Industrial Hemp in Vermont

Growing Hemp for Fiber

A PUBLICATION OF
THE UNIVERSITY OF VERMONT EXTENSION
NORTHWEST CROPS AND SOILS PROGRAM

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THE UNIVERSITY OF VERMONT
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CHAPTER ONE

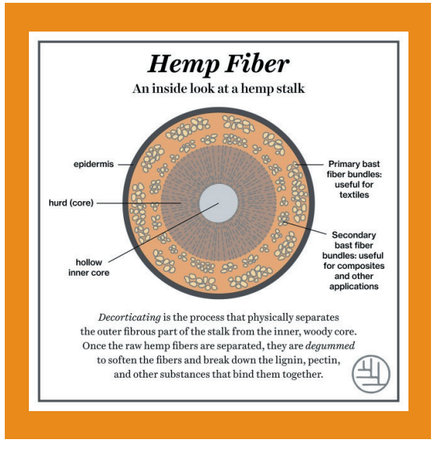
Introduction

Industrial Hemp (*Cannabis sativa L.*) is an emerging food and fiber crop in the Northeast. It is a non-psychoactive variation of Cannabis sativa defined by its low delta-9-tetrahydrocannabinol (THC) content threshold of 0.3%.

Overview

Grower and research experiences in the Northeast have begun to shed light on best management practices for the planting, harvesting, and processing of industrial hemp.

Hemp fiber, known for its high tensile strength, is categorized as bast fiber. Other examples of bast fiber plants include flax, jute, and nettle. Bast fibers are defined by long fibers that run the length of the stem and make up the outer 'bark layer' of the stalk. The inner 'woody core' of a hemp stalk is known as the hurd ***(Figure 1, below)***. In early 2023, the USDA issued a National Hemp Report that estimated the national average yield for 2022 fiber hemp at 3,070 lbs/ac In 2023, our average yields were over five times greater than this, at 16,438 lbs/ac Fiber hemp is poised to become a beneficial rotation crop on Vermont farms, and UVM Extension's Northwest Crops and Soils Program has been experimenting with hemp for several years to better understand its growth habit and quality specifications. This guide describes what we have found so far. For more details of specific results, please refer to our trial reports posted on www.uvm.edu/extension/nwcrops/research.



➞ ***Figure 1.*** *Cross section of a Hemp Fiber stalk. https://fibershed.org*

Other examples of bast fiber plants include flax, jute, and nettle.

CHAPTER TWO

Growing Hemp for Fiber

Growth Habit

Fiber hemp is direct seeded in spring after the last frost. Hemp grows quite tall and outcompetes weeds quickly if well-established. Generally, fiber hemp is harvested between 80 and 100 days. Depending on genetics, plants grown in Vermont can surpass 3m in height within this time frame. Fiber hemp is typically ready for harvest as soon as the male flowers emerge, which occurs in early August. Fiber hemp left longer will eventually go to seed and can be harvested for grain or dual-cropping.

Hemp is also a photoperiod-sensitive plant, meaning that it will respond to shortening daylight hours by advancing into the later stages of its lifecycle. Therefore, crop height will be affected by sun exposure. Generally speaking, hemp varieties can be expected to perform consistently across similar latitudes, because latitude determines day length. Thus far in our experimentation, we in Vermont have seen consistency with varieties bred in France, Italy, and other mainland-European countries. It is considered a good crop for new growers because it is forgiving under variable or suboptimal growing conditions or management practices. It also grows better on poor soils than many other grains and may be a good choice for rehabilitating degraded fields or those transitioning away from conventional management. Hemp can also be grown as a rotation crop with corn and soy.

Variety Selection and Seed

Hemp is defined as *Cannabis sativa L.* with less than 0.3% THC content. There are three general types of hemp that one might grow: fiber, grain, and flower. The genetic make-up of the variety determines which of these characteristics are expressed. For example, varieties optimized for

Figure 2. (opposite page): *Between plots in the 2023 Hemp Fiber Variety Trial.*
Figure 3. *(top left): Yellow stem variety Fibror 79 seen on left.*
Figure 4. *(bottom left): A hempseed germination test.*

*Figure 5. **(top):** Hemp seedlings a few weeks after planting.*
Figure 6. (middle): 2023 Fiber hemp trials seen from above.
Figure 7. (bottom): Freshly cut Fiber laid to ret with all root-ends and grain heads oriented the same way. Stems should be close enough to touch but with enough space to expose grass in between.

grain production are typically shorter in stature for ease of combining, while fiber varieties grow taller to maximize fiber yield. Some varieties claim both grain and fiber application, and to harvest both off of the same crop is called dual-cropping.

Fiber hemp is grown in many countries around the world, resulting in a wide array of genetic diversity. Hemp varieties can be either dioecious (populated by separate male and female plants in an approximate 50:50 ratio) or monoecious (male and female reproductive parts on the same plant) ***(Figure 17, page 9)***. Some varieties are better suited for biomass production, like Chinese variety Yuma, while others are specialized for textile-grade spinning fiber. If growing for a particular buyer, it is best to reach consensus on variety selection in order to meet expectations on the back end. Harvest and storage practices will also vary depending on the intended market.

Pests, Disease, & Field Preparation

Currently, fiber hemp is not particularly vulnerable to pests and disease in Vermont, but bird predation can be detrimental prior to germination. In terms of field preparation, fertilization prior to planting is recommended. Soil tests should be conducted early in the spring. Fiber hemp fields should be fertilized at a nitrogen (N), phosphorus (P), to potassium (K) ratio of 1.0:0.7:1.5, optimally one to two weeks before planting.

Our team has not yet experimented with planting fiber hemp in a no-till management practice, but this guide will stay up to date as new methods are tested. Seedlings can be expected to outcompete weeds where tillage is used.

Planting

Planting should occur when the air temperature has stabilized in the range of 46-50° F. In our region, this typically occurs at the end of May. Hemp is not sensitive to light ground frosts. Sowing density will depend on the end-use of the crop. Fiber hemp can be sown anywhere from 22-80 lbs/ac, with lower rates favoring biomass yields, and higher rates reserved for textile-grade spinning fiber. The idea with textile grade fiber planting is to crowd the plants in an effort to inspire upward growth with minimal branching. Prior to sowing, seeds should be dressed with a nonlethal bird repellent to mitigate bird predation. Row spacing for fiber hemp is 2-7 inches, though some insist that broadcasting seed is optimal. Planting depth should be 1-1.5 inches, and germination can be expected to occur in eight to ten days.

Harvest and Storage

The goal of the harvest in fiber hemp production is to harvest when maximum fiber volume and quality is reached. This

will occur prior to seed set, and can begin as soon as the male flowers begin to express. Varietal specifications and daylength will determine the duration of time between seeding and harvesting, but generally this occurs between 80-100 days. Additionally, processors may require specific harvest protocols to meet their quality goals.

Hemp-specific harvesting equipment is not currently widely available in the Northeast. Fiber crops are generally over 2.5 m tall, and equipment used for cutting hemp must be able to accommodate this large volume. On the research farm, plants are harvested with a sickle-bar mower, cut roughly 4 inches from the ground. Fiber is then laid to ret before drying and storing. As it rets in the field, fiber will dry down and lose significant water weight. On a small scale, standing the hemp up in the formation of a 'stook' ***(Figure 10, right, bottom)*** during a sun spell will halt the retting process and allow for moisture to evaporate.

Folks growing at a large scale for biomass production can utilize a harvest protocol that closely resembles that of a hay crop. Hemp grown in this way utilizes a lower seeding rate that targets a population of 50,000 plants/ac. This crop would then be cut with a disc cutter and raked periodically until it reaches 15 percent moisture.

Hemp fibers are very strong, and farmers must be cognizant of rogue fibers wrapping around machinery.

If retting is desired, the crop should be left in the field after cutting prior to baling. Once moisture is under 15 percent, the retting process will cease. At that point, it can be baled and stored, where it should continue to dry to 10 percent moisture in the bale. According to the Ministry of Agriculture and Irrigation in Alberta, sisal or hemp twine should be used as poly twine can contaminate the fiber. Plastic net wrapping can also be used, but no observations have yet been made on storing hemp under plastic. Bales should be stored undercover to prevent rotting due to rainfall absorption.

Retting

Retting is the process by which microorganisms colonize the stalks and eat the pectin and lignin that bind the bast fiber (bark layer) to the hurd (inner woody core). Whether harvesting for bast or hurd, retting is applicable, as it will loosen the one from the other. There are several ways to ret fiber, including water, winter, chemical and enzymatic methods, but this guide will focus on the most widely practiced method known as dew (or field) retting.

*Figure 8. **(top):** Well-retted hempstalk with bast fiber pulling away from hurd in a 'bowstring' formation.*
Figure 9. (middle): Fibers field retting by variety. Brown piles in the background have been retting longer than fresh green piles in the foreground.
Figure 10. (bottom): Retted fiber drying in a formation called a 'stook'.

Figure 11. (top): *Retted bast fiber.*
Figure 12. *(middle): Retted secondary bast fiber, or tow fiber.*
Figure 13. *(bottom): Hurd fiber.*

Dew retting begins as soon as the plants are cut and laid on the ground. In a moist mid-August, dew retting in Vermont takes roughly 16-20 days, but results will vary, as the process is entirely contingent on temperature and moisture.

Due to a lack of specialized harvesting equipment, retting on the research farm is conducted on a human scale. After harvest, stalks are laid on the ground in organized swaths of consistent orientation. Stalks should be close enough to touch but spread thin enough to allow for grass to poke through. Swaths are then flipped every 6 days, and with greater frequency if there are consecutive days of rainfall. This is done by manually inserting the handle-end of a long tool under the grain heads and turning the swath over itself, so that the root ends are flipped over but barely displaced from their original position. The top layer of the pile will dry and turn brown quicker than the underlayer, and so the function of this action is to ensure an even process.

On an industrial biomass scale, the retting process will consist of cutting and then leaving the stalks out for a stretch of time prior to baling. They could also be raked periodically to even out the microbial process until they reach 15 percent moisture. Once moisture is under 15 percent, the retting process will cease.

Before the retting process is complete, all the green coloring in the stalks will fade to brown. By the end of the second week, snapping a few stems and observing chips of hurd fall away while the bast fiber bends and flexes without breaking, is an indication that stalks are properly retted. Bast fiber may also pull away from the hurd on its own, creating a bowstring-like effect *(**Figure 8, page 5**)*. If the outer layer of bast fiber readily breaks, stalks are likely over retted.

Sampling and Reporting for Delta-9-tetrahydrocannabinol (THC)

In order to comply with federal law, Vermont hemp growers must register with the USDA using Hemp eManagement Platform (HeMP); a secure online system used to manage and submit mandatory reporting requirements. All fields must be sampled for compliance. Prior to harvest, it is the grower's responsibility to contact a sampling agent by email or phone to set up a sampling date and confirm that the sampling agent can send the samples to a vetted testing lab. Fields must be harvested within 30 days of sampling, and the sampler must follow the USDA guidelines to collect their samples. A THC content test is done by an approved laboratory to provide proof that the hemp crop has a THC level of less than 0.3 percent.

Hemp that tests above the acceptable THC level must be disposed of or remediated. A Disposal/Remediation Report (AMS-27) must be filed in HeMP no later than 30 days after the disposal or remediation is completed. Vermont hemp producers must also submit an Annual Report (AMS-28) to USDA by December 15th of each calendar year.

CHAPTER THREE

End Uses

Bast Fiber

The bast fibers comprise the outer layer of the hemp stalk and can be as long as the plant is tall. They are known for their length and high tensile strength. Bast fiber generally separates into two grades through processing: the line fiber (long fiber) and the tow fiber (short fiber); each with their own intended end-uses. Line fiber can be used for ropes, yarns, and textiles, while tow fiber is well suited for non-woven applications such as grow mats or insulation. It can also be used as raw material for paper making, paper packaging, or yarn blends.

Hurd Fiber

Truly every part of the hemp plant is of value. This photo ***(Figure 15, below, right)*** showcases dye made from the leaves of nine different fiber varieties trialed on our research farm in 2023. Each swatch represents a different variety. This botanical R&D was performed by Eric Henry at Solid State Clothing in North Carolina. This year they released a line of limited-edition hemp-dyed cotton t-shirts, making them the first American t-shirt brand to use hemp leaves for dye.

Other Bast Fiber Projects in Northern New England

In an effort to get bast fiber processing off the ground, the Northern New England Fibershed is conducting a Bast Fiber Processing Feasibility Study. They are working to gauge interest for a scutching mill in our region. The photo ***(Figure 16, below, page 9, bottom left)*** shows Fibershed members at the NY Sheep and Wool Festival at Rhinebeck where they educated the masses on bast fiber production. To learn more and get involved with their work visit https://nnefibershed.com/bast-fiber-working-group/.

Figure 14. (far left): *An antique break used for separating bast and hurd fiber.*
Figure 15. (left): *Botanical Dye made from 9 different varieties of dried hemp leaves.*

CHAPTER FOUR

Licensing and Support

Support With Setting Up Your License

Growing industrial hemp requires you to be licensed or authorized under a state, tribal or the USDA hemp program. If you'd like to grow industrial hemp in Vermont, you'll have to set up your license and register with the USDA. The USDA Hemp program has an informative website that will walk you through the requirements for growing industrial hemp and the license application process (https://www.ams.usda.gov/rules-regulations/hemp/information-producers). Once there, you will need to create an account using the Hemp eManagement Platform (HeMP) and use HeMP to submit a USDA Hemp Application. The USDA hemp production applications are accepted on a rolling basis throughout the year.

Once you have made an account with the Hemp eMangement Platform and submitted a license application, you will also have to complete a criminal history report.

Later in the season, there are a few record keeping and sampling requirements to remain in compliance.

For more information about industrial Hemp in Vermont, including research results, trial reports, and upcoming events, please visit the Northwest Crops and Soils Program website https://www.uvm.edu/extension/nwcrops or call (802)-656-7610.

Figure 16. (left): *Three members of the Northern New England Fibershed (NNEF) Bast Fiber Working Group Laura Sullivan, Andrea Myklebust, and Marion Dillon.*
Figure 17. (below): *L to R: female plant (not shown), monoecious plant, male plant (source https://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/crop15539/$file/HempHarvestStorage.pdf?OpenElement)*

CHAPTER FIVE

Summary of Findings/Conclusion

Summary of Findings

The demand for industrial hemp for grain and fiber continue to grow in the United States. Infrastructure to handle and process fiber is capital intensive and therefore growth of markets has been slow. However, investments are being made across the country and now farmers are being presented opportunities to enter the hemp marketplace.
Hemp is a crop that can offer many benefits to the cropping system and the northeast climate presents a suitable environment to grow this crop. Yields for the region are still quite variable but based on university variety trials we know exceptional fiber yields can be obtained. The primary obstacle to growing fiber hemp is establishing a good stand of hemp. A full stand of hemp will help to reduce weed pressure and optimize fiber yields and quality. Seed and seedlings can be susceptible to adverse early season conditions including soil crusting or soil pathogens. Planting high quality hemp seed into healthy soil with adequate moisture and temperature will help to assure a stand of hemp that can be high yielding. As we continue to understand and develop best practices for establishing and growing this crop farmers will be better equipped to meet the quantity and quality of hemp needed for a variety of fiber markets.

Research and education through public universities is important to build a viable and sustainable hemp fiber production system. As new information is developed we will share our results through our events and website at http://www.uvm.edu/extension/nwcrops/research.

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