2017 INDUSTRIAL HEMP PILOT PRODUCER DRIVEN RESEARCH

North Dakota Department of Agriculture

Plant Industries Division

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North Dakota Department of Agriculture

2017 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.

LEGAL STATUS

Industrial hemp is a variety of the plant species *Cannabis sativa* L. and is 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). Cultivation is 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 ("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 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 THC. Table 1 lists the cannabinoid compounds that are produced by *C. sativa.* The major omega-6 and omega-3 fatty acids produced in hemp are linoleic and linolenic acids which are said to be produced at the ideal 3:1 blend (3).

Table 1. List of Cannabinoids available for testing by MedScan Laboratories LLC.

Cannabinoid	Designation	Notes
Tetrahydrocannabinol	THC-A	Non-psychoactive, that converts to THC
Cannabidiol	CBD-A	Non-psychoactive
Cannabinol	CBN	Mild psychoactive
Cannabidivarin	CBDV	Non-psychoactive
Cannabigerol	CBG	Non-psychoactive, High levels in hemp
Cannabichromene	CBC	Non-psychoactive, 2nd highest level in hemp
Tetrahydrocannabivarin	THC-V	Highest level of all cannabinoids in hemp
Delta-9 tetrahydrocannabinol	THC	Psychoactive

THE PILOT PROGRAM

NDDA began accepting applications for the 2017 Industrial Hemp Pilot Program in December of 2016. Forty-two producer applications were received and reviewed by a committee created by the Agriculture Commissioner. The Commissioner deliberated on the committee recommendations and selected thirty-four pilot producers. Geographical spread, soil type, environmental conditions, and the proximity to processing facilities were also key considerations in the selection of the candidates.

The thirty-four growers planted a total of 3,020 acres of industrial hemp in 17 counties as part of this 2017 research program. Three of those producers did not harvest their crops or report research information.

The research focus varied according to producer interest. Producers collected data at each site, including general agronomic practices, rainfall, observations of insect pests, weeds and diseases, crop establishment and development, and grain yield.

Although not covered within the NDDA Industrial Hemp Pilot Program, the NDSU Langdon Research Extension Center ran a parallel program to assess the agronomic performance of ten different seed varieties.

Four hemp seed companies in Manitoba, Canada supplied the seven varieties planted in the 2017 program (Table 2). The varieties selected were a mixture of high yielding grain varieties and a type known to produce high oil content. Very tall hemp varieties - those suitable for fiber production - were not chosen for the program, as there are no fiber processing facilities nearby. The objective was to select hemp types that yielded well under northern prairie conditions. The Manitoba Agriculture website (1) publishes the historical data of several varieties. Since 1998, Canada has grown industrial hemp for both the seed and fiber markets, with most of the production located in the Prairie Provinces of Manitoba, Saskatchewan and Alberta. Up to 118,000 acres have been grown annually in Canada over the 1998-2011 period (1). In Manitoba, grain yields ranged between 100 to 1200 lbs./acre, with a bushel weight of 44 lbs. at 10% moisture content.

Table 2 exhibits the historical yield expectations amongst the test varieties under Manitoba conditions. 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. For instance, *cv Finola,* a variety bred for high oil content, generally produces the lowest grain yield relative to the other test varieties in nearly 20 years of Manitoba field trials. The other three varieties listed exhibited yields that were statistically equivalent over the same period. This finding suggests that there could be large swings in seed yields year to year. It is important to note that growing industrial hemp carries considerable risk to the producer as it is not eligible for crop insurance, and markets and returns are not consistent year to year.

Table 2. Long-term agronomic characteristics of the industrial hemp cultivars selected for the 2017 NDDA Pilot Research Program

Cultivar	Seed Source	Flower Type	Use	Maturity (days)
CANDA	Parkland IHG Coop	Monoecious	Grain, fiber	110
DELORES	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
FINOLA	Hemp Oil Canada Inc.	Dioecious	Grain	100
X-59	Agrinomics I.T. Consulting LTD	Dioecious	Grain	100

Crop management is a key consideration in variety performance. For instance, one grower in the 2016 Minnesota Department of Agriculture Pilot Program grew *cv Finola* for cold press oil extraction. Hemp seed oil contains omega-6 and omega-3 polyunsaturated fatty acids and has been touted to provide health benefits. Harvest was delayed until the crop was completely ripe, apparently to reduce the amount of green seed content, and hence chlorophyll in the oil. Delaying harvest is a risky proposition, as excessive seed losses can result from shelling out and blackbird feeding. Experienced growers recommend that harvest begin at the onset of blackbird predation.

Photo 1. North Dakota industrial hemp crop (2017)

Hemp varieties are monoecious or dioecious. The former cultivars have both male and female flowers on the same plant, while the latter cultivars maintain separate male and female plants (see Photo 1). Plants tend to be 75-80% dioecious with the proportion of exclusively monoecious female plants being 10-15% and males about 10% (Photo 2). Under stressful Manitoba conditions (hot/dry) the proportion of pure male plants can increase to 20%, reducing yield. Pilot producers in ND 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. Future studies will be needed to investigate this phenomenon.

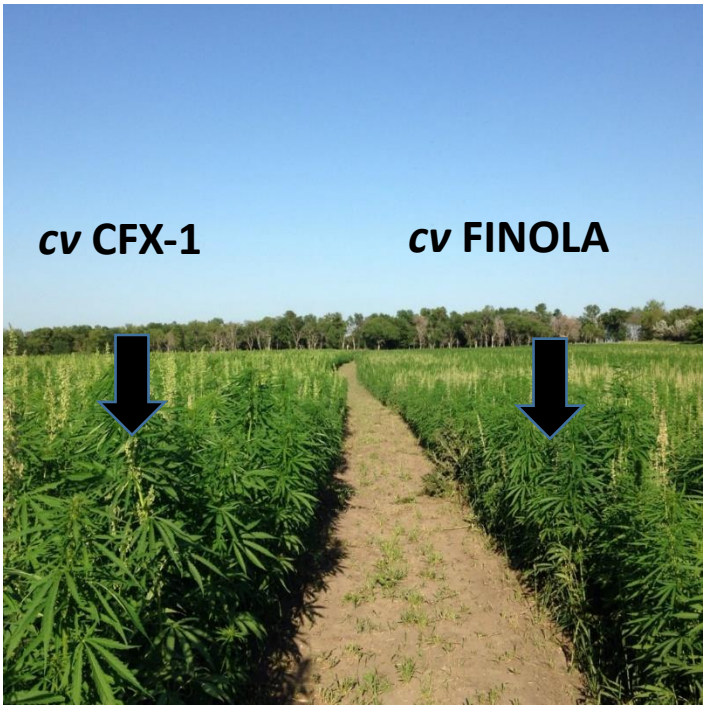


Photo 2. Industrial hemp pilot producer variety trial (Benson County July 2016).
Note: Monoecious plants - white stalks (male flowers) can constitute 10-20% or more of the plant stand.

2017 RESULTS - MATERIALS AND METHODS

In May and June of 2017, NDDA imported 85,000 pounds of industrial hemp seed through the four Manitoba suppliers: Hemp Oil Canada (*cv Finola*), Parkland Industrial Hemp Growers (*cv Canda* and *Delores*), Agrinomics I.T. Consulting LTD (*cv X-59*) and Hemp Genetics International (*CFX-1, CFX-2, CRS-1*).

Planting took place between May 17 and June 14, 2017 with the majority being planted the last week in May. Seeding rates ranged from 20 to 35 pounds per acre; planting depth varied from .5 to 1.5 inches deep; and row spacing was reported from 6 to 15 inches. General planting information included-25 pounds per acre seeding rate, .75 inch planting depth, and 7.5 inch row spacing.

Drought conditions in western and central North Dakota (ND) impacted planting dates and caused uneven delayed emergence, weed problems and thin plant stands.

Previous crops were wheat, barley, sugar beets, corn, sunflowers, soybeans, peas, potatoes, canola, lentils, and durum. Two fields were previously planted to alfalfa and hay barley. There are no registered pesticides (insecticides, herbicides, fungicides, nor seed treatments) for use in industrial hemp crops. With this being the case, producers were very cognizant to select their cleanest fields. In several instances, the growers pre-treated their fields with glyphosate to contain any early season weed growth. Hemp grows best under warmer soil conditions, and hence is planted later than other commercial crops. This late planting may allow for an additional

flush of weeds that can be eliminated by the pre-plant burn-off application of glyphosate. All but six of the growers fertilized their fields in the spring, April through June.

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.

Plant heights varied greatly most likely due to drought conditions at planting and throughout the growing season in western and portions of central ND.

SAMPLING INDUSTRIAL HEMP - THC CONTENT

NDDA staff collected random 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 (Photo 3). 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.

Photo 3. Industrial hemp stage at sampling time for THC analysis (Williams County 2017).

NDDA's hemp sampling protocols involved collecting the top 2-2.5 inches of 30 randomly selected industrial hemp inflorescences per 100-acre field. In fields over 100 acres in size, an additional 10 inflorescences were collected per additional 100 acres. Samples for THC analysis were bagged, labelled, and couriered immediately 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 THC content found in these plant parts were at trace levels.

The THC content from all fields sampled, amounted to only 0.001% to .031% of the allowable THC content by dry weight.

PEST ISSUES

No significant insect pest pressures were seen at any site. Cutworm, Bertha armyworm, corn borers, Lygus bugs, aphids (photo 4a) and grasshoppers on occasion can be a problem.

Bees were prevalent during flowering time at several field locations, as were lady beetles.

Lack of soil moisture at planting and throughout the growing season attributed to spotty emergence, increased weed pressure, and lower yields (Photo 4b). The most prevalent weeds included kochia, Russian thistle, lambsquarters, Canada thistle, common and giant ragweed, cocklebur, foxtail, and pigweed. Volunteer corn, sunflower, canola, and wheat were also problematic. In fact, two fields were considered failures and voluntarily destroyed by producers due to volunteer corn. The NDDA required destruction of another field due to almost total infestation of the noxious weed Canada thistle.

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 (*Polygonum convulvulous*) 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. Growers are strongly urged to apply a pre-plant spray of non-residual herbicide (such as glyphosate or glufosinate-ammonium) to contain any early season weed growth. 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.

Photo 4a. Aphids on a hemp leaf (Pembina County 2017).

Photo 4b. Thin canopy, dry conditions encourages weed development (Grant County 2017).

Hemp is reported to be susceptible to some seedling diseases such as *Pythium* and *Rhizoctonia*. *Sclerotinia* (white mold) and *Botrytis* are also said to be the most serious foliar diseases for hemp. The foliar diseases generally form at the top of the plant in the inflorescences.

HARVESTING INDUSTRIAL HEMP

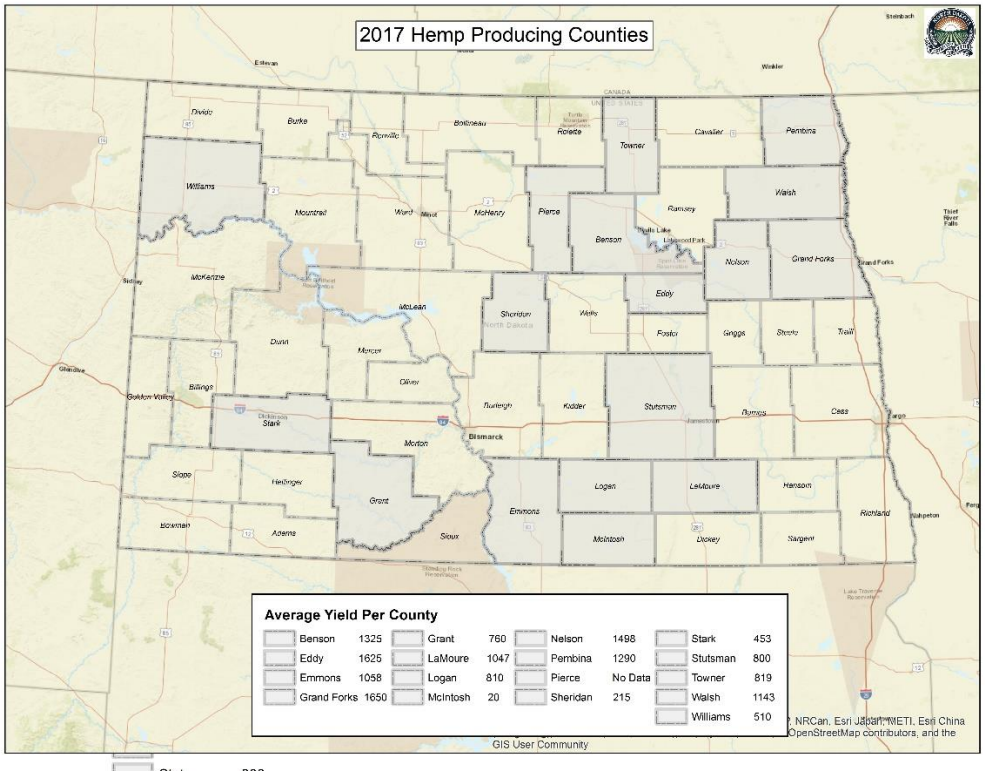
All harvesting was completed in September and October 2017. The hemp crop was straight cut, and no difficulties were reported, other than the combine speed being run intentionally slow to avoid any potential plugging or wrapping issues with the volume of green material. Some growers in Canada swath the 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. 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 (Photo 5).

Seed cleaning was required in all instances to reduce the amount of moist foreign material in the sample and lower the moisture content to a safe level for storage and processing.

Normal yields obtained in Manitoba are 800-1200 lbs./acre. The pilot producers in the eastern portion of ND (east of ND Hwy 281) were pleased with the results and harvested between 785-1800 lbs./acre - right in line with Canadian yield expectations for these varieties. Unfortunately, due to season-long drought conditions, those in central ND harvested between 215-1621 lbs./acre and those in western ND harvested between 315-1200 lbs./acre (Map 1a and 1b).

The variability in yields should caution potential growers wanting to grow hemp on stubble with low soil moisture reserves.

Map 1a. Average yield in pounds per acre



Map 1b. Industrial hemp varieties planted by county.

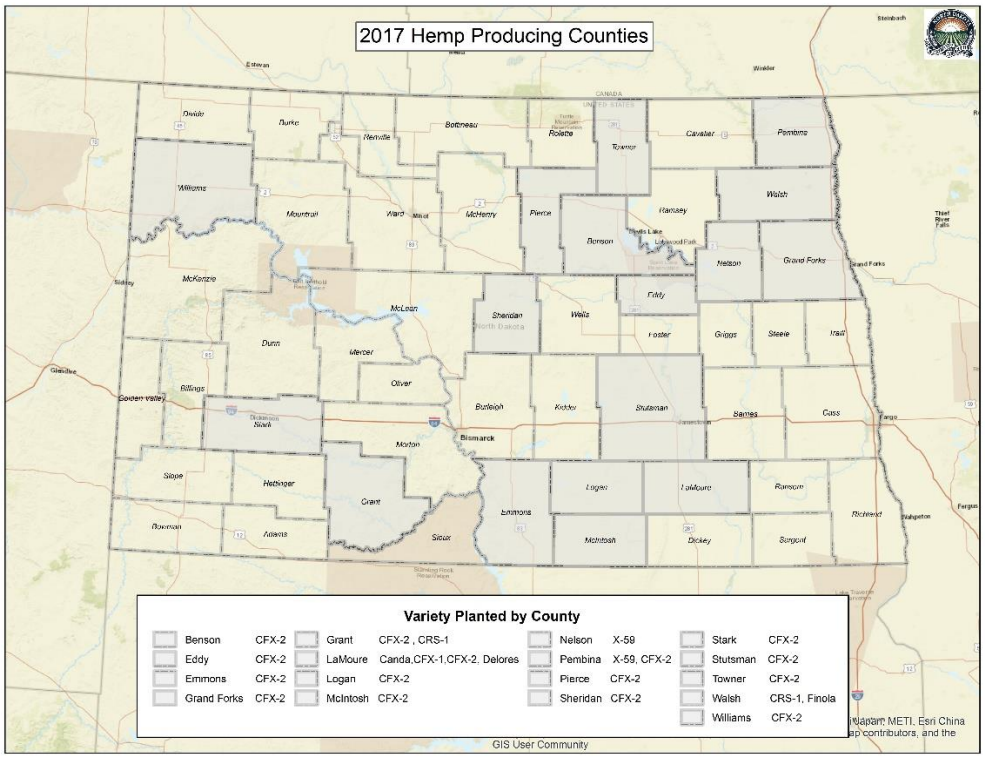
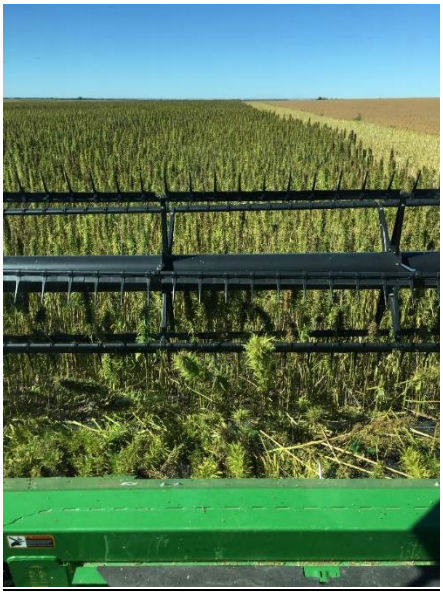


Photo 5. Harvesting industrial hemp (LaMoure County).



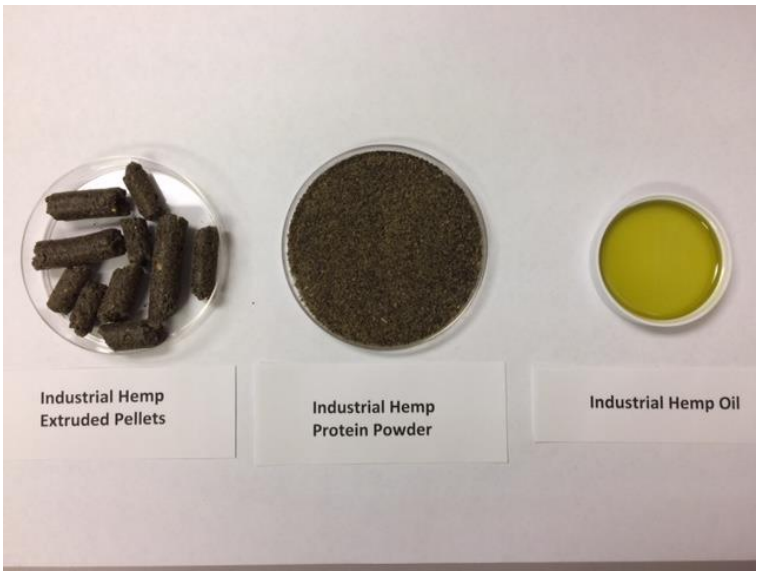
Because industrial hemp does appreciably branch/tiller, the stubble that remains is composed of long individual fibrous stocks that are tough to work down and generally moist such that burning will not be very effective (Photo 6). Normally the stubble is left standing over the winter and then rolled in spring to produce a dense soil cover to facilitate successful burning.

Photo 6. Post-harvest crop residue management (LaMoure County) 2016.

INDUSTRIAL HEMP PROCESSING

In 2017, the NDDA issued industrial hemp licenses to three processors (Anchor Ingredients, Healthy Oilseeds, and 17 Thistles). Another processor, Life Giving Seeds, was licensed in 2018. Most of the grain was sold to and processed at Healthy Oilseeds LLC., located in Carrington, ND. The grain was crushed to extract hemp oil, and the remainder milled to produce either a finely-ground high-protein flour or extruded into pellets (Photo 8). Seed contains 30-35% oil of a desirable fatty acid profile and flour contains around 25% protein. Reliable foreign markets for these commodities exist. Anchor Ingredients bought grain from one producer to test dehulling. Dehulled hemp or "hemp hearts" are a high demand commodity. Two producers baled the fiber and continue to store it while they explore the fiber market.

Photo 7. Processed industrial hemp commodities.



In 2016, representative samples of each of the above commodities (Photo 7) were sampled (Photos 8a, 8b) by NDDA staff following a U.S Drug Enforcement Administration (DEA) request, then couriered to MedScan laboratory to analyze for cannabidiol (CBD), and THC. Cannabidiol (CBD) is produced at higher levels than THC in hemp and is then extracted for its supposed medicinal properties (i.e. anticonvulsive, anti-epileptic and anti-microbial). As expected, the final analytical step of the processed commodities has shown low THC content (Table 3). This should result in unencumbered trade of the hemp commodities being held by the pilot producers.

Photo 8a: (Left) Hemp meal sampling Photo 8b: (Right) Hemp oil sampling

Table 3. THC and CBD content contained in harvested and processed samples.

Commodity	Mass % THC	Mass % CBD
Seed	0.124	0.638
Flour	0.008	0.015
Pellets	0.007	0.101
Oil	<0.001	<0.001

Other uses for industrial hemp are shown below (Table 4).

Table 4. Industrial hemp uses

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 ND remains limited. Federal guidelines prohibiting the transport of viable grain into other states continues to hinder our producers. The NDDA is working with the Drug Enforcement Agency to address the issue.

Healthy Oilseeds LLC in Carrington, ND, working in conjunction with Hemp Production Services out of Canada, signed contracts with growers for $0.54 per pound of cleaned, dried to less than 9% conventional grain.Healthy Oilseeds accepted delivery of organic grain first. Numerous producers continue to hold and manage their 2017 grain and are hoping to be able to deliver it to Healthy Oilseeds soon.

Anchor Ingredients and Life Giving Seeds each purchased hemp grain from single producers to explore the processing and marketing potential of industrial hemp.

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. However, lower market prices and yields due to drought conditions throughout much of the state existed in 2017.

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

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