

What is Industrial Hemp?

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Photo: Stephen Ward, © Oregon State University

Oregon State University hemp leader Jay Noller examines an industrial hemp plant.

About this publication

Industrial hemp may only be grown in compliance with applicable state and federal law, including the 2014 and 2018 farm bills and the anticipated U.S. Department of Agriculture regulations. The following information is being provided for educational purposes only to inform licensed growers operating in compliance with applicable state and federal laws. Consult your local authorities, Department of Agriculture representatives, or personal attorney for questions regarding the legality of growing industrial hemp in your jurisdiction.

Introduction

Industrial hemp (*Cannabis sativa* L.) was grown as a commodity fiber crop in the United States from the mid-18th century until the mid-1930s. As in many other countries, *C. sativa* was banned and was considered an illegal crop in the U.S. for several decades.

In 2014, Section 7606 of the federal Agricultural Act of 2014, commonly called the Farm Bill, allowed the cultivation of industrial hemp within authorized pilot programs for “the plant *Cannabis sativa* L. and any part of such plant, whether growing or not, with a delta-9 tetrahydrocannabinol [THC] concentration of not more than 0.3 percent on a dry weight basis.”

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The 2018 Farm Bill decriminalized the cultivation of industrial hemp and designated the USDA Agricultural Marketing Service to develop regulations regarding hemp production. At the time of this publication, the guidelines for legal industrial hemp cultivation under the 2018 Farm Bill have not been finalized. Until they are, all rules and restrictions must be followed per Section 7606 of the 2014 Farm Bill. The Food and Drug Administration will also continue to regulate hemp under applicable federal laws.

No one should implement the 2018 Farm Bill production provisions until the USDA rule is finalized.

Oregon growers, processors and members of the general public should contact the Oregon Department of Agriculture or consult their legal counsel for further information.

Genetically, industrial hemp belongs to *Cannabis sativa*, but botanists debate whether it is a single species (*Cannabis sativa* L.) with several subspecies or one of three species along with *C. indica* Lam. and *C. ruderalis* Janisch. Some botanists divide the genus *Cannabis* into *C. sativa* (the fiber/grain one), *C. indica* L. (the drug type) and *C. ruderalis* Janisch (intermediate, or wild, type). However, people crossbred the three species to obtain hybrids with desirable characteristics, leading some botanists to propose that all the subtypes belong to *C. sativa*, which could be divided into different subspecies or chemotypes (chemically distinct entities in a plant).

Global importance of industrial hemp

Industrial hemp is a temperate region crop; it grows best in more northern latitudes from the 42nd to 45th parallel. It grows well in the Pacific Northwest.

Industrial hemp is an annual cross-pollinating plant with rapid growth and development that results in significant biomass accumulation. Registered varieties of industrial hemp vary significantly in height and size. Two historical uses of industrial hemp are fiber and food. Industrial hemp seed oil, extracted from the grain, is valued as healthy table oil, and it has many applications in cosmetics, nutraceuticals and functional foods.

In recent years, *Cannabis sativa* has been rediscovered as a high-value crop and is quickly becoming established in the U.S. *C. sativa* can be used in many ways, including as a source of natural products of pharmacological interest. The various economic products of *C. sativa* are the basis for grouping hemp into four categories: (1) fiber hemp, (2) oilseed hemp (3) hemp products for medicinal markets, and (4) hemp products for recreational markets. Fiber and oilseed/grain hemp are collectively known as **industrial hemp**.

Fiber hemp products

Fiber hemp products historically have included textile, cordage and paper. China is the main producer of fine hemp textile fiber, which is often mixed with other natural fibers in the manufacture of fine linens. Several European Union countries, Eastern Europe, Russia and South Korea also are significant producers of hemp. With consumer preferences worldwide increasingly favoring natural products and production systems that are environmentally friendly, the market for textiles, fabrics and clothing that include fiber hemp has increased significantly.

Fiber hemp is also used in horticultural planting materials; biodegradable mulch; pressed and molded fiber products, including those used in the automobile industry; paper and pulp products (such as hygiene products, banknotes, filters, art papers, tea bags); building-construction products (such as fiberboards and fiber-reinforced cement boards); insulation materials; animal bedding (made from the woody core of the plant called hurds); plastic biocomposites; and compressed cellulose plastics. Due to its high biomass production, hemp shows promise as a bioenergy crop.

Hemp seed or grain

Hemp seed contains 20%–30% edible (fixed) oil; 25%–30% protein, which includes eight of the daily essential amino acids recommended for humans; 20%–25% fiber; 20%–30% carbohydrates; and many essential nutrients and vitamins.

Humans have used hemp seed as food since ancient times. Grain or oilseed hemp products include hemp seed, seed flour, seed protein, seed powder, seed oil, and hemp meal. Nowadays, hemp grain is used in human health food because of the desirable ratio of omega-6 and omega-3 fatty acids in hemp oil. It is not yet legal to feed hemp to animals in the U.S.

Hemp seed oil is used in many cosmetics and as a substitute for other industrial oils. Hemp seed oil has a pleasant flavor and is used like olive oil as table oil and in salad dressing. Hemp seed oil should not be used for frying or baking; when heated at temperatures above 320°F (160°C), flavor declines, and it may produce toxic byproducts. Also, hemp seed and hemp seed oil do not have a long shelf life. Sterilization of hemp seed (which is required in North America when used for consumption) may foster rancidity of the oil within the seed.

Hemp seed should be stored in dark containers and refrigerated to extend the shelf life and preserve the quality. Most of the hemp grain imported in the U.S. comes from Canada, where industrial hemp has been

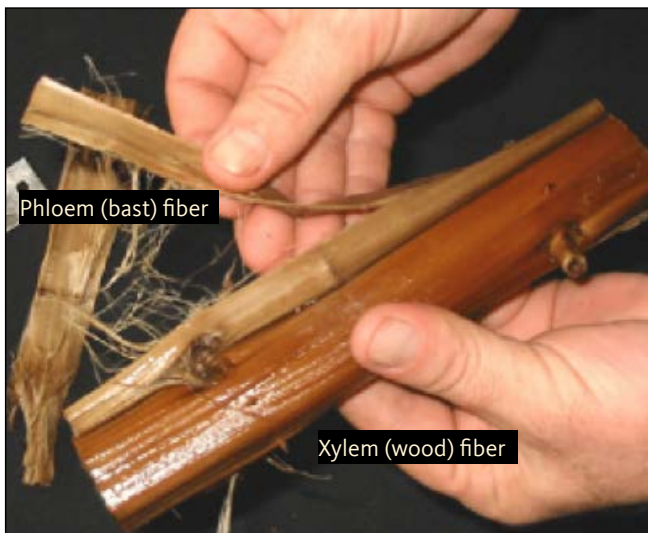


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Figure 1. Industrial hemp produces two types of fiber: phloem (bast) and xylem (wood) fiber.



Photos: V. Sikora, used with permission

Figure 2. Male (left) and female (right) hemp plants. Male plants flower and die earlier than female plants.

legalized since 1998. Canada is one of the primary producers of oilseed hemp, and most of the Canadian hemp seed is exported to the U.S.

Hemp oil

There are three different oils from industrial hemp: cannabidiol (CBD) oil, essential oil, and seed fixed (fatty) oil. Cannabidiol oil is legal in many states and is being included in a wide variety of products, from sparkling water to lotion. However, CBD's purported health benefits have not yet been verified by scientific research. Unlike the other major cannabinoid compound — tetrahydrocannabinol (THC) — CBD is classed as nonintoxicating and without “abuse liability,” which means it is not addictive.

Cannabidiol is known for a wide range of pharmacological activities, although there is still a need for research to clarify the exact mechanism of CBD action and its safety profile. A pharmaceutical-grade CBD extract was approved in 2018 by the FDA as a new medicine for the treatment of two rare forms of epilepsy in children. Another cannabis-based pharmaceutical that contains 1:1 THC and CBD has been on the market since 2010.

Hemp fibers

There are three different fiber cells in hemp stems: primary phloem, secondary phloem and xylem. The primary phloem includes the outer cells that provide long fibers. The inner cells generated by the cambium provide secondary phloem short fibers, and inside the cambium is the wood (hurds), which provides short fibers. The longer the fibers, the more valuable they are.

Primary bast fibers are the most commercially valuable of the hemp fibers, followed by the secondary bast fibers and then the wood core fibers. The fiber hemp plant height, stem diameter and other morphological features depend on the genotype (variety) and environment. Agronomic conditions (plant density, irrigation, fertilization, harvest time, etc.) play a critical role in plant morphology and fiber yield and quality.

References

- Pisanti, Simona, Anna Maria Malfitano, Elena Ciaglia, Anna Lamberti, Roberta Ranieri, Gaia Cuomo, Mario Abate et al. “Cannabidiol: State of the art and new challenges for therapeutic applications.” *Pharmacology & Therapeutics* 175 (2017): 133-150.
- Russo, Ethan B. “Cannabidiol claims and misconceptions.” *Trends in Pharmacological Sciences* 38, no. 3 (2017): 198-201.

Frequently asked questions

Question: What are the differences between hemp essential oil and hemp seed (fixed, vegetable) oil?

Answer: They are very different products.

Essential oils (aka volatile oils) are generally volatile organic substances produced by many types of plants that readily evaporate when exposed to air. They have a distinct, strong aroma that resembles the aroma of the plant from which it was extracted. Hemp essential oil is a complex natural product mix comprising around 140 individual constituents, including terpenes. The strong odors associated with hemp are primarily due to the terpenes; the cannabinoids such as THC and CBD have very little smell. Hemp essential oil and cannabinoids accumulate in the glandular trichomes, the epidermal hair-like structures on leaves and female flowers.

The **hemp seed (fixed) oil** does not contain cannabinoids or terpenes. It contains fatty acids like other edible vegetable oils. The composition of hemp seed oil is comparable to other edible oils. It has a high concentration of polyunsaturated fatty acids, which is considered good for human health. However, the high concentration of polyunsaturated fatty acids makes it sensitive to oxidation rancidity. The degradation of hemp seed oil is accelerated by light, heat or bacteria, making hemp seed oil excellent table oil for salad dressing but unsuitable for frying or baking.

Q: What is hemp oil? What is the oil content in hemp?

A: Industrial hemp contains fatty acid oil found in seeds and volatile oil found in flowers and leaves. The fatty acid oil content of seeds is about 30%.

Q: Does hemp include male and female plants?

A: Yes. Industrial hemp (and hemp in general) is dominantly dioecious, with male and female reproductive structures on separate plants (Figure 2, page 3). Male plants flower and die earlier and do not provide grain (seed) or sufficient fiber, the two commercial products. Breeding and selection efforts in other countries since the 1930s resulted in monoecious varieties (with male and female reproductive structures on the same plant) and even varieties with most or all plants being female.

Q: What is the fiber content of industrial hemp varieties?

A: Tests show fiber content ranges from 25% to 38% of dry biomass, although other reports have shown fiber content ranging from below 20% to 50%.

Q: What is the fiber yield of industrial hemp?

A: Reports from Europe say dry bast fiber yields vary from 1,070 to 2,680 pounds per acre (1,200 to 3,000 kg/ha), while the cellulose yield is usually from 6,250 to 8,920 pounds per acre (7,000 to 10,000 kg/ha).

Q: What are the estimated grain yields?

A: Grain yields can vary depending on the variety, cropping system and desired end product. Grain yields may range from 360 to 1,785 pounds per acre (400 to 2,000 kg/ha).

Q: What are the advantages of hemp fiber over other types of fibers?

A: Hemp fibers are naturally biodegradable and have other advantages over synthetic fibers, which are mostly fossil fuel-based.

Q: Are there differences between fiber and oilseed hemp?

A: Both are considered industrial hemp, but the cultural methods differ. Also, there are varieties selected for fiber production and others for grain production, although some of the varieties can be grown for both fiber and grain (dual-purpose varieties).

Q: Do industrial hemp varieties contain psychoactive/intoxicating constituents?

A: Yes, but at low concentrations (below 1%). The primary psychoactive compounds in hemp are tetrahydrocannabinols, or THC. Under the 2018 Farm Bill, industrial hemp must contain less than 0.3% delta-9 THC — too little to produce intoxicating effects.

Q: Is it true that hemp is used in the automobile industry?

A: Yes. Henry Ford used hemp products as body components (resin enforced with hemp and flax fibers) in one of the original cars in the 1940s. Recent news reports stated that some auto manufacturers use more than 30 different parts made of natural fibers, including hemp.

Regulations/government support

Q: Can I grow an industrial hemp crop legally in Oregon?

A: Yes, if it is grown and sold in compliance with the 2014 and 2018 federal farm bills. In Oregon, you also need a license from Oregon's state agriculture department.

When growing hemp commercially, it is advisable to source for certified seed. Oregon State University started certifying hemp seeds in June 2019.

Q: Is it legal to grow and sell hemp?

A: Yes, if it is grown and sold in compliance with the 2014 and 2018 federal farm bills. In Oregon, you also need a license from the state agriculture department. For details, see the department's website (<https://oda.direct/hemp>).

Q: Does the new federal Farm Bill address the issue with FDIC insurance? Are banks now willing to work with hemp growers?

A: Due to the shifting legal climate, some banks are now willing to work with industrial hemp growers. Check with your bank to find out what is available.

Q: Does current law prohibit fiber and oilseed hemp with a high concentration of THC content?

A: Yes. Countries regulate how much THC can be in fiber and oilseed hemp varieties. The U.S. limit for THC is 0.3% in dried biomass. If above that, the variety of *Cannabis sativa* is considered marijuana.

Q: Are there any programs or funding available for new farmers involved in hemp production, seed production or pilot research programs for hemp?

A: Oregon State University and the state Department of Agriculture are not aware of any such programs at this time.

Q: What are the land-use regulations regarding growing hemp or establishing hemp-processing facilities?

A: Hemp is an agricultural crop that has been decriminalized at the federal and state levels. As such, you may be able to grow hemp on any property that is zoned for agricultural production. If you have any questions about whether agricultural production is allowed on your property, contact your local planning department. Processing will vary from municipality to municipality. As part of your application to the state of Oregon, you will need to take a Land Use Compatibility form to your local planning department for approval. The land-use form is part of the handler application available on the state's hemp webpage at <https://oda.direct/hemp>.

Genetics

Q: Are there good cultivars for dual-purpose crops that provide high-protein forage and quality fiber?

A: Yes. Some varieties can be used as a dual purpose for grain and fiber production, but hemp is not an approved animal feed in the U.S.

Q: Will OSU certify hemp seed as with other crops?

A: Yes. OSU started certifying hemp seed in June 2019.

Q: What are good sources of hemp seed? Are there public hemp varieties?

A: Due to the rigor that goes into seed certification, OSU cannot, at the moment, ascertain any good sources of seed or public varieties.

Agronomics

Q: What are the soils, fertilizers and irrigation needed for hemp production?

A: Industrial hemp can be grown successfully on a variety of soils, but it grows best in well-drained, fertile soil. Hemp does not tolerate very wet soils. Production issues caused by growth in wet soils can include low fiber quality and uneven plant heights, which present challenges at harvest. Generally, hemp requires more water than most field crops.

Q: What are good cover or rotation crops to grow before or after hemp?

A: Industrial hemp fits well in rotations with wheat, barley, corn, alfalfa, potatoes and soybeans.

Q: What nutrients and pH levels are required for hemp?

A: Hemp nutrient requirements are similar to those of spring wheat. While hemp nutrient requirements for a given soil and region may not be available, nutrient requirements for wheat are. We suggest you test the soil and follow nutrient guidelines for spring wheat.

Pests

Q: How do you control grasshoppers and russet mites in hemp?

A: See information on the state guide list (<https://oda.direct/CannabisPesticides>) on what pesticides are not illegal for use on cannabis (includes both hemp and marijuana). Here is a link to the cannabis and pesticides handout: <https://www.oregon.gov/ODA/shared/Documents/Publications/PesticidesPARC/CannabisPesticides.pdf>.

Contamination

Q: If the soil contains chemical residues from pesticide applications made years ago (DDT/DDE, Paraquat, lead, arsenic, etc.) will it damage the hemp crop or make it unsaleable? Are there safe soil thresholds?

A: In general, some chemicals in the soil can be taken up and accumulated by plants, but others are not. Little is known about hemp's specific ability to uptake various chemicals. For chemical use in current crop management, see information referring to the state guide list (<https://oda.direct/CannabisPesticides>) on what pesticides are legal to use on cannabis (includes

both hemp and marijuana). Growers should not use any pesticides that are not approved for hemp by the state.

Here is a link to the cannabis and pesticides handout: <https://www.oregon.gov/ODA/shared/Documents/Publications/PesticidesPARC/CannabisPesticides.pdf>.

Here is the link to Oregon's list of pesticide active ingredients that hemp and marijuana are tested for: <https://www.oregon.gov/oha/PH/diseasesconditions/chronicdisease/medicalmarijuanaprogram/Documents/rules/333-007-0410-Exhibit-A-eff-05-31-17.pdf>.

Organizations

Q: Are there any hemp grower or industry groups forming?

A: A hemp commodity commission may be formed if state legislation calling for it is adopted. Meanwhile, efforts are underway to create a hemp grower association.

Q: I'd like to rent my field to a hemp grower. Whom should I contact?

A: A list of registered hemp growers in Oregon is at hemp-reports@oda.state.or.us.

Uses

Q: Where can I sell the hemp crop I grow?

A: If you are looking for a list of registered hemp handlers, you can contact the state at hemp-reports@oda.state.or.us for that list.

Q: Can hemp be fed to livestock? How good a feed is it?

A: While some countries allow hemp to be fed to animals, it is not legal to do so in the U.S. However, it is legal in Oregon to have hemp byproducts in cat and dog food as long as the product is registered as a veterinary remedy. See <https://www.oregon.gov/ODA/programs/AnimalHealthFeedsLivestockID/AHLicensing/Pages/VeterinaryProductRegistration.aspx> for more information.

Further information

- United States Department of Agriculture, National Institute of Food and Agriculture, <https://nifa.usda.gov/industrial-hemp>
- Oregon Department of Agriculture. Industrial Hemp. <https://www.oregon.gov/oda/programs/nurserychristmastree/pages/hemp.aspx>
- Oregon Department of Agriculture. 2019. Industrial hemp grower/seed registration application: <https://www.oregon.gov/ODA/shared/Documents/Publications/NurseryChristmasTree/Grower-SeedHandlerRegistration.pdf>
- Oregon Department of Agriculture, <https://apps.oregon.gov/SOS/LicenseDirectory/LicenseDetail/1443>
- Washington State Department of Agriculture. Industrial hemp research pilot, <https://agr.wa.gov/inspection/hemp/default.aspx>
- Ontario Ministry of Agriculture, Food and Rural Affairs: Growing Industrial Hemp in Ontario. <http://www.omafra.gov.on.ca/english/crops/facts/00-067.htm>
- North Carolina Department of Agriculture and Consumer Services: Industrial Hemp Pilot Program in NC. <https://www.ncagr.gov/hemp/>
- Kentucky Department of Agriculture. <http://www.kyagr.com/marketing/hemp-pilot.html>
- Colorado Department of Agriculture. Industrial hemp. <https://www.colorado.gov/pacific/agplants/industrial-hemp>
- Government of Canada. Producing and selling hemp: <https://www.canada.ca/en/health-canada/services/drugs-medication/cannabis/producing-selling-hemp.html>
- Alberta, Agriculture and Forestry. Industrial Hemp Enterprise: [http://www1.agric.gov.ab.ca/\\$Department/deptdocs.nsf/all/agdex126](http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/agdex126)
- Industrial Hemp: From seed to market. Cornell University Extension. <http://csetompkins.org/resources/industrial-hemp-from-seed-to-market>

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