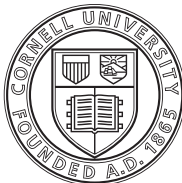


INDUSTRIAL HEMP

from seed to market



Photo from National Hemp Association



Cornell University



Photo: Associated Press

Hemp is commonly used to refer to Cannabis strains cultivated for industrial (non-drug) use. Industrial hemp has many uses and is used in various products including agricultural products, textiles, recycling, automotive parts, furniture, food and beverages, paper, construction materials, and personal care items.

Globally, approximately 30 countries grow hemp, with China being the largest hemp producing and exporting country, responsible for an estimated 1/5 of total global production. A list of countries that produce and export hemp can be found on the National Hemp Association website.¹⁶

Nationally, 32 states¹⁷ allow hemp production per the 2014 Farm Bill with Kentucky leading the effort. Vote Hemp estimates that in 2015, 9,650 acres of hemp were planted in 15 states, 30 universities conducted hemp-related research and 817 state hemp licenses were issued. The National Conference of State Legislatures provides a good overview of states' individual hemp pilot programs.¹⁸

The information provided within this document has been collected from regions in the world where hemp is grown.

Local research is needed to provide specific data on growing requirements for hemp in New York specifically relating to:

- spacing
- harvesting
- processing
- nutritional needs

PRODUCTION

CULTIVAR SELECTION

There are genetic differences between industrial hemp and marijuana. They have different uses and tetrahydrocannabinol (THC) levels. Hemp cultivars contain less than or equal to 0.3% THC while marijuana cultivars contain 3%-15% THC by weight. Different hemp cultivars produce variable quantities and qualities of fiber, as well as seed size and oil composition. There are some cultivars that have multiple purposes; but generally cultivars are used that are specific for one use or the other.¹

Cultivars are either dioecious (separate male and female plants) or monoecious (have male and female flowers). Monoecious cultivars are generally only grown by plant breeders.¹

SITE SELECTION, PLANTING AND NUTRITION

Hemp is an annual reaching heights up to 16 feet; anecdotal information cites plant growth of up to 4 inches per day (which helps hemp outcompete weeds), and research measurements cite up to 12 inches of growth in a week.²

- Hemp grows best in well-drained loam soils; avoid compact soils.
- Plant in late April or early May; best to plant after the danger of a killing frost or when soil temperatures are 50°F or above.
- Ideal seeding depth is ½ - 1 inch, but no deeper than 1 inch.³
- A standard grain drill can be used for planting conventionally or no-till.
- Hemp requires 12-15 inches of water throughout the growing season.¹
- For fiber, plantings are closer together to promote height and discourage branching and flowering.
- For seed production, flowering and branching are desirable, therefore plants are spaced further apart.
- Hemp is very similar to corn in its nutrient requirements. A lack of nitrogen greatly decreases mass for fiber production.¹

There are no labeled herbicides for hemp; however, hemp germinates quickly if there is sufficient moisture which helps with weed suppression.



HEMP PLANTS

prefer semi-humid conditions with temperatures between 60°-80°F

require abundant water for early plant development but are drought resistant once they are past the early development stage

grow best in well-drained loam soils

prefer a soil pH of 7.0-7.5 but will grow in a pH of 6.0

are cross-pollinated by wind

can endure 25°F (-5°C)

produce greater mass for fiber production when planted early

have less stem length and mass when planted later for seed production

HARVEST AND STORAGE

HEMP FOR SEED

Harvesting begins approximately six weeks after flowering or when the seeds have ripened.¹ Hemp grain can be harvested with a combine, however, a number of challenges have been noted. Specifically, hemp stalks wind around moving parts and cause plugging, and the resin is sticky, necessitating a cleaning process after harvesting is complete.

Approximately 80 percent of the seed is still viable after one year in storage. It can be kept longer if temperatures of 35-38°F are maintained (amount of time is unknown).³

Seed is damaged easily. To minimize damage:⁴

- Reduce the unloading speed and do not unload while moving.
- Use conveyors to unload from a grain bin to a dryer.
- Run augers at a lower speed. Use augers with a diameter of 10-13 inches.

Sample the seed in the grain bin to make sure it has dried to buyer specifications.⁴ Canadian processors specify a moisture content of 8-9% for stored seed.

Hemp seed heats quickly. When storing seed, hopper bins with aeration are the best choice. Overfilling grain bins can contribute to increased risk of the seed overheating.

HEMP FOR FIBER

Harvesting begins when plants are between early bloom and seed-set and should be executed in such a manner that stalks are not broken or cut up. Harvesting is usually done by hand, but in Canada they use baling and swathing equipment. Currently, specific equipment for harvesting hemp for fiber does not exist in the United States. In Kentucky they are experimenting with the use of a sickle-bar mower to cut the crop, after which the hemp is retted in the field and baled.³

Retting is a process that uses bacterial action or moisture (water) to soften the fibers in preparation for separation. The following describe several different types of retting:¹

- Dew retting is a process by which fibers break down in the field from environmental moisture (up to 5 weeks); the end product of which is a coarse fiber, light brown in color.
- Water retting is a process by which bacteria is used to break down plant pectin after hemp is immersed in water; a process that is known to produce better quality fiber.
- Warm water retting involves submerging hemp under water for 24 hours, at which time the water is replaced and heated for two to three days; a process that is known to create a very uniform clean fiber.
- Green retting is an entirely mechanical process that is used to separate the component parts; a practice typically used for textile/paper and fiberboard products.
- Chemical retting is a process that uses chemicals to dissolve the pectin, ultimately separating the fibers.

Cutting and baling for fiber must occur in a timely manner in order to reduce the amount of fiber wrapping.⁴ Processors will identify the bale size and retting process they prefer to be used. When baling, sisal or hemp twine should be used as poly twine can contaminate the fiber. Plastic net wrapping is an option because it can be easily removed.⁴

Moisture content of the stalks needs to be less than 15% when baled. Continued drying to a moisture content of 10% is then required.⁴

In 2017, Cornell University's School of Integrative Plant Science will be conducting grain and fiber trials in 3 locations with varying soil drainage conditions.



ECONOMICS OF GROWING INDUSTRIAL HEMP

It's important to note that available economic data is extremely limited from other states and/or countries that have a more developed industrial hemp industry. Below is a summary of known data available to date. However, as the industry continues to evolve, and more economic and yield data becomes publically available, it will be important to update Table 1.

Table 1. Economics of Production for Industrial Hemp

Location	Use*	Yield per acre (lbs)	Avg price per lb	Production costs	Gross profit margin (gross returns-production costs)	Note
Alberta, Canada ⁵	Seed on dryland : irrigated, respectively.	1,074 : 1,679	\$0.74 for both	\$409/acre, or, \$0.38/lb : \$574/acre, or, \$0.34/lb	\$396/acre, or, \$0.37/lb : \$748/acre, or, \$0.45/lb	NOTE: Figures are in Canadian dollars. Production data collected from 10 farms in 2015. Numbers are weighted averages. Author's note significant variation between individual farms.
Manitoba, Canada ⁶	Seed	575	\$0.68	\$392.61/ac	(\$1.61)/ac	NOTE: Figures are in Canadian dollars
Ontario, Canada ⁷	Not stated	1,100 : 800	\$0.60 : \$0.88	\$487/ac : \$377/ac	\$173/ac : \$327/ac	NOTE: Figures are in Canadian dollars. Figures represent conventional : organic respectively. Date of source is unknown. Yield and avg price/lb were reported in tons and converted to lbs by authors of this white paper. Conversion of 2,000 lbs/tn used.
Kentucky ⁸	Seed : fiber respectively	1,000 : 4 ton/dry matter/acre	\$0.68/lb : \$0.065/lb			Data was verbally provided through phone interview with Dr. David Williams, University of Kentucky. No published reports were identified.
Vermont ⁹	Not clearly stated	812				Noted great variance in yields, dependent on planting dates. Earlier plantings resulted in higher yields. Four planting dates between 5/26/16-6/17/16, with respective yield range of 1,850-552 lbs/ac.
Eaton, NY ¹⁰	Seed	850				Hurds were sold to a NYS based building materials company. Took avg based on stated yield of 800-900 lbs/acre
North Dakota	Grain : fiber respectively	1,110 : 5,134 ¹¹	\$1.00 (all grain product went to oil seed company) ¹³	\$366/ac (avg of 4 farms in 2016) ¹³	\$733/ac (avg of 3 farms in 2016) ¹²	Yield results are for Canadian and Finland industrial hemp cultivars. Note significant variance between cultivars. Also evaluated, but not listed in this table, were French and Australian cultivars. 2015 data reported in averages. Price/lb, production costs and gross profit margin are from a separate source than yield data.

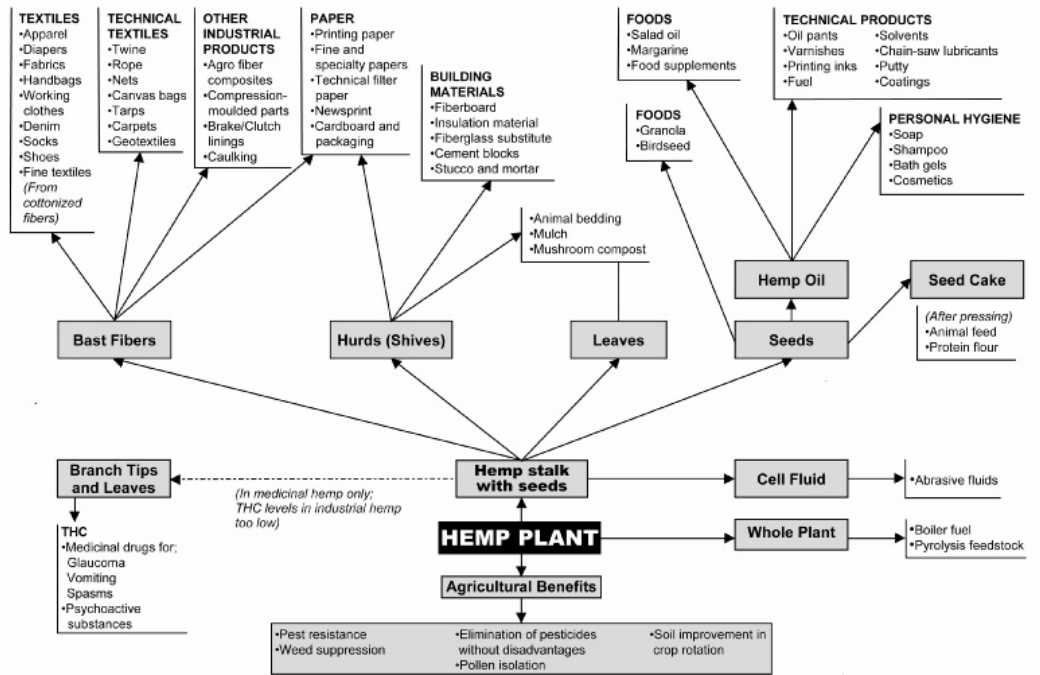
* the wording used in this column, be it either "seed", "fiber" or "grain" is reported in the exact term the source used

COMMERCIAL USES OF HEMP

There are an estimated 25,000 products derived from industrial hemp, that fall into nine submarkets: agriculture, textiles, recycling, automotive, furniture, food and beverages, paper, construction materials, and personal care. See Figure 1 for a breakdown of potential products.

Hemp can be grown as a fiber (the “stalk” of the crop), seed, or dual-purpose crop. The interior of the stalk has short woody fibers called hurds; the outer portion has long bast fibers.¹³

Figure 1. Uses for Industrial Hemp¹³

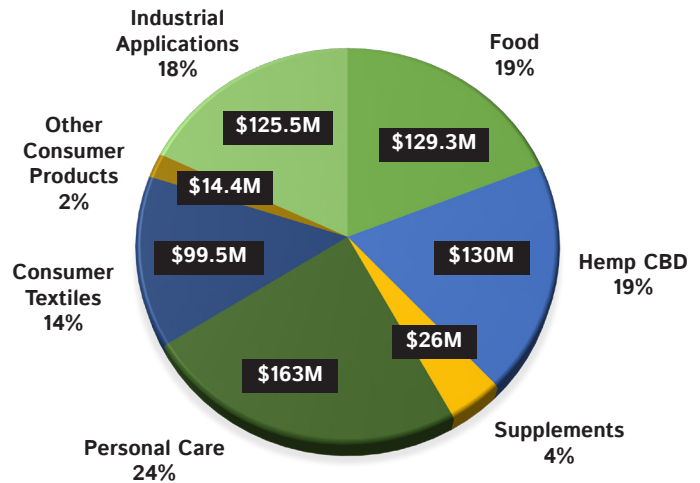


ESTIMATED RETAIL MARKET

Vote Hemp estimated the total retail value of hemp products sold in the U.S. in 2016 to be at least \$688 million¹⁴, which indicates a 20% growth over the 2015 retail value estimate of \$573 million.¹⁵ See Figure 2 for a breakdown of sales by market channel.

It’s important to note with regard to the estimated market value of \$688M that sales data on hemp food and body care products are likely significantly underestimated, as retailers such as Whole Foods, Costco and Alfalfa’s Market are not included in this market estimate.¹⁴ The Hemp Industries Association estimates an average of 15% annual growth in U.S. hemp retail sales during the 2010-2015 timeframe, with the majority of this annual growth attributed to hemp-based body products, supplements and foods. China is the largest importer of raw and processed hemp fiber into the U.S., with other imports coming from Romania, Hungary and India. Hemp seed and oil cake is predominately being imported from Canada, with significant growth recognized in the last several years.¹³

Figure 2. 2016 Industrial Hemp Sales by Market Channel¹⁴



Source: *Hemp Business Journal* and *Vote Hemp* estimates (consumer sales)

LEGAL POINTS & ISSUES

U.S. custom officials blocked the Kentucky Department of Agriculture's shipment of 250 lbs of viable imported seeds in 2014. Historically, the Drug Enforcement Administration (DEA) argued in support of this decision, as the *"importation of cannabis seeds remains to be subject to the Controlled Substance Import and Export Act"*. Two federal actions, which are detailed below, resulted in response to previous DEA interference in a state's right to grow and cultivate industrial hemp, as permitted under the 2014 Farm Bill.

STATEMENTS OF PRINCIPLES ON INDUSTRIAL HEMP

A joint statement was released on 8/12/16 from the DEA, the United States Department of Agriculture, and the Food and Drug Administration. Highlights of the statement are as follows, with full text available on the Federal Register website.¹⁹

- Growth and cultivation of industrial hemp may only take place in accordance with a state sanctioned agricultural pilot program intended to study growth, cultivation or marketing of industrial hemp.
- Not for the purpose of general commercial activity, industrial hemp products may be sold in a state with an agricultural pilot program or among states with agricultural pilot programs but may not be sold in states where such sale is prohibited.
- Industrial hemp plants and seeds may not be transported across state lines.
- The DEA's position that the importation of viable cannabis seeds may only be carried out by DEA registered persons was reinforced.

While some concerns regarding federal interference in a state's right to grow industrial hemp were ameliorated in this joint statement, it's argued that other important issues remain open to interpretation. For example, it's not clear whether or not the statement, *"not for the purpose of commercial activity"* could restrict sales of industrial hemp. Furthermore, *"may not be sold in states where such a sale is prohibited"* has been questioned as industrial hemp products are currently being widely marketed, distributed and sold through-out the United States.¹³

OMNIBUS APPROPRIATIONS ACT OF 2016

A provision was added to the Omnibus Appropriation Act of 2016 that includes an amendment that essentially restricted DEA's use of funds on certain activities as they relate to the cultivation of hemp, pursuant to the 2014 Farm Bill. Specifically, DEA appropriations cannot be used:

- a. "in contravention of section 7606 of the Agricultural Act of 2014 (7 U.S.C. 5940); or*
- b. to prohibit the transportation, processing, sale, or use of industrial hemp that is grown or cultivated in accordance with subsection section 7606 of the Agricultural Act of 2014, within or outside the State in which the industrial hemp is grown or cultivated."*

Language on the full amendment can be found on Vote Hemp's website.²⁰

IDENTIFIED BARRIERS TO GROWTH

A series of barriers to growth in the U.S. industrial hemp market were identified through both published documents and through conversations with growers.



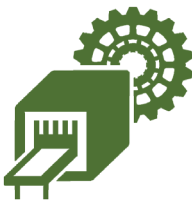
RE-ESTABLISHMENT OF AGRICULTURAL SUPPLY CHAINS

With the cultivation of industrial hemp being illegal for so many decades, many of the supply chains that once existed have since dissipated. In order to be competitive with global markets, these supply chains need to be reestablished with economies of scale at the forefront.



UPGRADED AND/OR SPECIALIZED HARVESTING EQUIPMENT

Harvesting hemp with a traditional combine provides many challenges due to the structure of the crop. Most notably, tough fibers wind around moving parts and fine fibers work into bearings, causing friction, which can ultimately lead to bearing breakdown and combustion. It's acknowledged that earlier grain varieties tend to be easier to combine and that proper settings can improve yield and quality of the grain, as well as provide less wear and tear to the equipment.²¹



PROCESSING AND MANUFACTURING IN NEW YORK

The need for processing and manufacturing is closely related to the need to reestablish agricultural supply chains. There are lingering questions about the legality of transporting hemp across state lines, which is why to date, the other state programs have maintained that hemp grown in the state is processed in the same state. If this is in fact a legal mandate, both new and existing New York companies that have the desire to process industrial hemp need to be identified and relationships need to be established with growers.



ACCESS TO CERTIFIED SEED

Anecdotally, it has been stated that this is a cumbersome process, that has been known to delay earlier planting dates.



U.S. GOVERNMENT DRUG POLICIES AND DRUG ENFORCEMENT ADMINISTRATION CONCERNS

It has been noted that DEA officials are concerned that efforts to legalize hemp are a front for those that would like to see marijuana decriminalized. Similarly, concerns have been raised that commercial cultivation of industrial hemp could complicate DEA's surveillance and enforcement activities as they relate to marijuana.¹³



GLOBAL COMPETITION

Questions have been raised as to whether or not the U.S. can compete with other countries, such as China, that have a long-standing industrial hemp cultivation and export market. Closer to home, Canada also has a significantly more established industrial hemp market that the U.S. would also have to compete with.



LIMITED AGRONOMICAL INFORMATION ON VARIETIES

Limited research exists on cultivars for their adaptability to New York State growing regions for seed, fiber, and dual-purpose hemp. Additional research is needed.

UPDATES FROM INAUGURAL HEMP SUMMIT

Governor Andrew Cuomo hosted an inaugural industrial hemp summit on April 18, 2017 in Ithaca, NY. The following series of announcements were made.²²

ENTITIES ELIGIBLE TO APPLY FOR AN INDUSTRIAL HEMP PERMIT

Previously, permits granted under NYS's Industrial Hemp Agricultural Research Pilot Program were limited to institutions of higher education. At the Governor's direction, the pilot was expanded to include private entities. Six private farms and businesses were issued permits in 2017, bringing the total number of hemp research sites across the state to 10. The 10 permits were granted to:

- 1st Century Hemp and RIT, Rochester, NY
- Cavallaro Farms, Goshen, NY
- JD Farms, Eaton, NY
- Old Mud Creek Farm, Hudson, NY
- Plant Science Labs, Buffalo, NY
- PreProcess, Ellisburg, NY
- SUNY Morrisville, SUNY Binghamton, SUNY Sullivan
- Cornell University

SEEK DEA PERMIT TO ALLOW INTERNATIONAL IMPORTS

Importing seed is central to hemp research in New York State. In addition to seeking a US Drug Enforcement Agency permit to import seed and establish a seed distribution site for international imports, the State Department of Agriculture and Markets will advocate to ease federal requirements to acquire hemp seed.

EXPAND RESEARCH AT CORNELL UNIVERSITY

To support researchers at Cornell's Agricultural Experiment Station in Geneva, \$400,000 will be awarded to Cornell University to explore best practices for growing varieties of hemp in different soil types and in various locations around the state. The Experiment Station will also assess hemp seed quality for germination and weed contamination.

ESTABLISH A HEMP TECHNICAL TEAM

The state will establish a Hemp Technical Team, consisting of a State Department of Agriculture and Markets liaison and three Cornell Cooperative Extension educators in the field, to support optimal growing and processing of industrial hemp.

INCREASE HEMP TESTING

The State Department of Agriculture and Markets will apply for a permit to increase ability to test industrial hemp for THC. This additional lab capacity will help ensure that New York hemp seed and other products are accepted in other states. Testing will also provide protection to the Department, growers and researchers that crops meet the acceptable THC level of 0.3 percent or below.

CREATE HEMP WORKING GROUP TO SUPPORT INDUSTRY DEVELOPMENT

The working group will include academic partners, key industry members and other state agencies to strengthen the hemp industry in New York State. The working group will help build relationships, share information on best management practices and regulatory requirements, and identify research needs.



MOVING FORWARD

considerations that warrant further research



Can the legality of transporting harvested hemp across state lines be demystified, with absolute certainty?

How do hemp returns compare to other commodity crops, such as corn and soybeans? Should traditional subsidies play a role in this analysis?

Who are existing NYS processors that could feasibly process hemp (i.e. oil processing companies, graineries, building material companies, food companies, decortication plants)?



RESOURCES

NYS Industrial Hemp Research Pilot Program, NYS Department of Agriculture and Markets

[Hemp Pilot Program Application](#)

[Hemp Pilot Program Guidance](#)

NYS/DAM Contact: Christopher Logue, christopher.logue@agriculture.ny.gov, (518) 457-2087

[Hemp as an Agricultural Commodity, Congressional Research Service, March 2017](#)

Serves as a non-partisan resource regarding hemp production and use, global production, federal law and requirements, state laws, DEA statements and guidance, and ongoing congressional activity.

[Economic Considerations for Growing Industrial Hemp: Implications for Kentucky's Farmers and Agricultural Economy Department of Agricultural Economics, University of Kentucky, July 2013](#)

Provides a policy review, review of world production and trade trends, an in depth look into the Canadian hemp industry, an examination of the U.S. market for industrial hemp and related products, enterprise budgets to analyze hemp profitability, and issues, opportunities, and challenges for Kentucky producers and processors.

[Industrial Hemp Production in North America: Production, Politics and Potential, Cornell University 2016](#)

Includes information on the North American history in brief, potential uses for hemp in North America, lessons from novel field crops in North America in recent decades, hemp production in North America, environmental impact, economics, politics, and the current status of industrial hemp.

[Industrial Hemp Harvest and Storage Best Management Practices, Alberta, Canada](#)

Provides information on the commercial uses of hemp, assessing maturity, seed sampling for THC content, swathing, combining, grain storage, seed cleaning, harvesting, baling and fiber storage, and retting.

[North Dakota State University Crop Production Webpage](#)

Provides an analysis of 2015 hemp production data as it relates to performance, economics and cultivar evaluations.

[Hemp Seed Production Costs and Returns, Alberta, Canada, 2015](#)

Provides a summary of the 2015 cost of production study for industrial hemp seed grown in Alberta, Canada.

[Guidelines for Estimated Crop Production Costs in 2017 in Manitoba](#)

Provides a series of budgets that estimate the cost of producing the most commonly grown field crops in Manitoba, Canada.

[Growing Industrial Hemp in Ontario, Canada, August 2009](#)

Provides detailed information on the following topics as they relate to industrial hemp: varieties, soil conditions, seedbed preparation and planting, fertility, weed control, diseases and pests, harvesting, retting and turning, baling and storing, and economics of production.

[Industrial Hemp Research Program, University of Vermont](#)

Contained on the University of Vermont's website are the results of various different industrial hemp trials.

[Industrial Hemp: Opportunities and Challenges for Washington](#)

This document breaks down U.S. hemp imports by both volume and dollar, in addition to providing a summary of other states' legislation allowing for the cultivation of industrial hemp.

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 2. <https://www.uky.edu/Ag/CCD/introsheets/hempproduction.pdf>
 3. http://hemp.ca.uky.edu/sites/hemp.ca.uky.edu/files/general/2015_hemp_article.pdf
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 8. Megan Burley call with Dr. David Williams, University of Kentucky
 9. <http://www.uvm.edu/extension/cropsoil/wp-content/uploads/2016-Hemp-PDxVar-Trial.pdf>
 10. <http://www.twcnews.com/nys/central-ny/news/2016/09/26/first-hemp-harvest-at-jd-farms.html>
 11. NOTE: Data found in "Industrial Hemp Performance in North Dakota 2015": <https://www.ag.ndsu.edu/langdonrec/crop-production-management>
 12. <http://www.votehemp.com/state/PDF/NDDA-hemp-program-report-2017.pdf>
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 15. <https://thehia.org/HIAhemppressreleases/4010402>
 16. <http://nationalhempassociation.org/countries-where-hemp-is-grown/>
 17. California, Colorado, Connecticut, Delaware, Florida, Hawaii, Illinois, Indiana, Kentucky, Maine, Maryland, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Hampshire, New York, North Carolina, North Dakota, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Utah, Vermont, Virginia, Washington, West Virginia, and Wyoming.
 18. <http://www.ncsl.org/research/agriculture-and-rural-development/state-industrial-hemp-statutes.aspx>
 19. <https://www.federalregister.gov/documents/2016/08/12/2016-19146/statement-of-principles-on-industrial-hemp>
 20. <http://www.votehemp.com/PDF/2016-Omnibus-Appropriations-Hemp-provision.pdf>
 21. <http://www.omafra.gov.on.ca/english/crops/facts/00-067.htm#harvesting>
 22. NOTE: Recent updates from the inaugural hemp summit were pulled verbatim from the following webpage: <https://www.governor.ny.gov/news/governor-cuomo-convenes-first-ever-industrial-hemp-summit-grow-new-yorks-agricultural-industry>

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