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Opportunities in Commercial Hemp Production

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INTRODUCTION

Industrial hemp (*Cannabis sativa*) has been used for food and fiber for centuries (Courtwright, 2001) and was an important crop to Kentucky (Figure 1) and other U.S. States prior to the 1950s. Subsequently, the U.S.A. imposed restrictions on *Cannabis* and related products until the 2014 Farm Bill began the process of making industrial hemp a legal agricultural commodity (Johnson, 2015). To separate recreational and medicinal *Cannabis* from industrial hemp, the 2018 Farm Bill clarified the legal definition of industrial hemp as containing less than 0.3% THC (the major psychoactive cannabinoid in *Cannabis*).

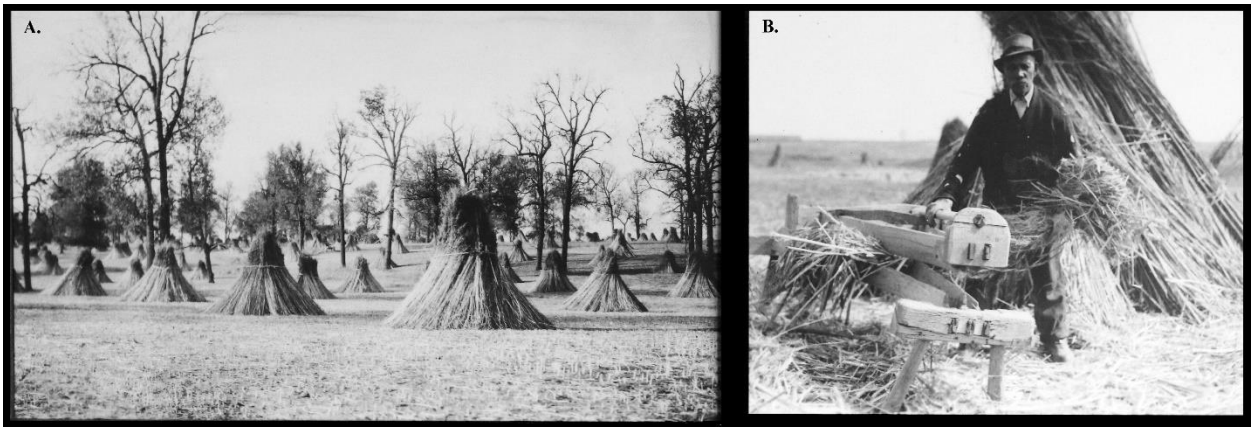

Figure 1. Historical images of industrial hemp production in Kentucky before 1945. A. Industrial hemp harvest in central Kentucky. B. Processing hemp for fiber.

Industrial hemp plants have been traditionally used for fiber or the seed (grain) utilized in food crops. The additional use of hemp for extraction of CBD (cannabidiol) oil has recently increased the demand for hemp plant production. Opportunities related to the hemp industry that involve traditional horticultural production and propagation practices suggest involvement in the hemp industry could be potentially profitable. A basic understanding of hemp morphology, production and propagation can be important in deciding whether to enter the industrial hemp market.

HEMP MORPHOLOGY

Although there are exceptions, most agricultural hemp plants are dioecious and produce male and female flowers on separate plants (Fig. 2). Most seed-propagated crops will produce approximately an equal number of male and female plants. Both male and female plants are required for seed production, but only female plants are useful for cannabinoid production. The majority of cannabinoids including THC, CBD, and CBG are produced in the bracts and sepals subtending flowers in the inflorescence (Fig. 3). The highest production of cannabinoids is in female inflorescences that are prevented from producing seeds. It is important therefore to roque-out male plants prior to flowering in seed-propagated crops or to isolate production fields from clonal female plants to avoid unwanted wind-borne pollen.

Figure 2. Dioecious hemp plants. A. Plant with a terminal male inflorescence. B. Terminal female inflorescence without seed production. C. Female inflorescence producing seeds.

Figure 3. Female floral production of CBD. A. Hemp inflorescence showing cannabinoid secretion crystalizing on the foliar surfaces. B. CBD is produced in trichomes on the leaf surface.

PRODUCTION SYSTEMS FOR CBD

Before initiating any production system, growers must check and usually register with their State Department of Agriculture. Hemp production protocols differ between States and some States require mandatory orientation before permits are issued. In 2019, USDA has issued regulatory guidelines and tolerances for State testing of hemp crops prior to harvest to ensure they meet the legal definition of hemp (0.3% THC). Growers will also have to stay current with changing or evolving rules regarding labeling and use of pesticides. As a new agronomic crop, there are few pesticides currently labeled for use in hemp. Field selection can be important for successful crop production and where perennial weeds are a problem, they should be controlled the year prior to planting hemp.

Agricultural systems currently employed for CBD crops include both field and greenhouse production. Field production can be initiated by direct seeding, seedling transplants or clonal cuttings. Greenhouse production is generally from clonal cuttings. Direct seeding is a cost-effective propagation method but there are issues with seed source, stand establishment and unless growers are using feminized seeds, labor will be required to roque male plants. Seedling transplants can be mechanically transplanted using conventional cone-style planters and this improves stand establishment. There is the same issue with sex determination in transplants as there is with a direct-seeded crop. Cuttings are more costly, but stock plants have been selected as high CBD-producing female plants and therefore cutting-propagated plants offer the highest yield potential per unit of planting space.

Field production varies depending on the propagation source and weed management strategy. Direct-seeded crops are produced on an agronomic scale with close in-row and between-row spacing. Crops produced from seedling or cutting transplants are most efficiently mechanically set with equipment that transplants and runs irrigation simultaneously. Row spacing reflects mechanical vs. hand weeding equipment and whether transplanting will be into plastic mulch (Fig. 4).

Figure 4. Hemp production systems. A. Irrigated clonal field with minimal row spacing. B. Irrigated and plastic mulch field on wide spacing. C. Greenhouse production in containers.

Propagation Systems

There is currently high demand for quality hemp propagules from germplasm selected for high CBD production. There are potential opportunities for entry into the propagation hemp market without significant alterations in infrastructure beyond those typically employed in other horticulture production.

Seed production in the U.S.A. is expanding mostly on the west coast. There can be issues with seed quality and availability of regionally adapted selections. There has also been issues with growers purchasing feminized seed that do not yield the desired high percentage of female seedlings. Feminized seed must be produced in isolation from female plants fertilized with a known pollen source. Typically, selected female plants are induced to produce male flowers employing an anti-ethylene compound like silver thiosulfate to become a suitable pollen donor. Properly pollinated, female plants have seeds that produce predominantly female seedlings. Any unwanted pollen contamination reduces the percentage of female plants in the seed-propagated progeny. Properly feminized seeds are currently in demand and command a high value for the seed producer.

There are greenhouse producers that are moving from traditional flower plug and transplant production to producing hemp seedlings. There has been a trend for large CBD producers to partner with greenhouse growers to produce seedling transplants. There is currently only a small demand for organic transplants, but that is anticipated to increase as CBD production diversifies based on market demand.

High input production systems like traditional or organic field production on irrigated / plastic mulch fields or year-round greenhouse production currently require reliably high CBD producing female clones from cuttings. There is currently a demand for cutting propagated material and this demand may increase as the price for CBD adjusts to the demands of the market. High quality cutting production should include a clean stock plant program. Several tissue culture firms are beginning to offer clean stock to large scale cutting producers. In addition to initiating from and maintaining clean stock plants, cutting growers must consider daylength control for seasonal cutting production to avoid photoperiodic flowering in stock plants. Night interruption lighting is sufficient to maintain vegetative stock plants. Stock plant production for cuttings is currently domestic, but growers should consider the potential for offshore entry into this market when considering their long-term business model.

CONCLUSION

Industrial hemp for CBD production is a classic example of an "emerging" high value crop. There are opportunities for early adopters to profit from the high demand for CBD. However, the supply and demand for CBD is already beginning to moderate and growers need to assess the risk before entering this market. There are opportunities for traditional horticulture enterprises that currently produce or propagate flower or woody crops to enter this market with limited change in existing infrastructure. Limited entry into this market may yield short-term profitability with acceptable risk while the long-term market demand becomes clearer. Growers should also consider lateral movement into future regional markets for medical or recreational THC-cannabis or other non-psychoactive cannabinoids like CBG (cannabigerol) that may enter the market and may not require significant changes in production techniques.

Literature Cited

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