hemp products, with the exception of 2018 when, due to the export of fiber hemp, the overall value of imports, including seeds, polyphenols and fiber, reached $3.3 million, while export value exceeded $4.2 million, mainly due to the doubled fiber export.

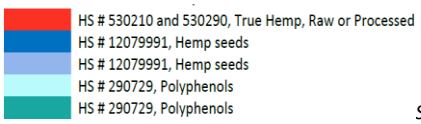
Hemp seeds are the most abundant traded product. Indeed, hemp seeds import reached $2.5 million in 2018 and increased by 47% during January-August 2019 as compared to the previous year (Figure 7), corresponding to a volume in 2019 of 1,500 MT hemp seeds (+55% compared to 2018). About 80% of hemp seeds are imported from the Netherlands and 18% from France.

Hemp seeds export reached $909,000 in 2018, but decreased by 35% during January-August 2019 compared to the previous year (Figure 8.). Hemp seeds are mainly exported to the United States accounting for 65% of total exports in 2019, followed by Italy and Germany (8% each). This corresponds to a export volume of 84 MT in January-August 2019 (-15% compared to 2018).

Figure 8. Romania – Hemp-based products import

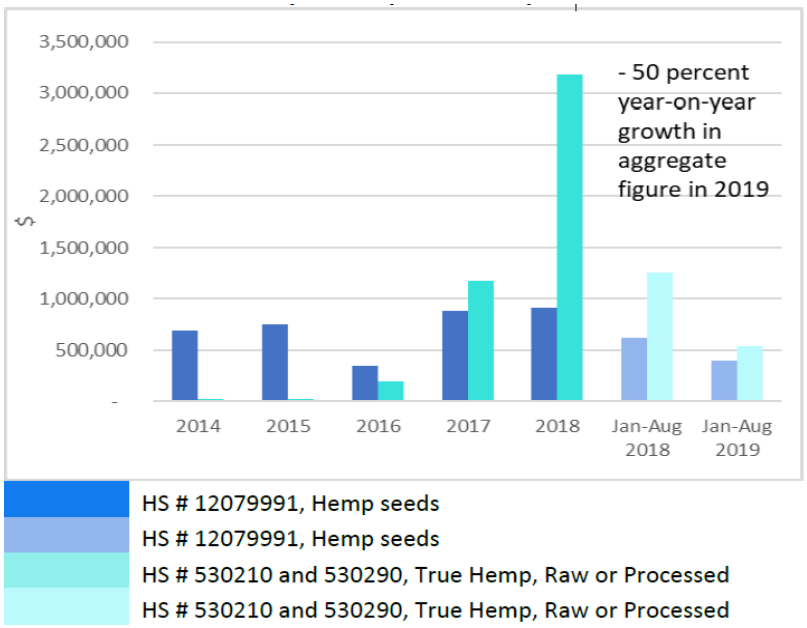


[66] https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Romanian%20Industrial%20Hemp%20Market%20Overview%20_Bucharest_Romania_02-23-2020



Source: Trade Data Monitor, LLC

Figure 9. Romania – Hemp-based products export



Source: Trade Data Monitor, LLC

The industrial hemp market in Romania has been booming over the last five years. Different foreign investors and farmers are investing in the Romanian hemp sector: Germany in the Banat area, France in the southeast, Switzerland in Suceava and Canada in Iasi for the CBD processing.
Romania supports hemp production through various programs and hemp farmers may apply for various types of subsidy payments. In 2018, domestic support levels for eligible hemp farmers could reach $382/Ha, based on the following categories: single area payment ($113/Ha); redistribution payment ($5.5/Ha for 1-5 Ha and $56/Ha for 6-30 Ha); greening payment ($64/HA); the Program for Young Farmers ($28/Ha); the National Transitory Program ($24.5/Ha); and coupled support ($96/Ha). To be eligible to receive such support, farmers need to comply with a series of criteria, including proof of a minimum average yield, proof of crop delivery to a processor, a self-declaration regarding the hemp varieties and the volume of seeds used in the field. Additionally, areas are subject to THC content testing.

At national level, one of the main players is the ***Asociaţiei Cultivatorilor de Cânepă*** (National Association of Industrial Hemp Producers - President Eng. Laurenţiu Pintrijel), established in 2017. It currently has 15 members all over the hemp value chain: growers, processors, institutions and research firms in the field.
A new cluster on hemp, ***Caneparo Cluster***, was born on December 2020 with the objective of identifying all players in the field, initiatives and value chains and contributing to their development. At the moment, Caneparo cluster includes players operating in cultivation, agricultural research on hemp, research for innovative and new materials hemp-based, SMEs working with hemp on various segments of the hemp chain, mainly textile and construction.

Table 9. Caneparo Cluster members

Arco Max srl,	Katty Fashion srl,
Ivan Patzaichin – Mila 23 Association	Milen Tech srl
National Association of Industrial Hemp Producers,	Nord Intermed Consulting Group srl,
Reginnova NE Association,	ÖKO Initiative srl,

Cemacon SA,	Pandora Prod srl
DC Communication srl,	PRODIN SA,
Faltin SA,	ROChallenges srl,
EcoMax srl,	Serplus Internațional srl,
National Research-Development Institute for Machinery and Installations for Agriculture and Food Industry – INMA,	"Aurel Vlaicu" University of Arad
	"Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine

Furthermore, the ***Ind-Agro-Pol*** competitiveness pole in agro-industry addresses different aspects of the hemp value chain, starting from the RDI and going to cultivation, specific equipment for hemp crops, processing. This cluster has developed a tech and innovation center in the South-Muntenia region of Romania. Furthermore, it is actively interested in developing various hemp processing technologies, circular processes, new materials for various sectors.
Hemp production in Romania can rely on almost complete value chains, beginning from the development and breeding of new hemp strains. The main varieties in Romania have been developed since the 1980s by two local research centerss in Lovrin and Secuieni: ***SCDA - Station of Agricole Research-Development Secuieni*** which has developed strains like *Jubileu, Dacia, Diana, Zenit, Denise*, and ***SCDA Lovrin*** which has developed strain *Lovrin 110*.
According to the *National Institute of Statistics*, Botosani (363 Ha), Suceava (307 Ha), and Iasi (104 Ha) counties in the northeastern part of Romania have the largest hemp areas. According to *Payments and Intervention Agency for Agriculture - APIA*'s, in2020, the largest farmers in the country were: ***Dronkers Grond srl*** from Alba, ***Byanca Plai srl*** from Botosani, ***Milen Tech srl*** from Iaşi, ***Esperanza Natura srl*** from Mehedinți and ***Agraficient srl*** from Alba.

Some Romanian farmers are also specialized in fiber hemp, investing in special harvesting equipment aiming to process hemp seeds and stems. In this context, many RDI projects are implemented by the ***INMA – National Institute of R&D for Machines and Installations designed to Agriculture and Food Industry***, a RDI entity founder member of ***Ind-Agro-Pol*** competitiveness pole.

Table 10. Main INMA hemp mechanization projects

Object	***Funds***
Green harvesting equipment for hemp stalks	national RDI funds
Equipment for processing hemp stalks in green	national RDI funds
Mechanization technology and technical system for hemp crop harvesting	national RDI funds
Eco-innovative technique for sequential hemp harvesting, seed conditioning and oil obtaining	national RDI funds
Seed dryer and biomass for hemp – .	private funds

Other members of ***Ind-Agro-Pol*** are manufacturers of agricultural machinery and seed processors, including those working with hemp such as ***Ruris Impex Srl, Servoplant Srl, Mecanica Ceahlau Sa, Islaz Sa***.
Moreover, in Romania operates one of the most advanced hemp multi-harvest systems, the *'double-cut' machine* born from the ***John Deere-Hempflax Europe*** collaboration (*see chapter 5*).

Industrial hemp applications

Although Romania has reduced the number of its processing facilities (28 in the 1990s), some of them are still in operation handling a wide range of products, including hempseeds for humans and animals, CBD for cosmetics and edibles, protein powder for shakes and smoothies, and nutritional bars. These products are widely available in retail chains and online. They are in general located in favorable areas for hemp cultivation, such as Alba, Botosani or Bihor counties.

The biggest facility *HempFlax2.0* for hemp decortication was built by the Dutch company ***Hempflax Europe*** in 2015 after a €5 million investment in Pianu. The Romanian site was based initially on the original Dutch facility, albeit with improvements made to enhance capacity and efficiency. In the region, Hempflax has about 1,000 ha hemp of in cultivation. ***Faltin SA***, Fălticeni, operating in the Textile and Fabric finishing and Fabric Coating Mills industry, carried out the hemp fiber processing and spinning; ***Cavvas*** is a manufacturer in Cluj-Napoca operating in the natural textile threads and yarns sector.
Another big player, operating in the food sector, is ***Canah***, from Bihor, specialized in hemp seed processing for almost ten years. It produces both human food (also hemp-based cacao, protein organic and not) and pet food. Currently, after Canah, ***SC Luna Solai*** – Cluj and ***SC Andrada*** – Dorohoi are the main processors producing hemp-based oil and food derivatives.
Consumer demand is expected to grow as a variety of hemp products come on the market. Hemp is used as a key ingredient in many foods, such as breakfast cereals, protein shakes and protein bars, which are sold online and in retail chains. CBD products also are found in pharmacies and health stores. In this field, the ***National Research-Development Institute for Food Bioresourses*** (IBA Bucharest) organizes the National Office for Medicinal Plants, Aromatics and Hive Products – NSMPAHP, which notifies food supplements.[67] From 2012 until now, 22 hemp-based food supplements legally entered the market (in their formula the raw material/ingredients are: hemp seeds, seed oil, seed coat as fiber source, embryos), while in 2021-2022 8 food supplements (herbal tea from hemp leaves and CBD oils having as origin some UE member states) benefited from mutual recognition (Reg. UE 515/2019). Over 30 products notified under the procedure of mutual recognition are now under safety assessment.
As a research and development institute, IBA Bucharest has developed some hemp projects, such as:

- *9PCCDI.9.03.2018 – VALINTEGR* - "Nutritious food concentrate from bee products with the addition of partially defatted hemp seeds and dehydrated goji berries and currants" Patent application no. A/00457/26.07.2019;
- *EXPERTAL 06/15042022* – "Research on the quality and safety requirements that must be met for a dietary supplement (CBD oil) to be authorised as novel food/NF" – technical and scientific support for a Romanian FBO (food business operator) to develop an eligible NF application.

In the hemp feed sector, ***IBNA Balotești*** *National Research-Development Institute for Animal Biology and Nutrition* represents the most important research unit in the field of animal science in Romania. IBNA researchers conducted in recent years some interesting studies about the effect of dietary hemp seed in sows during gestation and lactation and in piglets.[68]
Besides seeds, the Romania's most traded product, hemp biomass is poorly used (e.g. inflorescence, fiber and not even woody hurd that remains chopped in the field and is used only as biostimulant for the soil). The majority of the hemp crop is exported to Hungary for processing, alongside other countries in western Europe.
A large portion of the product supplying the European CBD market comes from Romanian hemp plantations, but the country makes little use of the plant, also for regulatory restrictions about flowers. However, with one of the cheapest land markets in the EU, Romania represents an interesting opportunity to combine low cost of production with high value and/ or niche crops.
In conclusion, Romania has almost all the competencies for the development of industrial hemp, from RDI to cultivation and processing. However, the different operators of such value chains seem not to be fully integrated to exploit the actual potential of hemp. The purpose of the two clusters is

- Setting up a R&D specific center for the necessary research to support various projects and legislation: e.g. retting technologies, harvesting, new materials, phytocannabinoids etc.

[67] https://bioresurse.ro/en/pages/notificari
[68] L.M. Palade and others, National Research Development Institute for Animal Biology and Nutrition, IBNA Balotesti "Effect of Dietary Hemp Seed on Oxidative Status in Sows during Late Gestation and Lactation and Their Offspring" *Animals* 2019, 9 (4), 199 https://doi.org/10.3390/ani9040194
M. Habeanu and others, National Research-Development Institute for Animal Biology and Nutrition-IBNA-Balotesti "Preliminary study on the interrelation between sow milk quality and litter performance in relation to their health" *Scientific Papers-Animal Science Series*: Lucrări Ştiinţifice - Seria Zootehnie, vol. 66

- Developing the hemp clusters competencies on all relevant aspects – legal, public affairs, projects, business support, with a focus on tech and digital competencies.
- Internationalization
- Developing processing facilities in Romania by using successful models.

Medical cannabis

In July 2019, following the EU Parliament's 2019 resolution on the benefits of medical cannabis, a new draft law (no. 631/2019) was submitted regarding the legal framework for medical cannabis and substances, and preparations containing cannabis. Alexandra Cristea, president of ***Victoria Mea Association*** – a member of ***Ind-Agro-Pol*** competitiveness pole – is the initiator of this draft law According to the draft law, named "*Victoria*", terminally ill patients may be given cannabis painkillers (palliative treatments), following a prescription from a specialist doctor. The draft law, named "Victoria", has also the purpose of authorizing the cultivation and marketing of cannabis and cannabis derived medicines in drug stores. The draft law also proposes the establishment of the **Romanian Agency of Cannabis**, which would be responsible for issuing authorisations for the activity of growing or processing medical cannabis, as well as ensuring the control, verification and surveillance of operations and transactions of medical cannabis. However, the proposal of Cannabis Agency received a negative opinion from the Government and is now in parliamentary debate.

Hemp Value Chains in Romania: Weakness and Strengths

Strengths	Weakness
Extensive hemp cultivation areas, strong know-how and networking	Restrictive and incoherent legislation – confusion between cannabis/industrial hemp
Hemp trade improved in 2017-2022	Lack of fiber processing facilities
Good base for RDI in varieties and hemp text tech	Medical cannabis prescription not allowed
Know-how in harvesting technologies and seed production	No THC content in any products if not duly authorizes