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Defining “Industrial Hemp”: A Fact Sheet

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Botanically, industrial hemp and marijuana are from the same species of plant, *Cannabis sativa*, but from different varieties or cultivars. However, industrial hemp and marijuana are genetically distinct forms of cannabis¹ that are distinguished by their use and chemical makeup as well as by differing cultivation practices in their production. While marijuana generally refers to the cultivated plant used as a psychotropic drug (whether used for medicinal or recreational purposes), industrial hemp is cultivated for use in the production of a wide range of products, including foods and beverages, personal care products, nutritional supplements, fabrics and textiles, paper, construction materials, and other manufactured goods. Both industrial hemp and marijuana also have separate statutory definitions in U.S. law.²

Despite these differences, industrial hemp continues to be subject to U.S. drug laws, and growing industrial hemp is restricted. Under current U.S. drug policy, all cannabis varieties, including industrial hemp, are considered Schedule I controlled substances under the Controlled Substances Act (CSA),³ and the U.S. Drug Enforcement Administration (DEA) continues to control and regulate hemp production. Strictly speaking, the CSA does not make growing hemp illegal; rather, it places strict controls on its production and enforces standards governing the security conditions under which the crop must be grown, making it illegal to grow without a DEA permit. In other words, a grower needs to get permission from the DEA to grow hemp or faces the possibility of federal charges or property confiscation.

At issue is the extent to which hemp production and marketing may be distinguished from marijuana. Congress made significant changes to U.S. policies regarding industrial hemp with the omnibus 2014 farm bill. The Agricultural Act of 2014 (P.L. 113-79)⁴ provides that certain research institutions and state departments of agriculture may grow industrial hemp as part of an agricultural pilot program. In addition, in subsequent omnibus appropriations, Congress has blocked DEA and other federal law enforcement authorities from interfering with state agencies, hemp growers, and agricultural research. Appropriations bills have also blocked the U.S. Department of Agriculture (USDA) from prohibiting the transportation, processing, sale, or use of industrial hemp that is grown or cultivated in accordance with the 2014 farm bill provision. Congress has continued to introduce legislation that seeks to further distinguish between hemp and marijuana. For more background information, see CRS Report RL32725, *Hemp as an Agricultural Commodity*.

Industrial hemp and marijuana can be distinguished from one another in three key ways: (1) differing statutory definitions, (2) differences in chemical makeup and use, and (3) differences in production practices. This fact sheet describes these three differences.

Statutory Definition

When Congress defined the term “industrial hemp” as part of the 2014 farm bill, it provided a means to further distinguish between hemp and marijuana in U.S. law.

Accordingly, “industrial hemp” is defined in statute as “the plant *Cannabis sativa* L. and any part of such plant, whether growing or not, with a delta-9 tetrahydrocannabinol concentration of not

¹ In this report, “cannabis” refers to the plant species *Cannabis sativa* and all of its industrial, medicinal, and recreational varieties. The terms “industrial hemp” and “hemp” are used interchangeably, and the term “marijuana” refers to the plant used as a medicinal or recreational drug unless otherwise specified.

² 7 U.S.C. §5940(b)(2); and 21 U.S.C. §802.

³ 21 U.S.C. §§801 *et seq.*; Title 21 C.F.R. Part 1308.11.

⁴ P.L. 113-79, §7606; 7 U.S.C. 5940. The provision was included as part of the research title of the farm bill.

more than 0.3 percent on a dry weight basis.”⁵ Industrial hemp that meets this statutory definition may be cultivated by certain research institutions and state departments of agriculture as part of agricultural pilot programs if allowed under state laws where the institutions or state departments of agriculture are located. In addition, according to federal guidance issued in August 2016,⁶ institutions of higher education and other authorized participants may be eligible to participate in research or other programs concerning industrial hemp that USDA administers.

By contrast, marijuana (or “marihuana,” as it is spelled in the older statutes) is more broadly defined in the CSA:⁷

(16) The term “marihuana” means all parts of the plant *Cannabis sativa* L., whether growing or not; the seeds thereof; the resin extracted from any part of such plant; and every compound, manufacture, salt, derivative, mixture, or preparation of such plant, its seeds or resin. Such term does not include the mature stalks of such plant, fiber produced from such stalks, oil or cake made from the seeds of such plant, any other compound, manufacture, salt, derivative, mixture, or preparation of such mature stalks (except the resin extracted therefrom), fiber, oil, or cake, or the sterilized seed of such plant which is incapable of germination.

Accordingly, “marijuana” as defined is a Schedule I controlled substance, and the unauthorized manufacture, distribution, dispensation, and possession of marijuana is strictly prohibited.⁸

This report does not cover issues pertaining to medical or recreational marijuana. Regulation of marijuana is also outside the scope of this report and is complicated by numerous state legalization initiatives.⁹

Chemical Makeup and Use

There are many different varieties of cannabis. Although industrial hemp and marijuana are both cannabis varieties, they have been bred and selected for different uses and may be distinguished by their use and chemical makeup.¹⁰

The term “industrial hemp” dates back to the 1960s¹¹ and generally refers to cannabis varieties that are grown primarily as an agricultural crop (such as seeds and fiber and byproducts such as

⁵ 7 U.S.C. §5940(b)(2)). The terms *Cannabis sativa* and *Cannabis sativa* L are the same, and “L.” denotes use of the Linnean system of taxonomy.

⁶ DEA, USDA, and Food and Drug Administration (FDA), Joint “Statement of Principles on Industrial Hemp,” 81 *Federal Register* 156: 53395-53396, August 12, 2016. See also DEA’s website at http://www.deadiversion.usdoj.gov/fed_regs/rules/2016/fr0812_4.htm. For more information, see CRS Congressional Distribution memorandum, “Joint DEA/USDA/FDA ‘Statement of Principles on Industrial Hemp,’” September 23, 2016, available upon request from the author, Renée Johnson.

⁷ Marijuana is defined in the CSA at 21 U.S.C. §802.

⁸ Generally, all cannabis varieties are commonly considered to be of a single species. However, not all researchers agree on a single taxonomy. Other cannabis species may include *Cannabis indica* (meaning from India) and its known subspecies. See, for example, R. C. Clarke and M. D. Merlin, “Cannabis Taxonomy: The ‘Sativa’ versus ‘Indica’ Debate,” *HerbalEGram*, vol. 13, no. 4 (April 2016).

⁹ For more information, see CRS Report R43164, *State Marijuana Legalization Initiatives: Implications for Federal Law Enforcement*; CRS Report R43435, *Marijuana: Medical and Retail—Selected Legal Issues*; and CRS Report RL34635, *The Controlled Substances Act: Regulatory Requirements*.

¹⁰ See, for example, S. L. Datwyler and G. D. Weiblen, “Genetic Variation in Hemp and Marijuana (*Cannabis sativa* L.) According to Amplified Fragment Length Polymorphisms,” *Journal of Forensic Sciences*, vol. 51, no. 2 (2006).

¹¹ See L. Grlic, “A Combined Spectrophotometric Differentiation of Samples of Cannabis,” United Nations Office on Drugs and Crime, January 1968.

oil, seed cake, and hurds).¹² Industrial hemp is generally characterized by plants that are low in delta-9 tetrahydrocannabinol (delta-9 THC), the dominant psychotropic ingredient in *Cannabis sativa*.¹³ Hemp is also characterized by higher levels of cannabidiol (CBD), the primary nonpsychotropic ingredient in *Cannabis sativa*.¹⁴ Accordingly, a high ratio of CBD to THC might also classify hemp as a fiber-type plant rather than a drug-type plant. Opinions remain mixed about how CBD levels might influence the psychoactive effects of THC.

By contrast, marijuana generally refers to the flowering tops and leaves of psychoactive cannabis plant varieties, which are often grown for their high concentration of delta-9 THC. Marijuana's high THC content is concentrated primarily in the flowers and to a lesser extent in the leaves. THC levels for marijuana are much higher than for hemp and are reported to average about 10%. Some sample tests indicate delta-9 THC levels reaching 20% to 30% or greater.¹⁵ Recent developments in cannabis research and breeding, however, may be resulting in plant varieties with even more elevated levels of delta-9 THC and other cannabinoids.

Cannabinoids refer to the unique chemical compounds produced in the *Cannabis sativa* plant, which are known to exhibit a range of potential psychological and physiological effects.¹⁶ While THC is the primary psychoactive ingredient in cannabis, there are multiple THC isomers and variants. Other cannabinoids are not considered to be psychotropic, such as CBD and multiple possible other variations.¹⁷ THC and CBD are considered to be among the most abundant cannabinoids in cannabis, and both are considered to be medically valuable. THC and CBD are also the most well-known and researched cannabinoids. Among the isomers of THC, properties may vary, and not all have been well-characterized.¹⁸ The interaction between delta-9 THC and other cannabinoids in the cannabis plant is also not well known. The **text box** lists the 66 classified cannabinoids and their known variants in *Cannabis sativa*. Generally, cannabinoids are concentrated in the flowering head of the plant.¹⁹

In general, a level of about 1% delta-9 THC is considered the threshold for cannabis to have a psychotropic effect or an intoxicating potential.²⁰ In the United States and some other countries,

¹² Hurds are soft inner core fiber of the hemp stalk. Hurds are woody in texture and mostly used in non-woven items, including hempcrete and animal bedding.

¹³ R. C. Clarke and M. D. Merlin, *Cannabis: Evolution and Ethnobotany* (Berkeley, CA: University of California Press, 2013), p. 255. A psychotropic drug is capable of affecting mental activity, behavior, or perception and may be mood-altering.

¹⁴ U. R. Avico, R. Pacifici, and P. Zuccaro, "Variations of Tetrahydrocannabinol Content in Cannabis Plants to Distinguish the Fibre-Type from Drug-Type Plants," *UNODC Bulletin on Narcotics*, January 1985; C. W. Waller, "Chemistry of Marihuana," *Pharmacological Reviews*, vol. 23 (December 1971); K. W. Hillig and P. G. Mahlberg, "A Chemotaxonomic Analysis of Cannabinoid Variation in Cannabis (Cannabaceae)," *American Journal of Botany*, vol. 91, no. 6 (June 2004); and A. W. Zuardi et al., "Cannabidiol, a Cannabis sativa Constituent, as an Antipsychotic Drug," *Brazilian Journal of Medical and Biological Research*, vol. 39 (2006).

¹⁵ National Institute of Drug Abuse, "Quarterly Report, Potency Monitoring Project," University of Mississippi, 2008. Based on sample tests of illegal cannabis seizures (December 16, 2007, through March 15, 2008).

¹⁶ Clarke and Merlin, *Cannabis: Evolution and Ethnobotany*, p. 255.

¹⁷ Ibid. For example, cannabigerol, cannabichromene, and cannabidivarin are reported to be nonpsychotropic.

¹⁸ See, for example, E.A. Carlini, "The Good and the Bad Effects of (-) Trans-Delta-9-Tetrahydrocannabinol (Δ^9 -THC) on Humans," *Toxicon*, vol. 44 (July 2004), pp. 461-467. For example, other identified isomers of THC, such as delta-1 THC and delta-6 THC, may be related to delta-9 THC and delta-8 THC, respectively, but based on differing numbering systems.

¹⁹ J. E. Joy, S. J. Watson, Jr., and J. A. Benson, Jr. eds., *Marijuana and Medicine: Assessing the Science Base*, Institute of Medicine, 1999.

²⁰ See, for example, E. Small and D. Marcus, "Hemp: A New Crop with New Uses for North America," in *Trends in New Crops and New Uses*, ed. J. Janick and A. Whipkey (American Society for Horticultural Science Press, 2002).

cultivars having less than 0.3% THC may be cultivated under license as industrial hemp, while cultivars having more than that amount are considered to have too high a drug potential.²¹ Some suggest that cannabis with a THC level of greater than 1% be considered a drug varietal (e.g., marijuana).²² Others suggest that "marijuana plants often have a THC level of 5% or more."²³

Cannabinoids

More than 480 natural components are found within the *Cannabis sativa* plant, of which 66 are classified as cannabinoids, or chemicals unique to the plant. Cannabinoids are separated into the following subclasses.

Delta-9 tetrahydrocannabinol (delta-9 THC)	Number of known variants: 9
Delta-8 tetrahydrocannabinol (delta-8 THC)	Number of known variants: 2
Cannabigerol (CBG)	Number of known variants: 6
Cannabichromene (CBC)	Number of known variants: 5
Cannabidiol (CBD)	Number of known variants: 7
Cannabinol (CBN)	Number of known variants: 7
Cannabinodiol (CBND or CBDL)	Number of known variants: 2
Cannabicyclol (CBL)	Number of known variants: 3
Cannabielsoin (CBE)	Number of known variants: 5
Cannabitriol (CBT)	Number of known variants: 9
Other miscellaneous types	Number of known variants: 11

Source: J. E. Joy, S. J. Watson, Jr., and J. A. Benson, Jr. eds., *Marijuana and Medicine: Assessing the Science Base*, Institute of Medicine, 1999; and Australia's National Cannabis Prevention and Information Centre, "Cannabinoids" (posted by the University of Washington's Alcohol and Drug Abuse Institute).

For purposes of legal cultivation, most hemp-producing countries, including the United States, generally specify THC levels for industrial hemp at less than 1%. Laws regulating hemp cultivation in the European Union (EU) and Canada also specify a threshold level based on THC content as the dividing line between industrial and potentially drug-producing cannabis. Some countries, however, have based their industrial hemp definition of THC more broadly (i.e., not limited to delta-9 THC). For example, Canada's hemp regulations define industrial hemp as

the plants and plant parts of the genera *Cannabis*, the leaves and flowering heads of which do not contain more than 0.3% THC w/w [% weight per weight], and includes the derivatives of such plants and plant parts. It also includes the derivatives of non-viable cannabis seed. It does not include plant parts of the genera *Cannabis* that consist of non-viable cannabis seed, other than its derivatives, or of mature cannabis stalks that do not include leaves, flowers, seeds or branches, or of fibre derived from those stalks.²⁴

²¹ E. Small and D. Marcus, "Tetrahydrocannabinol Levels in Hemp (*Cannabis sativa*) Germplasm Resources," *Economic Botany*, vol. 57, no. 4 (October 2003); and G. Leson, "Evaluating Interference of THC Levels in Hemp Food Products with Employee Drug Testing" (prepared for the province of Manitoba, Canada), July 2000.

²² F. Grotenhermen and M. Karus, "Industrial Hemp Is Not Marijuana: Comments on the Drug Potential of Fiber Cannabis," nova-Institute, <http://www.internationalhempassociation.org/jiha/jiha5210.html>.

²³ See, for example, Agriculture and Agri-Food Canada, "Industrial Hemp" (also as cited by K. C. Hayes et al., in a University of Vermont Legislative Research Shop report, May 21, 2008).

²⁴ Canada's Minister of Justice, "Industrial Hemp Regulations," SOR/98-156, August 29, 2016. Canada has also set a maximum level of 10 parts per million for THC residues in products derived from hemp grain, such as flour and oil.

In the EU, the regulatory threshold for hemp is the “weight of THC (tetrahydrocannabinol) in the weight of a sample maintained at constant weight” is no more than 0.2% “for the purposes of the grant of aid for subsequent marketing.”²⁵ However, the regulatory threshold in most EU countries is generally consistent with that in the United States and Canada at 0.3% THC.²⁶ In New South Wales, Australia, the THC limit is 1%.²⁷ In most cases, hemp seeds are certified as having no more than 0.3% THC prior to cultivation.²⁸ Accordingly, the United Nations and most international trade agreements generally recognize 0.3% THC as the upper regulatory limit.²⁹

Regulatory thresholds for hemp grown in other countries—such as in China, Russia, and elsewhere—are not readily available.

Production Practices

Production differences among cannabis varieties depend on whether the plant is grown for fiber/oilseed or for medicinal/recreational uses. These differences involve the varieties being grown, the methods used to grow them, the timing of their harvest, and selecting for different traits between the two crops. Concerns about cross-pollination among the different varieties are critical. All cannabis plants are open, wind, and/or insect pollinated, and thus cross-pollination is possible.

Because of the compositional differences between the marijuana and fiber varieties of cannabis, farmers growing either crop would necessarily want to separate production of the different varieties or cultivars. For growers of medicinal or recreational marijuana, cross-pollination with industrial hemp would significantly lower the THC content and thus degrade the value of the marijuana crop. Likewise, growers of industrial hemp would seek to avoid cross-pollination with marijuana plants, especially given the illegal status of marijuana. Plants grown for oilseed are also marketed according to the purity of the product, and the mixing of other genotypes would degrade the value of the crop.³⁰

Maintaining a discrete genotype is largely attributable to a key feature of cannabis reproduction: *Cannabis* is dioecious, meaning that there are separate male and female plants, each with distinctive growth characteristics. For drug production, the female flowers are far more valuable, whereas male plants are used to produce hemp fibers.

Hemp is grown and harvested differently from marijuana, as though they were two different cannabis crops. When cannabis is grown to produce marijuana, it is cultivated from varieties where the female flowers are specifically selected to prevent the return of separate male and female plants.³¹ When cultivating marijuana, the female flowers are short and tightly clustered. In

²⁵ Council Regulation (EC) No 1420/98 of 26 June 1998 amending Regulation (EEC) No 619/71 laying down general rules for granting aid for flax and hemp. For other detailed country information, see nova-Institute, “Scientifically Sound Guidelines for THC in Food in Europe,” July 2015.

²⁶ Grotenhermen and Karus, “Industrial Hemp Is Not Marijuana.”

²⁷ Government of New South Wales, “Growing Low THC Hemp under License in NSW, Frequently Asked Questions,” PUB12/66, January 2012.

²⁸ See, for example, provisions in Colorado Industrial Hemp Act C.R.S. 35-61-101 (1). The Association of Official Seed Certifying Agencies (AOSCA) has developed standards for certifying hemp seed.

²⁹ See, for example, United Nations, Office on Drugs and Crime, “Recommended Methods for the Identification and Analysis of Cannabis and Cannabis Products,” 2009.

³⁰ CRS communication with Anndrea Hermann, Hemp Oil Canada, Inc., December 2009. Pollen is present at a very early plant development stage.

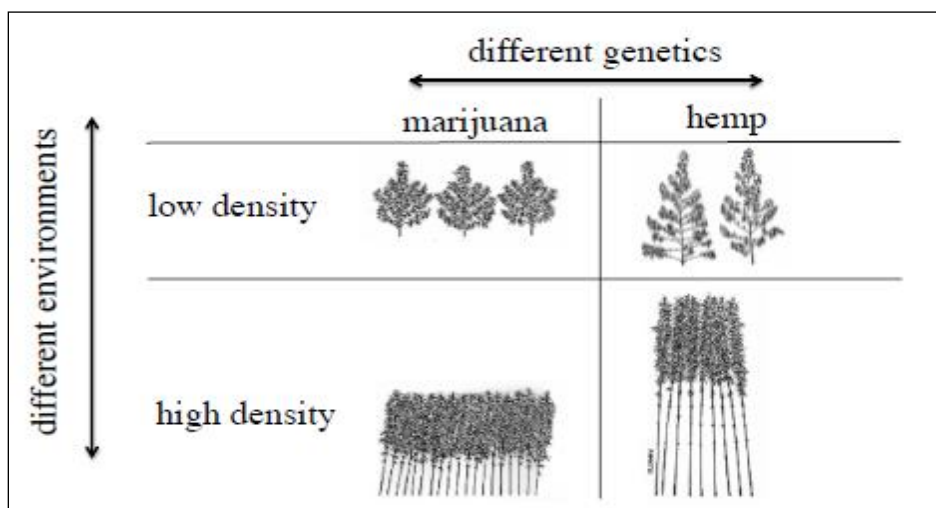
³¹ H. van Bakel et al., “The Draft Genome and Transcriptome of *Cannabis sativa*,” *Genome Biology*, vol. 12, no. 10 (continued...)

marijuana cultivation, growers remove all the male plants to prevent pollination and seed set. Some growers will hand-pollinate a female plant to get seed; this is done in isolation from the rest of the female plants. The incorporation and stabilization of monoecism (female only plants) in marijuana cultivation requires the skill of a competent plant breeder and rarely occurs under non-cultivated conditions. Drug-grade cannabis also contains high resin concentrations. By contrast, when cannabis is grown to produce industrial hemp, the plant is discouraged from flowering to force the plant to grow taller with less branching (consisting of male plants only). Fiber-grade cannabis generally has low levels of resin.

If industrial hemp varieties are grown in or around marijuana, the hemp would pollinate the female marijuana plant. Likewise, marijuana growers would not want to plant near a hemp field, because this would result in a harvest that is seedy and lower in THC and degrade the value of their marijuana crop.³²

These cultivation practices generally result in different observable traits under field conditions. In general, among the visual plant differences between hemp and marijuana are **plant height** (hemp is encouraged to grow tall, whereas marijuana is selected to grow short and tightly clustered); **cultivation** (hemp is grown as a single main stalk with few leaves and branches, whereas marijuana is encouraged to become bushy with many leaves and branches to promote flowers and buds); and **planting density** (hemp is densely planted to discourage branching and flowering, whereas marijuana plants are well-spaced) (**Figure 1**).

Figure 1. Trait Variation in Cannabis Phenotype
(marijuana and industrial hemp)



Source: George Weiblen, University of Minnesota, presentation at the 2013 Annual HIA Conference, Washington, DC, November 17, 2013.

(...continued)

(2011). In botany, dioecious is a term describing plant varieties that possess male and female flowers or other reproductive organs on separate, individual plants.

³² An example of another plant whereby different crops are cultivated selecting for different traits is sweet corn and field corn (or corn for grain). Corn may also naturally cross-pollinate and requires early selection and removal of plants before pollination based on certain plant traits. Otherwise intermixing plants of the two types of corn may result in cross-pollination and degradation of each crop.

Notes: An optimal marijuana plant will be well-spaced to encourage branching and to remain short (shown in the boxes on left), whereas hemp is more densely spaced to discourage branching and to grow taller (boxes on the right). Photographs contrasting marijuana and industrial hemp are also available at Vote Hemp's website ("Different Varieties of *Cannabis*," http://www.votehemp.com/different_varieties.html).

Cultivated hemp plants usually reach between six and 15 feet tall and generally consist of a single main stalk with few leaves and branches. Hemp plants grown for fiber or oilseed are planted densely (about 35-50 plants per square foot) to discourage branching and flowering. The period of seeding to harvest ranges from 70 to 140 days, depending on the purpose, cultivar (variety), and climatic conditions. The stalk and seed are the harvested products.³³

Industrial hemp production statistics for Canada indicate that one acre of hemp yields an average of about 700 pounds of grain, which can be pressed into about 50 gallons of oil and 530 pounds of meal.³⁴ That same acre will also produce an average of 5,300 pounds of straw, which can be transformed into about 1,300 pounds of fiber.

In contrast, as previously noted, marijuana is cultivated to encourage the plant to become bushy with many leaves, with wide branching to promote flowers and buds, requiring that plants be well-spaced by as much as about one to two plants per square yard. The flower and leaves are the harvested products.

The different cannabis varieties are also harvested at different times (depending on the growing area), increasing the chance of detection of illegal marijuana if production is commingled. Because of these differences, some claim that drug varieties of cannabis cannot easily be grown with oilseed or fiber varieties without being detected.³⁵

Genomic research in Canada corroborates the notion that over thousands of years of cultivation, cannabis farmers have "selectively bred *Cannabis sativa* into two distinct strains—one for fiber and seed, and one for medicine" (both as an herbal drug and as a pharmaceutical compound).³⁶

However, recent advances in cannabis research and development—as well as plant breeding and the creation of new cultivars and hybrids—are resulting in plant varieties that do not always precisely present these distinctive observable characteristics.³⁷

Despite the regulatory challenges of growing industrial hemp, there are many marketable uses of hemp and broad interest in facilitating and promoting hemp cultivation in the United States. For an extended discussion of the agricultural uses and the regulatory and legislative framework surrounding industrial hemp, see CRS Report RL32725, *Hemp as an Agricultural Commodity*.

³³ The stalk provides two types of fibers: (1) the interior or core short woody fibers (or hurds) and (2) the outer portion of the stem, which contains the long bast fibers (referring to the cellulosic fibers that grow on the outside of the hemp plant's stalk, which are used for animal bedding and oil absorbents, among other uses).

³⁴ Agriculture and Agri-Food Canada, "Industrial Hemp," <http://www4.agr.gc.ca/>.

³⁵ D. P. West, "Hemp and Marijuana: Myths and Realities," February 1998, <http://www.gametec.com/hemp/hempandmj.html>. Also see information posted by Vote Hemp Inc., "Different Varieties of Cannabis," http://www.votehemp.com/different_varieties.html.

³⁶ *ScienceDaily*, "How Hemp Got High: Cannabis Genome Mapped," October 24, 2011, citing research by H. vanBakel et al., "The Draft Genome and Transcriptome of *Cannabis sativa*," *Genome Biology* (2011).

³⁷ CRS communication with Duane Sinning, Assistant Director, Colorado Department of Agriculture (Plant Division), February 2, 2016.

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