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Hemp Crop Opportunities

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Mini Review

Hemp (*Cannabis sativa* L.) is the world's most recognizable and controversial plant that was rediscovered as a sustainable and high yielding crop. Cannabis belongs to family Cannabaceae and is classified under the Cannabis genus as one species *Cannabis sativa* L with the subspecies *C. sativa* L. and *C. indica* Lam [11] and many varieties [15]. The mainly products of cannabis cultivation are— the bast fibers for cordage and textiles, the seeds for food and seed oil and the flowering tops for medicinal and psychoactive drugs [16]. The global market consists of more than 25,000 hemp products and new applications are continuously appearing [13].

The end use of cannabis plants influenced the way the plant will be cultivated. Outdoors in fields, is strongly applied for fiber and seed production. It is important for fiber purposes to achieve a high plant density and plant height, by having the seed rows at short distances. For seed and buds, is recommended to space plants farther apart because under these circumstances the plant produces more flowers and seeds per square meter and creates wider branches, although the fibers of such plants are short and potentially useful only for technical applications [9].

For cannabinoid-oriented production and for better control of the growing conditions, indoor and greenhouse methods are most appropriate, although they require more energy and produce more CO_2. However, in the case of cannabinoid production from flowering tops, indoor cultivation produces more grams per square meter, while outdoor production may produce more grams per kWh of energy [22]. Indoor cultivation allows precise control of all parameters for growing the plants, produce the expected quality and flowers and prevent the cross-pollination among different varieties because of wind and/or insects. For this reason, medical cannabis is almost exclusively cultivated indoors [22].

USA legalized the production of hemp federally as an agricultural commodity, which was eventually accepted in most of the states [21]. Other countries with active hemp grower and/or consumer markets are Australia, New Zealand, India, Japan, Korea, Turkey, Egypt, Chile, and Thailand [12]. China is regarded as a global leader in the manufacturing of consumer textiles and hemp but regarding China's hemp production and cultivation, official statistics are lacking [21].

In Europe farmers in order to meet the standard eligibility conditions for direct payments, have to use certified seed of varieties listed in the EU common catalogue of varieties with a THC content below 0.3%, however, the national limits may be different. France is the leading producer with 70% of the EU's total production, followed by the Netherlands (10%) and Austria (4%) (EU Hemp, data) while the starting point for cultivation shall be not only the market demands but also the legislation for the final product market.

Hemp is an annual, wind-pollinated crop, with both dioecious and monoecious varieties [4]. A monoecious plant produces both male and female flowers while dioecious varieties have separate female and male plants. Only the female plants survive the entire growing season, while male plants die after flowering. The hemp response in the field is the result of an interaction between genotype, environment, and crop management, with plant density, mineral nutrition, and irrigation level being the main factors involved in the final yield and its quality [17,19].

The challenges faced by hemp farmers include choosing the most appropriate variety according to the end use, using the most efficient production techniques, and having access to harvesting equipment and procedures [5]. Extended agronomic research will be needed to match varieties to various soils and

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climates and determine input requirements (as fertilizer, herbicides, and pesticides) that optimize the amount and value of outputs [9].

Crop cultivation takes place in well-drained and medium-heavy soils and moderate fertilization is needed. In the Northern Hemisphere, sowing takes place mostly from March to May, and in the Southern Hemisphere, from September to November. Three to four months are needed from the time of seeding to harvesting [3]. Hemp crops help regenerate soils and can greatly increase the benefits of crop rotations. According to Adesina et al. (2020), the root system of industrial hemp is deeply distributed in the soil, which improves soil porosity and friability regenerating soil structure.

Furthermore, industrial hemp has emerged as a highly successful commercial crop due to its carbon-sequestering property, higher biomass production, and various end-use products [2]. Their processing generates zero waste, as all parts of the plant can be used or further utilized. Because of its phytoremediation ability, hemp can also be used very successfully in ecological reconstruction and related land reclamation. As its root system grows, it can eventually eliminate heavy metals and other contaminants from deeper soil layers [23]. Furthermore, because *C. sativa* L. plants store carbon in their stems and roots through photosynthesis, they can absorb significant amounts of Carbon Dioxide (CO_2). This helps to lessen the consequences of climate change [1,14].

Uses of industrial hemp are found in many areas of industry. Its basic and best-known use since ancient times is in textiles. The fibers of the plant are strong enough to allow its use in clothing fabrics, ropes, shoes, sailing fabrics, etc. To produce fiber, core fibers are mechanically separated from bark (using a decorticator) or by retting, or by a combination of the two. After being separated, dried and baled hemp fibers can be further processed by additional mechanical separation, and spinning into yarn [24]. Hemp fiber is also used to make biodegradable mulch, horticultural planting materials, pressed fiber products, paper and pulp products, building-construction materials, insulation materials, animal bedding made of hurd, plastic bio composites, and compressed cellulose plastics [13].

The seeds are used in human nutrition and show a high nutritional value, either as flour or as oil [6]. Hemp seed consists of 20 to 30% edible oil, 20 to 30% protein, 20 to 25% fiber, 20 to 30% carbohydrates, and many other important nutrients and vitamins [10]. Hemp seed oil characterized by high Polyunsaturated Fatty Acids (PUFAs) content and low Saturated Fatty Acids (SFAs) amounts [8] while grain products include whole and dehulled hemp seeds, hemp seed oil, hemp seed flour, hemp seed cake (a byproduct of mechanical oil pressing), hemp seed meal, hulls of hemp, and hemp protein isolates and concentrates [13].

The flowering top of the hemp plant is distinguished by a resinous blend from over one hundred known cannabinoids and aromatic compounds, mostly terpenes. Δ9-Tetrahydrocannabinol (THC), the less active Δ8-Tetrahydrocannabinol, along with the primary degradation product of THC, called Cannabinol (CBN) have physical and mental effects on humans, considered psychotropic and for this reason are of extensive scientific interest. Other cannabinoids with increasing market interest are Cannabidiol (CBD) and Cannabigerol (CBG) which are non-psychotropic but proved to have therapeutic impact in many diseases and symptoms [18].

In conclusion, it should be noted that every stage of the entire value chain of *Cannabis sativa* L.-growing, processing, using, and finally recycling, reuse, and waste management-fulfills the objectives of the circular economy action plan and for this reason begun to gain significant attention from both the scientific community and the consumers, while its production is increasing at a constant rate.

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