



*Agriculture Commissioner
Doug Goehring*

2018 INDUSTRIAL HEMP PILOT PROGRAM

Producer Driven Research



**North Dakota Department of Agriculture
Plant Industries Division**

North Dakota Department of Agriculture

2018 Industrial Hemp Pilot-Program

INTRODUCTION

The North Dakota Department of Agriculture (NDDA) created the Industrial Hemp Pilot Program to research the growth, cultivation, and marketing of industrial hemp in North Dakota. The goal was to increase the understanding of how industrial hemp fits into the current agricultural landscape and investigate how it may contribute to the economy of North Dakota.

HISTORY OF LEGAL STATUS

Industrial hemp is a variety of the plant species *Cannabis sativa* L. and was considered a Schedule I Controlled Substance under the Controlled Substances Act (CSA, 21 U.S.C. §§801 et seq.; Title 21 C.F.R. Part 1308.11) until recently. Cultivation was highly restricted and only allowable for research purposes authorized under a provision of the Agricultural Act of 2014.

The Congressional Research Service's *Hemp as an Agricultural Commodity* written by Renee Johnson (2), states that:

The Agricultural Act of 2014 ("2014 Farm Bill," P.L. 113-79) provided that certain research institutions and state departments of agriculture may grow industrial hemp, as part of an agricultural pilot program, if allowed under state laws where the institution or state department of agriculture is located. The 2014 Farm Bill also established a statutory definition of "industrial hemp" as the plant *Cannabis sativa* L. and any part of such plant with a delta-9 tetrahydrocannabinol (THC) concentration of not more than 0.3% on a dry weight basis. The enacted FY2015 appropriations (P.L. 113-235) further blocked federal law enforcement authorities from interfering with state agencies, hemp growers, and agricultural research.

The term hemp refers to the agricultural crop of *C. sativa* L. which produces cannabinoids, but only trace levels of the psychoactive cannabinoid THC. The 2018 Farm Bill passed in late December redefined hemp and took it off the Controlled Substance Schedule I list. In accordance with guidance issued by the United States Department of Agriculture, NDDA will operate the 2019 Industrial Hemp Pilot Program under the rules of the 2014 Farm Bill.

THE PILOT PROGRAM

The NDDA began accepting applications for the 2018 Industrial Hemp Pilot Program in December of 2017. Fifty-seven producer applications were received and approved by the Commissioner. After the licensing process, 27 producers chose to participate actively in the research pilot program with over 2,778 acres of industrial hemp. Thirty of the approved growers later decided not to participate after considering grain market conditions and made personal business decisions not to plant any hemp in the 2018. One of the licensed producers did not harvest their crop due to a damaging rain and high wind that resulted in a nearly total crop failure.

There were four hemp seed companies that supplied the eight varieties planted in the 2018 program (Table 1). Two of the companies were Canadian, one was from Italy and the last was a North Dakota producer. Legacy Hemp, the North Dakota producer, has exclusive rights from Terramax Corp. (Canadian-based company) in the U.S. and provided the variety X-59 Hemp Nut. The varieties chosen by producers were a mixture of high-yielding grain

varieties. A fiber variety was chosen from Northern Italy to study the feasibility of using hemp fiber in bio-composite and eco-friendly plastic materials. Most producers selected hemp types that yielded well under northern prairie conditions.

Table 1 exhibits the agronomic characteristics of hemp cultivars used in the 2018 program. All varieties were plant variety protected (PVP) and pedigreed (certified or foundation grade). Canadian seed laws specify that all hemp seed sold must be of a certified pedigree and tested by Canadian agencies to ensure a THC content below 0.3% on a dry weight basis. The Carmagnola seed variety from Northern Italy was chosen because of its high fiber quality, known low THC levels, and long history of hemp production in the northern climate of Turin, Italy.

| Cultivar | Seed Source | Flower Type | Use | Maturity (days) |
|------------|------------------------------|-------------|--------------|-----------------|
| CANDA | Parkland IHG Coop | Monoecious | Grain, fiber | 110 |
| CFX-1 | Hemp Genetics Int. | Dioecious | Grain, fiber | 105 |
| CFX-2 | Hemp Genetics Int. | Dioecious | Grain | 103 |
| CRS-1 | Hemp Genetics Int. | Dioecious | Grain | 110 |
| X-59 | Terramax Corp. / Legacy Hemp | Dioecious | Grain | 100 |
| Grandi | Hemp Genetics Int. | Dioecious | Grain | 100 |
| Carmagnola | Schiavi Seeds Italy Origin | Dioecious | Fiber | 160 |
| Joey | Parkland IHG Coop | Monoecious | Grain, fiber | 100 |

Table 1. Long-term agronomic characteristics of the hemp cultivars selected for the 2018 NDDA Pilot Program.

Crop management is a key consideration in variety performance along with multiple environmental factors. Temperature, fertilizer input, soil type, soil temperature, and precipitation among other growing factors varied across North Dakota and resulted in a wide range of pounds per acre among all varieties grown by producers in 2018.

Pilot producers in North Dakota observed that because hemp does not branch very well, there may be some benefit to boosting the planting density (above 10-12 plants/square foot) to improve yields. A side benefit to this practice is increased competition against weed growth.

2018 RESULTS - MATERIALS AND METHODS

In May, June, and July of 2018, NDDA imported 52,000 pounds of industrial hemp seed through the three suppliers: Parkland Industrial Hemp Growers (*cv Canda* and *Joey*); Hemp Genetics International (*CFX-1*, *CFX-2*, *CRS-1*); and Schiavi Seeds through Northern Italy (*Carmagnola*). Legacy Hemp planted a combined 27,701 pounds of certified X-59 variety at its main farm and through its three separate contracted growers.

Hemp varieties can be either monoecious or dioecious. Monoecious cultivars have both male and female flowers on the same plant, while the dioecious cultivars maintain separate male and female plants. Male plants are taller, light colored and spindly, while the female plants are bushier and green. In 2018 both monoecious and dioecious varieties were planted.

Planting took place between May 23 and July 12, 2018, with most of the fields planted in June. Seeding rates ranged from 20 to 60 pounds per acre; planting depth varied from 0.125 to 1.5 inches deep; and row spacing was reported from 6 to 15 inches. Common planting practices among the 2018 growers included: 25 pounds per acre seeding rate, 0.75-inch planting depth, and 7.5-inch row spacing. Soil temperature at planting varied between 60-70 degrees Fahrenheit.

Previous crops were wheat, barley, sugar beets, corn, sunflowers, soybeans, peas, potatoes, canola, lentils, and durum. There are no registered pesticides (insecticides, herbicides, fungicides, nor seed treatments) for use in industrial hemp crops. Because of this, producers tried to select weed free fields. Hemp grows best under warmer soil conditions, and therefore is typically planted later than other commercial crops.

Planting density should be set to achieve 10-12 live seeds/square foot. Planting should take place once soils warm and into a firm and moist seed bed. Hemp is highly photo sensitive, and planting later will reduce the crop height, but not result in lower yields, nor later maturity. Early May plantings favor producing very tall plant stands (suitable for fiber production) but will not provide significant gains in earlier harvesting nor seed yields.

Weather conditions leading up to planting seed is a major factor in germination success; one field was voluntarily destroyed due to heavy rains and soil crusting that delayed germination and stunted growth (Figure 1). Another field in western North Dakota was reported to have a summer hail event which bent stalks over and reduced seed yield. The hail damage reduced a 75-acre field to 120 lbs. total yield for the whole field (Figure 2).



Figure 1. Soil crusting after rain, Emmons County, 2018



Figure 2. Hail damage, Williams County, 2018

SAMPLING INDUSTRIAL HEMP - THC CONTENT

NDDA staff collected composite samples from each hemp field to evaluate the THC content in the foliage of the hemp inflorescences. Sampling was timed when approximately half of the seeds were resistant to compression. The THC content in hemp is known to peak when the seeds begin to ripen. Seed forms quickly, usually about 10 days after the first flower. NDDA's hemp sampling protocol involved collecting the top two inches of 30 randomly selected industrial hemp inflorescences per field. Samples for THC analysis were bagged, labelled, and couriered to the federally-accredited laboratory MedScan Laboratory Inc., in Williston, ND.

Standard published analytical methods were followed by MedScan Labs to determine the delta-9-tetrahydrocannabinol (THC) content. In all cases the total THC content found in these plant parts were at trace levels. The THC content from all fields sampled, amounted to only 0.003% to 0.045% of the allowable 0.3% total THC content by dry weight.

PEST ISSUES

No significant insect pest pressures were seen at any site. Cutworm, European Corn Borer, Bertha armyworm, corn borers, Lygus bugs, aphids and grasshoppers on occasion can be a problem. There were beneficial insects such as bees present during flowering time at several field locations, as well as lady beetle adults and larva.

The most prevalent weeds included kochia, Russian thistle, lambsquarters, Canada thistle, common and giant ragweed, cocklebur, foxtail, and pigweed. Volunteer cash crops such as corn, sunflower, canola, pea, and wheat were also reported to compete with hemp. Extra handling at harvest was necessary to remove the moist weeds and dry down the hemp seed to a safe level for storage (10-11% moisture content).

Both wheat and wild buckwheat are problematic as it is most difficult to separate out of hemp seed. Wheat also may cause issues with processors who hope to maintain gluten-free facilities. Ideally, all fields need to have a low inherent weed population as there are no registered pesticides for use in hemp production. Hemp is very competitive against weeds under ideal conditions. It emerges very rapidly (3-4 days) in warm/moist soils and can quickly shade and outcompete weeds. Growers commented on how quickly hemp develops.

PESTICIDE USAGE

All pesticides must be registered with the NDDA before they can be used, sold, or distributed in North Dakota. The North Dakota Pesticide Act prohibits use of a pesticide in a manner inconsistent with the product's labeling. There are some pesticide products that display broad label language that does not prohibit use on hemp.

HARVESTING INDUSTRIAL HEMP

One pilot researcher completed a fiber study using the Northern Italy variety Carmagnola. The fiber variety Carmagnola averaged 7.5 inches per week of growth and a fiber yield of 1,900 lbs. per acre (Figure 3 and 4). The hemp fiber crop (Figure 10) was cut with a sickle bar mower and allowed to break down in the field for a few weeks using a process called retting. Retting is a process where the glue-like substances holding the plant fibers together becomes degraded by moisture, bacteria, and air. The Carmagnola study above used dew retting, using the available moisture in the air, bacteria, and time to break down the hemp fibers. The hemp stalks were baled with a round baler and sent to a processor for manufacturing (Figure 5 and 6).

The hemp harvest was delayed in some fields until the seed was completely ripe, apparently to reduce the amount of green material in the bins at storage. Delaying harvest is a risky proposition, as excessive seed losses can result from shelling out of the seed-holding bract, and blackbird feeding. Experienced growers recommend that harvest begin at the onset of blackbird predation.



Figure 3. Carmagnola stem, 2018



Figure 4. Carmagnola stalk, 2018



Figure 5. Hemp Bale, 2018



Figure 6. Baled Hemp Stalks, 2018

The hemp harvest took place from August 8 to October 25, 2018. Some of the harvest was delayed due to an early snowfall. The hemp crop was straight cut, and the combine was run at a reduced speed to avoid any potential plugging or wrapping issues with the volume of green material. Some growers in Canada swath the crop; however, it is prone to sprout. Normally the seed moisture content at harvest should be 18-19%; and seed is considered dry and safe for storage at 10% moisture or less. Hemp plants may appear quite green at normal harvest time; the seed matures rapidly at this stage and may shell out readily during the harvest operation.

Equipment Used:

Hemp Research Pilot participants used the equipment shown in Table 3.

| Ground Preparation: | Planting Equipment: | Harvest Equipment: |
|---------------------|----------------------------------|--|
| Protill | Air Seeder-Horsch Anderson | Case combine 9230 |
| Discing in spring | Moldboard Plow-Packer Pony Drill | 9610 John Deere combine with Flex Head |
| Light Discing | Almaco Seed Drill | Sickle Bar mower (fiber harvest) |
| Rototiller | Precision Planter Almaco | Hand harvested, pruning shears, flails |
| Light Discing | Hoe Drill | New Holland TR 96 Rotary Combine |
| No Till | No till Air Drill | 9610 John Deere combine, Straight Head |
| No Till | No till Air Drill | 9500 John Deere Combine |
| Chisel Plow | Super Cutter seed drill | Combine unknown model |
| Discing in spring | John Deere 9350 Disc Drill | 9600 John Deere Combine |

Table 3. Equipment Used

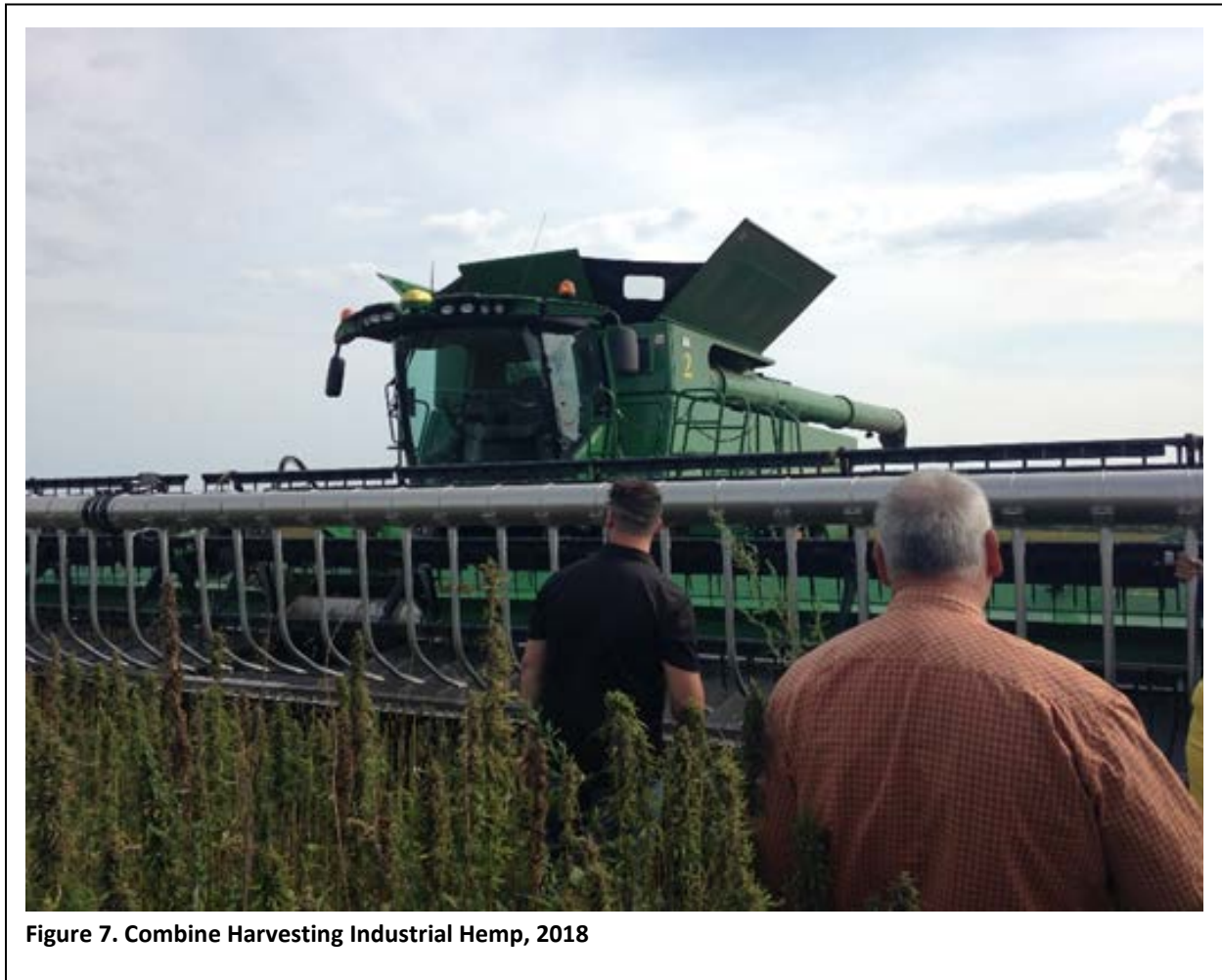


Figure 7. Combine Harvesting Industrial Hemp, 2018

Because industrial hemp does appreciably branch/tiller, the stubble that remains is composed of long individual fibrous stocks that are tough to work down and are generally moist such that burning will not be very effective (Figure 8). Normally the stubble is left standing over the winter and then rolled in spring to produce a dense soil cover to facilitate successful burning (Figure 9). Residue management is a challenge due to hemp’s tough fibers.



Figure 8. Hemp Stubble after baling, 2018



Figure 9. Hemp stalks left in field, 2018

INDUSTRIAL HEMP PROCESSING

In 2018, the NDDA issued industrial hemp licenses to four processors: Anchor Ingredients, Healthy Oilseeds, Life Giving Seeds, and 17Thistles. Hemp has multiple uses as represented in Table 4. Healthy Oilseeds processes cold press oil, protein fiber, and hemp hearts. Life Giving Seeds processes protein fiber powder, cold pressed oil, and hemp hearts. Anchor Ingredients researched the processing of dehulling grain into hemp hearts. The 17Thistles company did not process any hemp in 2018. Hemp seed oil contains omega-6 and omega-3 polyunsaturated fatty acids and has been touted to provide health benefits (3).

Table 4. Industrial hemp uses (*few products certified)

| Food Uses | Hemp Oil Product Uses | Hemp Fiber Product Uses |
|---------------------------|-----------------------|--------------------------|
| Confectionary Items | Cooking | Fabric |
| Beer | Salad Dressing | Insulation |
| Flour | Dietary Supplements * | Carpeting |
| Feed * | Body Care Products | Paneling |
| Dietary | Fuel | Pulp and Paper |
| Snacks | Detergents | Recycling Additive |
| Non-dairy Milk and Cheese | Spreads | Automobile Parts |
| Baking | Paint | Animal Bedding and Mulch |

Economics of Industrial Hemp

Marketing and processing of industrial hemp in North Dakota is developing. According to the Manitoba Agriculture Industrial Hemp Production figures, commercial hemp grain contract price ranged from \$0.75 to \$0.84 per pound for clean high-quality grain. Organic production price is generally 30 to 40% higher depending on the contractor (1). One processor in North Dakota reported contract prices of \$1.00 per pound certified organic and \$0.45 per pound for conventional grain.

In general, producers considering hemp as a cropping option should research hemp production and processor options, so they fully recognize the benefit and cost to their operation. Contracts are recommended to ensure a market and an economical return. Markets continue to develop, and processors are expanding their processing capacity to accommodate the rise in demand for hemp products (1).

Conclusions

Industrial hemp holds promise as a viable alternative crop for North Dakota producers. Based upon the industrial hemp grower experiences, the crop appears to be well adapted over most of North Dakota's agricultural conditions.

Generally, the field trials had lacked significant diseases and other pests. The pilot program growers were comfortable growing the new crop and could plant, maintain, and harvest hemp without significant modifications to their current farming equipment and practices.

References

1. Anon. 2016. Manitoba Department of Agriculture, Industrial Hemp Production.
2. Johnson, Renee. 2015. "Hemp as an Agricultural Commodity: Congressional Research Service", CRS Report.
3. Hemp Genetics International (HGI). Hempgenetics.com/index.html