



Industrial Hemp as a Modern U.S. Commodity Crop

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History of industrial hemp



- Native to central Asia; propagated for 1000s of years.
- Was one of the main textile fibers of the world until the mid/late-19th century.
- After the federal Marihuana Tax Act was enacted in 1938, nearly all hemp production ceased (except for a brief revival during WWII). Not illegal until 1970.

Hemp Botany



Summer annual

Can be dioecious or monoecious

Exhibits strong photoperiodic flowering

Huge phenotypical and biochemical differences among genotypes

Photo: Matt Barton

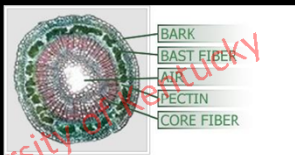
Why grow hemp today?



Three major harvestable components:

- Fiber
- Grain
- Cannabinoids

Bast and hurd fibers



Industrial applications (injected, molded, composite materials - green plastics)

Building materials

Fabrics

Animal bedding

Energy/carbon sequestration?

Carbonaceous materials?

Grown for fiber...

- Goal is strong vegetative growth
 - Variety selection is key relative to latitude and climate
 - Planting date is key relative to variety
- Not too much fertilizer
- Harvest is at the onset of reproductive growth
 - BPs and new engineering for harvest equipment are under investigation
 - Retting is key to success in high-quality fiber production regardless of other factors.







Hemp for grain...

- Mostly very different varieties than those bred primarily for fiber (latitude of origin?).
 - Shorter stature much easier to harvest with conventional equipment.
 - Again, variety selection relative to latitude and climate is paramount.
- More fertilizer; pretty much like corn.
- Harvest at 75% maturity, but must be dried immediately.
- Dual-purpose crops are harvested for grain initially and fiber subsequently.



Hemp for cannabinoids



From: <http://www.cbsnews.com/pictures/charlottes-web-manjuna-pediatric-seizures/>

48950 Federal Register / Vol. 83, No. 189 / Friday, September 28, 2018 / Rules and Regulations

Schedules of Controlled Substances: Placement in Schedule V of Certain FDA-Approved Drugs Containing Cannabidiol; Corresponding Change to Permit Requirements

AGENCY: Drug Enforcement Administration, Department of Justice.

ACTION: Final order.

“As noted, until now, Epidiolex has been a schedule I controlled substance. By virtue of this order, Epidiolex (and any generic versions of the same formulation that might be approved by the FDA in the future) will be a schedule V controlled substance. Thus, all persons in the distribution chain who handle Epidiolex in the United States (importers, manufacturers, distributors, and practitioners) must comply with the requirements of the CSA and DEA regulations relating to schedule V controlled substances.”

“As further indicated, any material, compound, mixture, or preparation *other than Epidiolex* that falls within the CSA definition of marijuana set forth in 21 U.S.C. 802(16), including any non-FDA-approved CBD extract that falls within such definition, remains a schedule I controlled substance under the CSA.”

2018 Hemp Farming Act/Farm Bill

Conforming changes to Controlled Substances Act

(a)

In general

Section 102(16) of the Controlled Substances Act (21 U.S.C. 802(16)) is amended—(1) by striking (16) The and inserting (16)(A) Subject to subparagraph (B), the; and (2)

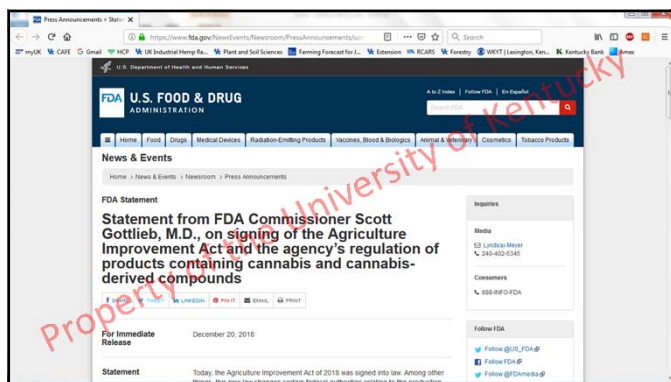
by striking Such term does not include the and inserting the following:

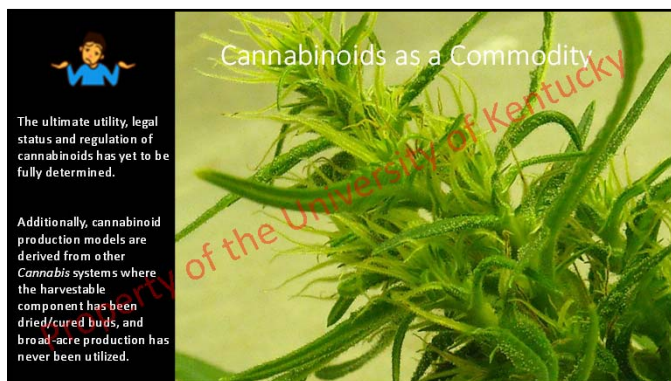
(B)

The term *marihuana* does not include—

(i) hemp, as defined in section 297A of the Agricultural Marketing Act of 1946; or

(ii) the





Hemp for cannabinoids...

- For optimal production, could essentially be the same exact system as other current *Cannabis* production systems.
 - Mainly interested in female flower buds, no males or pollenated (fertilized) flowers.
- BPs for field-scale production of cannabinoids are completely unknown.
 - Variety selection?
 - Planting methods?
 - Fertility?
 - Harvest methods?
 - 'Curing'?
 - Drilled/chopped/dried/ensiled/dual-purpose models could very likely be competitive.
 - European model [dual-purpose with grain]?



Production Report Data*

<u>2017</u>	<u>Grain</u>	<u>Fiber</u>	<u>Floral</u>
Growers	20	14	112
Acres Planted	1,227	159	1,883
Acres Harvested	826	120	1,371
Avg. Yield lb/acre**	\$18	2,556	1,024
Avg. Price per lb	\$1.70	\$0.34	\$7.20

*Preliminary analysis of 2017 production report data is not complete.
 **Average Yield was calculated only from plots with reported yields above zero. (Does not include dual purpose Grain & Floral)



Maturity of global hemp industry efforts

- Canada: 12 March 1998
- EU: Not precise (never banned in France or Finland); England, 1993; Germany, 1996, etc. From: Hemp Support: Evolution in EU Regulation. Valarie VanTresce, 2001.
- China: Not precise; never banned in many traditional production areas. "Jiang's farm is in China's frosty north and is one of the country's major centres for the legal crop. Authorities in the province turned a blind eye to its production before legalising and regulating it last year (2016). Another major growing area is in Yunnan province where the plant's production has been regulated since 2003." From: South China Morning Post
- U.S.: April 2014.

General status/conclusions?

Global hemp compared to standard U.S. commodities

- "Preliminary information for 2017 indicate that hemp acreage in Canada and the European Union (EU) countries reached record levels, which could put global acreage at more than 330,000 acres." From: *Hemp as an Agricultural Commodity*. Renée Johnson, Specialist in Agricultural Policy. June 22, 2018. Congressional Research Service.
- U.S. 2017 Acreages (values)
 - Corn = 90.9 million A (\$48 billion/\$528)
 - Soybeans = 89.5 million A (\$41 billion/\$458)
 - Wheat = 45.7 million A (\$8 billion/\$175)
 - Cotton = 12.1 million A (\$7.25 billion/\$599)
 - Canola = 2.16 million A (\$532 million/\$246)
 - Sunflower = 1.214 million A (\$390 million/\$321)

Source: USDA NASS
Photo: Matt Barton











UK Agronomic Hemp Data-Fiber

- Until 2018, 3.8 ton/A; 5.1 ton/A this year
- Effects of plant populations on yield, stem morphology, and uniformity of physical characteristics
 - Seeding rates
 - Row spacing
- Seed production from fiber lines
 - Planting dates



UK Agronomic Hemp Data-Grain

- ~1000#/A since 2015
- Still very excited about the potential for certified seed
- Quantity and quality of oil from hemp grain
 - Significant differences in both among varieties
- Dual-purpose trials
 - Grain yields okay
 - Straw ~1-1.5 ton/A
 - Grain/cannabinoids?



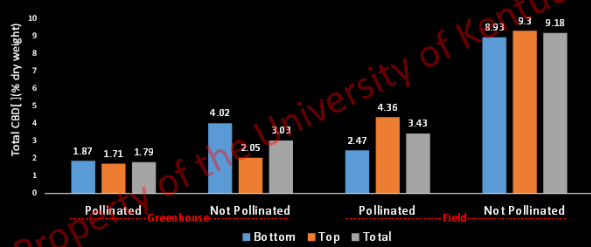
UK Agronomic Hemp Data-Cannabinoids

- Economics are undefinable today
- Production models totally up in the air
- Significant differences in pollinated vs. un-pollinated buds
 - Greenhouse
 - Field (confounded by location; theoretically by other means as well).
- Need work on production models, perhaps dual purpose cannabinoid crops if the *molecule* is the harvestable component of interest.
 - Grain and/or straw.
 - Ensilage?



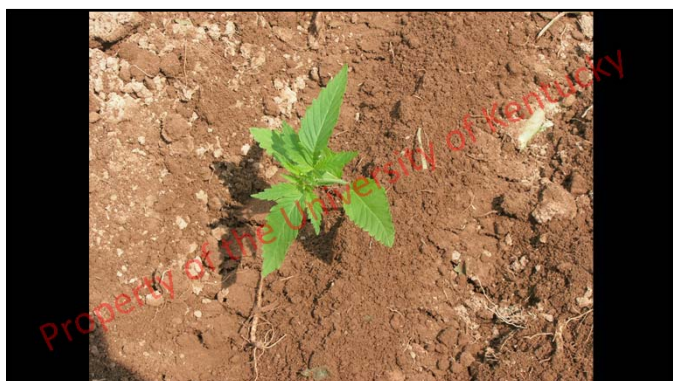


Total CBD Concentrations as a Function of Pollination and Bud Location on Plants Grown in the Greenhouse or in the Field



















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