

Industrial Hemp Harvest and Storage Best Management Practices

Industrial hemp (*Cannabis sativa L.*) is an emerging food and fibre crop in Alberta. It is a non-drug variety of *Cannabis sativa* with low delta-9-tetrahydrocannabinol (THC) content of less than 0.3 per cent. In 2014, 108,000 acres of industrial hemp were grown in Canada, and 25,560 of those acres were grown in Alberta.

Grower, processor and research experiences on the Prairies have provided an understanding of best management practices for harvesting and storage of industrial hemp. These experiences will help guide harvest and storage practices to ensure the strict quality requirements for food and fibre production.

1. Food and Fibre

Industrial hemp has two main commercial uses, as food or fibre.

1.1 Food production

Currently in Alberta, the two main contract markets for industrial hemp are with two food processing companies, Hemp Oil Canada and Manitoba Harvest, which are located in Manitoba. These companies make contract agreements with producers for seed production of industrial hemp, and have strict quality requirements.

Hemp seed yield is variable with yield ranging up to 1200 to 1500 kg/ha (1068 to 1336 lbs./ac.) but average is between 850 to 1000 kg/ha (750 to 890 lbs./ac.).

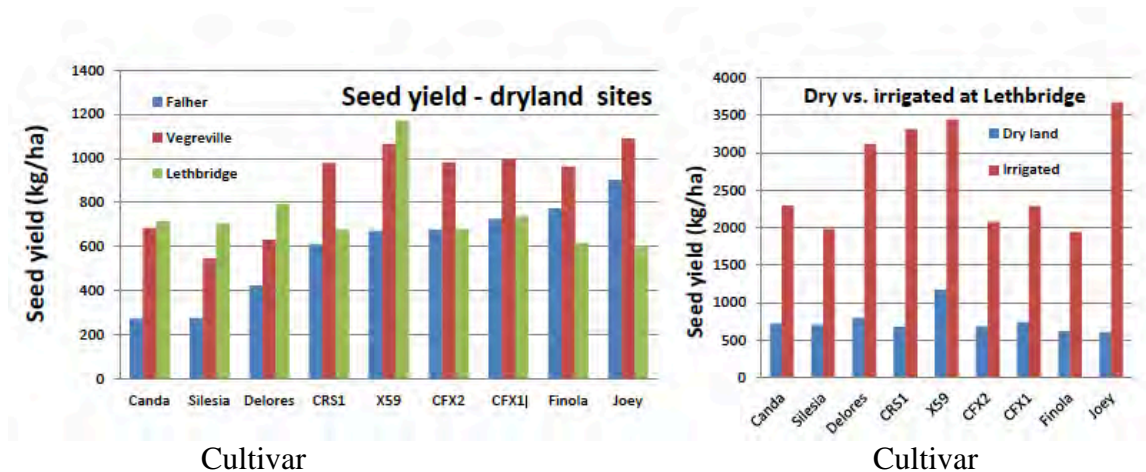


Figure 1. Seed Yield of Industrial Hemp, Variety Trials 2014

Source: Slaski, J.J.; Industrial Hemp: new opportunities for diversification of farmers' income and cropping options. Organic Alberta 2015 Conference.

Hemp Seed Food Grade Requirements - Physical Properties

Processors require hemp seed that is of good food grade quality, dry and sound, and complies with the following standards:

- **Variety:** From the Health Canada approved list of *Cannabis* varieties
- **Colour and appearance:** Grayish-brown seeds. Mature good quality hemp seeds will have dark markings on them.
- **Flavour and Odour:** Slight nutty flavour and odour.
- **Purity:** Seed cleaned to 99.9 per cent purity. The maximum admixture without deductions is 0.1 per cent by weight. Weathered, immature or frozen seeds have a colorless light brown seed coat. All poor quality seed must be removed through the cleaning process.
- **Grading:** Peroxide level is a grading factor done by the industry. Peroxide values are a measure of rancidity that may occur in the sample. Industrial hemp processors prefer a grain sample with a peroxide value under 2 meg/kg. Growers can reduce the peroxide levels by minimizing seed injury during harvest, cleaning and handling. This can be achieved by harvesting at the higher range of the acceptable per cent seed moisture content and by slowing down the speed of the augers, harvest and cleaning equipment and using belt conveyors where possible.
- **Toxins:** Must have acceptable levels of coliform and e-coli – check processor requirements.
- **Moisture content:** Should not exceed eight per cent.



Photo 1a: Hemp seed in hull with some green



Photo 1b: Clean, high quality hemp seed in hull

1.2 Fibre production

In addition to food production from seed, industrial hemp also has large potential for fibre production. Currently in Alberta, there are no markets for fibre, but several projects are in the planning and implementation stages with potential start up in the fall of 2015. See Figure 1.

Fibre yields from high yielding fibre varieties can yield six to 12 tonnes/ha (2.4 to 4.8 tonnes/ac.) Hemp provides greater fibre yields than most other fibre crops and is known for its high tensile strength. Manitoba Agriculture reports that fibre yields from dual purpose varieties is 0.30 to 0.60 tonnes/ha (0.75 to 1.5 tonnes/ac.).

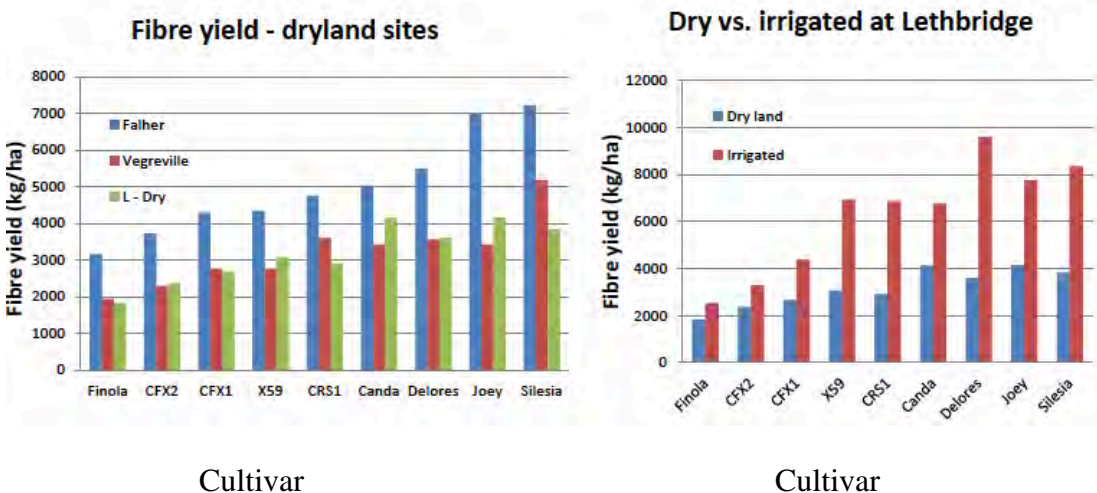


Figure 2. Fibre yield of nine cultivars grown under rain-fed and supplementary irrigation in Alberta in 2014

Source: Source: Slaski, J.J.; Industrial Hemp: new opportunities for diversification of farmers' income and cropping options. Organic Alberta 2015 Conference.



Photo 2: Tall fibre crop

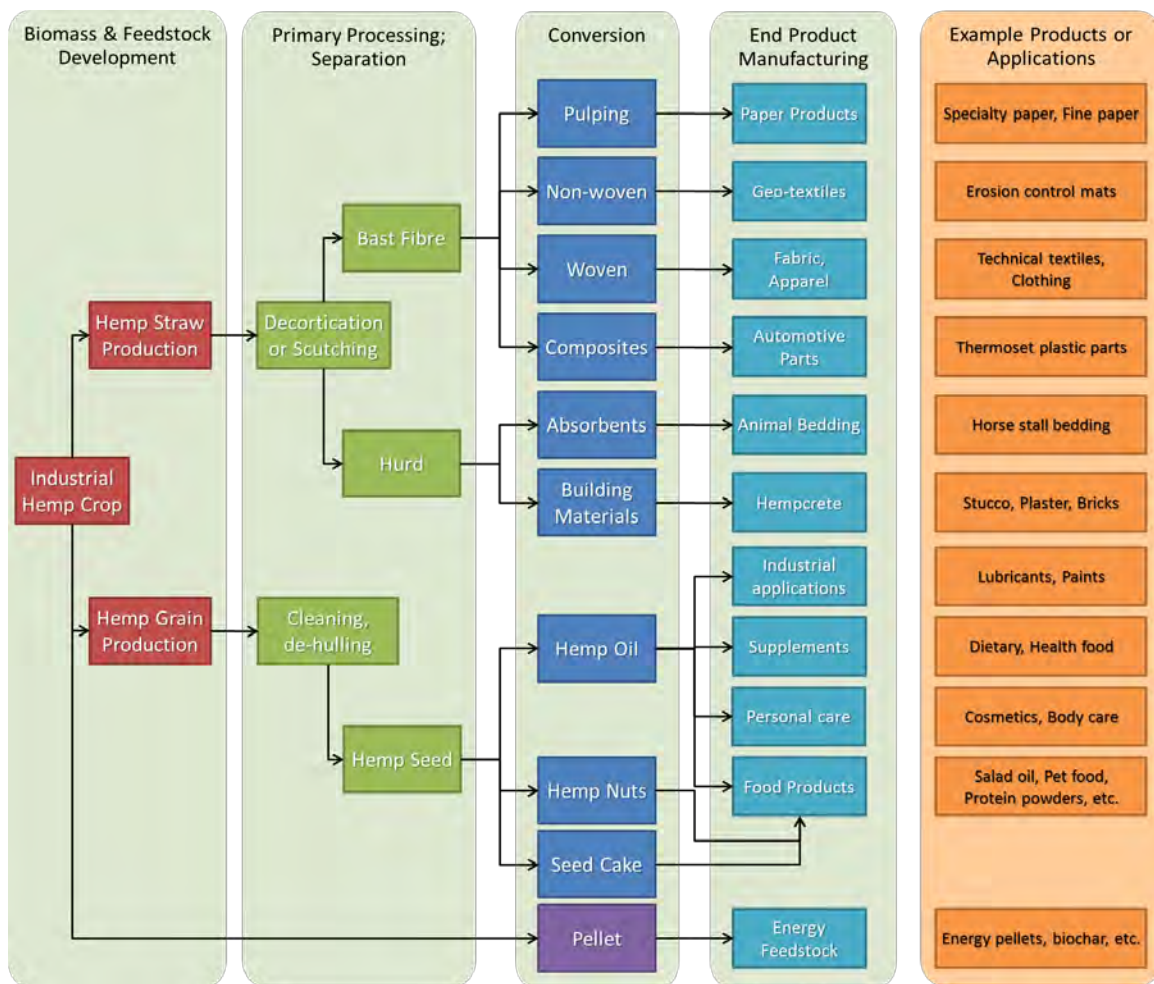


Figure 3. Industrial Hemp Supply Chain

2. Assessing Maturity

Currently industrial hemp is grown primarily for seed in Alberta with varieties selected for short height and low fibre production. As fibre markets develop, industrial hemp may fall into three distinct categories: grain, fibre, and dual purpose (for grain and fibre). Harvest and storage practices will vary depending on the intended market.

Grain varieties are typically the shortest varieties and range from 0.9 m to 2.7 m (3 to 9 ft.) tall. Fibre-only varieties can grow more than 3.0 m (10 ft.) tall.

Crop height is also influenced by photoperiod. Flowering and seed set is triggered by shortening daylength. In northern areas, the crop will grow taller with longer daylength prior to setting seed. The same variety may grow 1.2 to 1.5 m (4 to 5 ft.) in height in southern Alberta and 2.4 to 3 m (8 to 10 ft.) tall in the Peace River region.

Most industrial hemp varieties are dioecious where male and female plants are separate in an approximate 50:50 ratio. The male plants flower and pollinate the female plants. After pollination, the male plants die off and the female plants continue to grow and set seed.



Photo 3a: Hemp female plant

Photo 3b: Hemp hermaphroditic plant

Photo 3c: Hemp Male plant

Some monoecious (male and female reproductive parts on same plant) varieties exist and are mainly bred for fibre production.

Table 1. Morphological stages of development of Finola

Morphological stages	Days after sowing
Emergence of seedlings	Day 5-7
First true leaves	Day 7-10
Second true leaves	Day 10-12
Third true leaves	Day 12-15
Fourth true leaves	Day 15-25
Beginning of flowering	Day 25-30
Beginning of pollination	Day 30-35
Peak time of pollination	Day 40-45
Apparent seed formation	Day 55
End of pollination	Day 55-65
Small smell from females	Beginning day 50-60
30-70% mature seed	Day 70-80
60-80% mature seed	Day 90-100
Male flowers	Normally dead by day 100
Harvest time	Day 100-120 after sowing

Sown between mid-May and early June near latitude 50° N

Source: http://www.finola.fi/Finola_Development_2013.pdf

2.1 Environmental conditions

Wind and hail are two important environmental conditions that need to be considered when assessing harvest timing. Hail can impact both seed and fibre production. The weaker male plants generally get damaged by these conditions more than female plants. Damaged plants will often branch out and regrow, which can minimize losses for fibre production. However the regrowth may cause staging problems for seed harvest. If growing for seed, assess female plants for seed production and harvest at the stage that provides optimum seed yield with minimal immature seed. See Section 2.5.



Photo 4: Hail damage and regrowth on hail damaged plant.

Wind can cause shattering loss of mature seed. In southern Alberta where high winds can occur during the fall, swathing has been used as a strategy to help reduce shattering loss. See Section 4.

Hemp can tolerate mild frost down to -5°C for a short period without harm to mature seeds or crop growth. A killing frost will hasten maturity and can act like a desiccant. If a killing frost occurs, seed will mature rapidly and a harvest is recommended within a few days to prevent yield loss and harvest difficulties due to dry stem fibre. For taller, later maturing hemp varieties, a killing frost can be desirable as it can help to expedite harvesting. Like any crop, harvest timing must balance weather forecasts and the potential for yield and quality loss due to wind, wet weather and frost conditions.

2.2 Assessing maturity for fibre-only varieties

If growing industrial hemp for only fibre, the crop is harvested when maximum fibre volume and quality is reached. This point is reached prior to seed set. In dioecious varieties, harvest timing for fibre occurs prior to seed set and the dying off of the male plants. Monoecious varieties have a similar harvest timing aimed at maximizing fibre volume and quality. Typically, harvest occurs when flowers first emerge.

Environmental conditions and daylength will determine the length of time between seeding and harvesting. Additionally, processors may have specific quality needs, and require a specific harvest timing to meet their requirements.

2.3 Assessing maturity for grain and dual purpose varieties

Harvest timing for grain is aimed at maximizing seed yield and quality. Hemp has indeterminate growth. Seed maturation starts at the bottom of the seed head and moves upwards, resulting in mature seeds lower down and immature green seeds at the top of the seed head. Additionally, once mature, the seed bract that holds the seed dries out, and the seed can shatter quite easily, resulting in significant seed loss.



Photo 5: Hemp ready for seed harvest

Birds can also damage seed crops. As the hemp seed matures, bird feeding may cause shattering and seed loss – an additional harvest timing consideration.

Swath and straight combine timing is a balancing act between minimizing shattering loss and the ability to deal with high moisture grain. Consideration should be given to harvest capacity of both the combine and grain drying equipment. For larger acreages or lower grain drying capacity, start combining at higher seed moisture content so that the harvest can be completed before the crop becomes too mature and shattering losses occur.

2.4 Moisture content

To limit seed loss from shattering and birds, hemp is combined green at higher moisture content than is safe for storage. This harvest stage also helps minimize the difficulties in handling drier fibrous stems. Moisture content of seed at harvest varies, with shorter grain varieties generally harvested with a slightly hard kernel and taller varieties at higher seed moisture content with a softer kernel.

Longer season varieties grow taller with harvest required at higher seed moisture content to minimize fibre handling problems in harvest equipment.

General harvest seed moisture content:

- Short season, i.e. Finola: 12 to 16 per cent
- Mid-season, i.e. CFX1/2: 14 to 18 per cent
- Full season, i.e. CRS-1: 18 to 24 per cent
- Longer season, i.e. Alyssa: 20 per cent or more

Hemp seed harvested tough (See Section 2.5) requires immediate aeration within three to four hours of harvest to maintain optimal quality. Heated hemp seed will oxidize resulting in poor quality oil and food products. Combine capacity should be matched with aeration and grain drying capacity. Safe storage moisture content is below nine per cent but some processors require storage at eight per cent moisture.

Grain Moisture Charts

While hemp seed is not a grain under the authority of the Canada Grain Act, the Grain Research Laboratory of the Canadian Grain Commission developed a moisture conversion table that allows conversion of temperature and meter readings to percentage moisture content. The conversion table for hemp seed is for Model 919/3.5 moisture meters.

<http://www.grainscanada.gc.ca/guides-guides/moisture-teneur/table-tableau/hemp1.pdf>

Conversion tables for other models may be available from the manufacturers.

2.5 Visual assessment

When hemp seed is harvested tough, the seed heads (buds) will still be mostly green. A few of the leaves on the seed head will be turning brown. The stem fibres will have shed most of their leaves, but have not completely matured, making the stem easier to handle with harvest equipment. The seed hull will become brownish and firm.

The seed head will dry from the bottom of the seed head towards the top. The seed at the junction of the stem and leaf stalk at the bottom of the seed head will ripen first and turn motley gray in appearance. The ripening of the seeds inside the seed head will start at the inside of the bud and move outwards. The bracts holding the seeds will dry out and shrink when the crop is ripening, exposing the seed and subjecting the seed head to shatter loss. Some of the leaves on the bud may turn purple as the crop matures.



Photo 6: Mature seed head

3. Seed Sampling For Delta-9-tetrahydrocannabinol (THC) Content

An approved sampler who is licensed with Health Canada and is a Professional Agrologist must sample industrial hemp crops. 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 per cent. Some processors arrange sampling and testing at bulk rates that are more cost effective for growers than arranging their own testing program.

The sampler must follow the Health Canada guidelines outlined in *Guidance on Sampling and Analysis of delta-9 THC (Tetrahydrocannabinol) in Hemp* to collect samples, dry them and submit them to an approved laboratory for analysis.

A complete description of sampling and testing protocols, including Accredited laboratories can be found on the Health Canada website at: <http://www.hc-sc.gc.ca/hc-ps/substancontrol/hemp-chanvre/about-apos/index-eng.php>

If the information is not readily available on Health Canada's website, ask your contracted processor.

3.1 Exemptions

Some industrial hemp varieties are exempt from testing for THC. A list of approved cultivars and those exempt from testing can be found on the Health Canada website or from your contracted processor.

Increasingly, cultivars are being exempted on an annual basis. In 2014 in Alberta, CRS 1, CFX 2, USO14, USO31, and Crag were exempted from annual testing as required under paragraph 16(1) of the IHR (Industrial Hemp Regulations). In total, eleven cultivars are exempt from THC testing in all Canadian Provinces. It is important to check with Health Canada when applying for a license to find out if you are required to sample and test the crop for THC.

Also check with your processor for the most up-to-date listing of exempt varieties. It is the responsibility of the grower to make sure the crop is sampled if it is not on the Health Canada exempt list.

Also note that exempt varieties are still subject to random testing by the Canadian Food Inspection Agency.

3.2 Timing

Sample timing is prior to harvest, when 50 per cent of the first seeds resist compression, normally in mid-July to mid-August, depending on seeding date, variety and geographic location.

THC content may rise as the hemp variety matures. Finola should be sampled about 60 to 80 days from seeding, as the THC content may rise as the crop matures towards 100 days and onward.

3.3 Reporting

Results should be reported to Health Canada on the required form within 14 days of receipt from the lab.

The approved sampler will take a representative sample of 60 plants from your field. Thirty plants will be left with the grower, while a portion of the other 30 plants will be sent to the approved lab for drying and testing. In the event that the test comes back over the legal limit, the original sample will typically be retested, and the farmer saved sample can also be tested.

If the field consistently tests over the legal limit, it will have to be destroyed.

4. Swathing

Swathing of hemp can be done in some circumstances but is dependent upon variety and environmental conditions. Generally, swathing is more common in southern Alberta as a risk management tool against shattering loss due to high winds. However, it carries considerable risk of seed quality loss and increased levels of microbial contamination if hail or rain flattens the swath onto the ground. Swathing should only be considered when the forecast is for dry weather during the next two to five days so harvest can be done prior to any rain.

Pros of swathing

- Reduction of shattering loss due to wind.
- Partial dry down of seed moisture content before combining.
- Potential reduction of aeration and drying requirements.

Cons of swathing

- Seed in contact with the ground may be subject to mould and bacterial development and coliform contamination causing quality loss and downgrading of seed.
- Rain may cause quality deterioration and germination in the swath.
- Risk of seed contamination with small stones, dirt, other foreign material, and manure.
- Standing hemp will dry faster in damp conditions than swathed hemp.
- Some combines are less able to handle the drier stem fibre reducing combine capacity.

Each field should be assessed for the potential for swathing. Finola hemp crops are suitable for swathing, if desired, as Finola is an early maturing, short variety with lower fibre volume. However, while Finola on dryland in southern Alberta may grow three to four feet high and allow swathing, irrigated Finola may grow 1.4 to 1.8 m (5 to 6 ft.) tall and require greater combine capacity if the crop is swathed. Moving further north, Finola may grow even taller, with reports of Finola growing up to 2.4 m (8 ft.) tall with longer daylength.

Mid-season varieties like CFX-1 and CFX-2 may sometimes be swathed depending on height and stage of development, but long season varieties like CRS-1 must be straight combined since the volume of straw would plug combines.

4.1 Swath and combine timing

Swathing can be carried out at 15 to 18 per cent seed moisture content prior to the bottom mature seeds shelling out. Swathing at seed moisture lower than 15 per cent means increased shatter loss. The crop is cut at 20 to 30 cm (8 to 12 in.) high.

After swathing, the crop may be left in the swath for two to four days to allow the seed moisture to drop by a few percentage points. The leaf matter will dry down. Left in the

swath much longer than two days and the stem fibre starts to dry down too much, turning into a rope-like material that can plug the combine. Under good environmental drying conditions, seed moisture may be down to 10 to 12 per cent at combining.

Common swathers with draper headers are suitable for swathing industrial hemp. New knives and guards are recommended to eliminate clogging of the cutter bar. Swather width will depend on swather and combine capacity. Some growers have built shields out of puckboard or sheet metal to help reduce build up of fibrous material on exposed belts, pulleys and other moving parts.

5. Combining and Straight Combining

Prior to harvest, ensure all equipment, including combines, trucks, augers, grain cleaners and storage bins are dry and free of foreign material. Purity standards are very high at 99.9 per cent, and contamination with other crops, especially wheat, weeds and foreign material can result in higher cleanout at the seed cleaner and reduced or rejected loads.

For most growers, straight combining is the preferred method of harvesting hemp for seed. The combine header is lifted to cut the crop just below the seed head, which typically is the top one-third of the plant (top 60 to 90 cm or 23 to 35 in.). This minimizes the volume of fibre moving through the combine, and reduces fibre wrapping and increases harvest efficiencies. Often, shorter plants in the canopy may not have mature seed and are not worth cutting low to get the seedhead. Growers have reported that crops over eight feet high are difficult to harvest.

Seed moisture content determines straight combine timing. Start harvesting when seed moisture content is 12 to 15 per cent for Finola and 14 to 20+ per cent for taller grain varieties. (See 2.4 Seed Moisture Section).



Photo 7: Straight cutting hemp

5.1 Combine equipment requirements

Typically, shorter hemp crops like Finola can be harvested with most modern combines with little or no modification. Use draper headers for straight combining as they feed the combine more uniformly. Fibre stems may wrap on auger headers. New knives and guards are important to eliminate plugging. Both batt and pick-up reels have been used.



Photo 8: Ready to straight cut hemp

Conventional and single rotary combines are preferred. Most growers use rotary or conventional John Deere or Case IH rotary combines. Larger capacity combines with conventional cylinders greater than 1.25 m (50 in.) help deal with the large, fibrous volume going through the combine. Dual rotary combines are less desirable as the risk of fibre wrapping and plugging of the opposing rotors is considerable.

Feeder chains, shafts and exposed moving parts should be regularly checked for wrapping. Disable the straw chopper to drop the straw and prevent wrapping and plugging of the straw chopper.

Combine fires are a risk from wrapped fibre on moving parts and fine dust igniting on hot surfaces. Frequently monitor for fibre wrapping and keep hot engine surfaces clean. Some producers keep a water truck handy during harvest.

Combine speed should be set to provide uniform crop flow through the combine to prevent plugging and wrapping. Carpet knives are handy tools for cutting away wrapped fibre.

Clean all equipment out at the end of the day to prevent pockets of seed from heating and mixing with the next day's harvest.

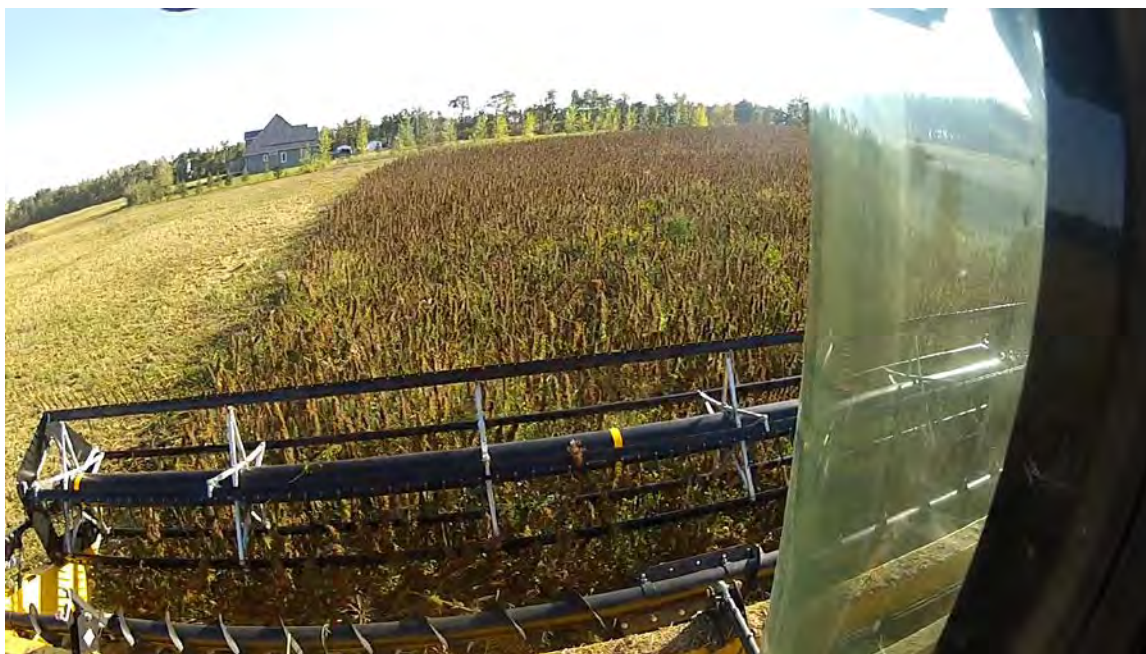


Photo 9: Straight cutting hemp

5.2 Combine modifications

Growers have found that some modifications help to reduce or prevent fibre wrapping:

- Exposed moving parts can be shielded with puckboard or sheet metal to prevent wrapping.

- Deflectors can be added to keep the crop away from header reel ends and to narrow the feed-house inlet to help keep fibre from wrapping on outer shafts and pulleys.
- ABS pipe can be placed over front drive shafts to prevent wrapping.
- Cables and hydraulic lines should be tied in close to the machine to help reduce fibre build-up.
- Extend header hydraulics by about 30 cm (1 ft.) to help raise the header higher for tall varieties.



Photo 10: Straight cutting hemp

5.3 General combine settings

Hemp seed is easy to thrash. The seed coat can be easily damaged, exposing the seed to oxidation of the oil, decreasing quality and risking possible rejection of the sample. Combines should be initially set to gently thresh the seed and adjusted as required to minimize seed loss out the back of the combine.

Cylinder speed: Initial settings should be similar to canola settings at around 450 to 500 RPM. Higher speeds may damage the seed and increase chaff going to the cleaning system.

Concave: With a seed size similar to wheat, standard small grain concaves are suitable. Set concaves similar to canola at 2.5 to 5.0 cm (1 to 2 in.). Wider settings are used for drier crops to help reduce seed damage.

Fan Speed: Depends on crop maturity. More air is required for higher seed moisture to keep sieves clean and to help blow out immature kernels. Less air may be required if chaff is drier. Slightly less air is required than for wheat at 650 to 800 RPM but fan speed may range can up to 900 RPM.

Sieve/Shoe: Setting similar to wheat and slightly wider than canola. Try 8 mm (0.25 in.) bottom setting and 9 mm (0.375 in.) chaffer setting.

Rotor speed: Similar to canola recommendations of around 350-500 RPM at 17 to 25 per cent moisture content. Faster speeds for drier crops. Some growers report Massey combines may require slightly faster rotor speeds. Push the pitch of the flow bars to maximum slope to move fibre through the combine as fast as possible. Excess rotor speed may overload the cleaning system with green material.

Rotor concaves: Best results with wheat concaves in the front and slotted concaves in the rear of the rotor cage.

5.4 Hemp seed handling

Hemp seed can be easily damaged, resulting in decreased seed quality. Damaged seed hulls are more vulnerable to rancidity. When moving hemp seed from combine to dryer to bin to seed cleaner to processor, handle hemp seed gently:

- When unloading combines, reduce unloading speed. This will mean no unloading on the go.
- Conveyors are recommended.
- If using grain augers, run at lower speed and ensure augers are full.
- Use larger diameter augers of 25 to 32.5 cm (10 to 13 in.) rather than smaller 15 to 17.5 cm (6 to 7 in.) diameter augers.

5.5 Sampling

Hemp seed processors require a bin grain sample after the grain has dried to their specifications. Hemp seed samples should be collected when moving grain into bin storage. Samples from each truckload should be taken at regular intervals and combined to create an overall representative sample for each bin. Submit the representative sample to your contracted processor according to their requirements.

6. Grain Storage

Hemp seed must be properly dried, stored and monitored to preserve grain quality. Heated or mouldy seed will result in the rejection of the seed for food use. Processors report that spoiled hemp is worth 44 to 55 cents per kg (20 to 25 cents/lb.) in the birdfeed market, substantially less than \$1.76 to \$1.98 per kg (80 to 90 cents/lb.) for conventional seed and \$3.08 to 3.23 per kg (\$1.40 to \$1.47 per lb.) for organic seed production according to 2014 prices.

Heating, sweating, evaporation and condensation may be excessive in parts of the bin leading to local pockets of mould growth (see Section 6.2). In the early stages of heating

seeds stick together and form lumps. This will lead to a rapid increase in free fatty acid content of the oil resulting in deterioration of oil quality. Heating in storage will lead to mould growth and, in some cases where the temperature is high, scorching of the seed will be obvious. Damage in the forms of heating or bacteria activity may also cause hot spots, fermentation and, in some cases, loss in weight.

Processors require specific moisture content for stored seed of eight to nine per cent, depending on processor. Contact your contracted processor for specific seed moisture requirements. Hemp seed may need to be stored for up to one year and even into subsequent years while processors source seed from their growers to meet their production demands. Properly dried and monitored hemp seed will store for one to two years without loss of food quality.

Hemp seed can rapidly heat, within two to four hours of combining and must be immediately put under aeration or through a dryer to preserve seed quality. If harvest speed is slow, do not allow hemp seed to sit in the truck at the side of the field for more than a few hours before getting it to aeration or drying facilities. Do not allow damp hemp seed to sit in the combine hopper or truck overnight.

The suitability of aeration or artificial grain drying will depend on the seed moisture content at harvest and ambient air temperature/humidity conditions.

It is essential to match grain drying and conditioning capacity to combine harvest speed. It is advisable to have excess grain drying capacity than to be under capacity and risk losing seed quality.

6.1 Storage type

When selecting storage systems for hemp, priority should be given to cleanliness, handling, conditioning and aeration capabilities. Hopper bins with aeration are the best choice. Flat metal bins with aeration flooring are also a good choice. Mini-bulk bags have been used to store hemp seed as long as the moisture content is eight per cent or less.



Photo 11: Hopper bin with aeration and grain dryer

Grain bags are not recommended as little information is available on hemp storage in grain bags and growers should consider other options to safely store their high-value hemp crop.

Health Canada regulations require hemp grain to be securely locked while in storage.

For general information on grain storage, go to ARD's *Grain Storage: Considerations – Report* at: [http://www1.agric.gov.ab.ca/\\$Department/deptdocs.nsf/all/sis15194](http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/sis15194)

6.2 Grain temperature and moisture migration

More dried grain loses condition because grain temperatures are not controlled than for any other reason. Improper control of the temperature inside the bin causes moisture to move or migrate from one part of the grain mass to another, where the moisture can accumulate and cause grain spoilage problems.

In the fall, when the air temperature decreases, the grain along the bin wall cools down faster than grain in the middle of the bin. The difference in temperature starts air moving down the bin wall and toward the centre of the bin. As the air moves through the grain it becomes warmer and begins to pick up moisture from the grain. When the warm moist air hits the cool upper surface of the grain, condensation occurs (Figure 4). Moisture will

concentrate on the sides of the bin and the cone at the top during the fall and winter. Flattening the cone can help prevent moisture buildup.

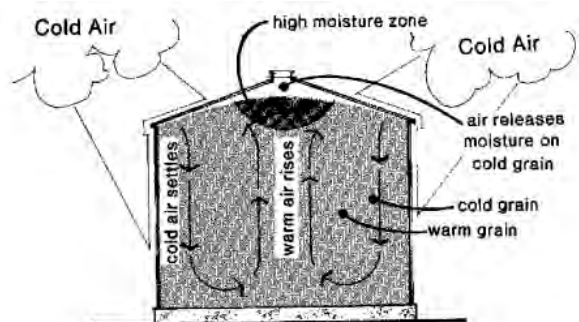


Figure 4.

In the spring moisture migration is reversed. The warming action of the sun on the outside of the bin causes moisture currents to move up the bin walls and then down the centre of the bin. Moisture condensation occurs at the centre of the bottom of the bin (Figure 5.)

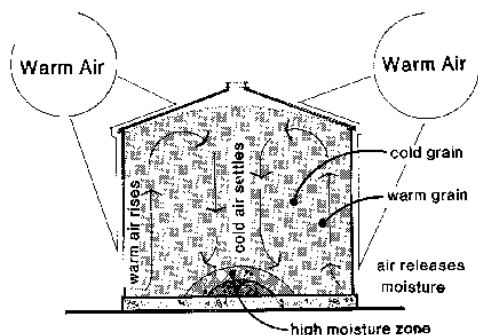


Figure 5.

Hemp should be rotated when seasons change, fall to winter, and winter to spring, to minimize moisture migration and spoilage. This is done by removing the grain from the bin and rotating it back into the bin. The grain temperature equalizes and moisture fronts are broken up to help stabilize air movements.

For general information on managing grain in storage, go to the following links. While the information is not specific to hemp, it provides a good overview of storage, conditioning, aeration and drying of grain.

Management of Cereal Grain in Storage:

[http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/agdex4509?opendocument](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex4509?opendocument)

Cereal Grain Drying and Storage:

[http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/crop1204](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/crop1204)

Storage of Canola: [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/crop1301](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/crop1301)

6.3 Aeration

Full floor aeration or rocket systems in hopper bins are suitable for aeration to cool and dry hemp seed. Hemp seed is large, similar to wheat, and air moves through it easily.

One to three weeks of aeration is required to dry grain, depending on ambient conditions, grain moisture, fan and bin capacity. For nearly dry seed under 12 per cent moisture, a tube aeration system with medium fan capacity may be adequate. If ambient conditions are unfavourable, the addition of artificial heat with a propane heater can help dry grain down more quickly.

At higher seed moisture, a grain dryer may be required to dry the grain down to mid-teens and then a good aeration system using a full floor screen and high capacity fan, plus turning or moving the grain once or twice may be required to keep the grain cool and conditioned.

For aeration systems, a hopper bottom bin with a large capacity fan of five to 10 hp and a 100,000 BTU propane burner to add artificial heat is one of the best systems for drying hemp seed. Caution must be used when applying supplemental heat. Use low heat less than 35C to ensure the seed does not overheat.

Do not overfill aeration bins as the hemp seed may heat before the grain is dried and cooled to safe storage conditions. For seed below 20 per cent moisture, fill to less than 50 per cent capacity. Fill to no more than one-third bin capacity if seed moisture is above 20 per cent.



Photo 12: Aeration fan ready to be mounted

The general rule of thumb for fan hp requirements, provided by processors, is that one hp of fan is required for 150 to 200 bushels in good drying conditions for grain five to six percentage points above dry. For example, a 5 hp fan will efficiently dry down 750 to 1000 bushels of 15 per cent moisture seed in a 2000-bushel bin.

Once aeration has commenced, processors have found that turning 17+ per cent moisture grain within 24 to 48 hours, and mid-20s moisture grain within 24 hours will help keep grain in condition. Continue aeration and monitoring.

If any heating or crusting of grain is observed, the seed should be immediately pulled out of the bin and dried.

6.4 Artificial heat drying

In many installations a continuous drying system will not be able to handle the seed at the same rate at which it is being combined. Temporary holding of the wet seed will be necessary and it is very important to make provision for cooling in the pre-drying stage. Ventilation with ambient air at the rate of 0.6 to 0.8 m³/min/tonne should be adequate. At a depth of 1.5 m this would require a pressure of 2.5-5cm w.g.

For growers with artificial heat grain dryers, hemp seed can be quickly dried down to safe storage levels. Batch and continuous flow grain dryers are suitable. Batch dryers have an increased risk of developing hot spots during drying. Continuous flow grain dryers are recommended.

Use moderate heat. Plenum temperatures around 45C and air temperature in grain of about 35C. Overheating the seed can cause the seed to turn yellow and degrade the oil quality.

The seed should be cooled down to ambient air temperatures after drying prior to bin storage.

6.5 Monitoring

As a high-value crop, hemp seed should be frequently monitored during the first six weeks in storage to ensure the crop retains its quality. Continue to regularly check until delivery. Hot spots may develop that could mix with the entire bin and result in the complete loss of the bin.

The best monitoring system is a well-designed bin system with cables and automated monitoring. A cable system will help ensure hot spots are detected early with minimal effort. One cable can monitor a bin diameter of 6 to 7.2 m (20 to 24 ft.), but more cables will provide better coverage. Larger bins will require more cables.

Alternatively, probing grain bins frequently at multiple points will allow a grower to monitor each bin. Probing, though, usually only accesses the grain near the bin door at the bottom and the top access doors. Hot spots may be missed.

If hot spots are detected, the bin should be turned and aerated to cool the grain.

7. Seed Cleaning

Once the processor calls for delivery, hemp seed must be cleaned prior to delivery. Each processor has preferred seed cleaners, and each seed cleaner must be licensed by Health Canada to handle hemp seed.

Truckers must be licensed to haul hemp seed from farm to cleaner to processor.

Ensure all grain handling equipment is cleaned, including augers, conveyors and trucks. Seed cleaning equipment will also need to be thoroughly cleaned to ensure cross contamination with other grains, especially wheat, does not occur.

Most seed cleaning equipment, including air and screen, indent and gravity tables, are suitable. Color sorters are becoming more common for ensuring the seed meets the strict quality specifications of 99.9 per cent purity. Purity is a key issue with hemp seed, as some processors try to meet gluten-free status.

A representative sample of the cleaned hemp seed should be collected after cleaning and submitted to the processor according to their requirements.



Photo 13: Cleaned hemp seed sample

Hemp seed is usually shipped directly from the seed cleaner to the processor. Upon arrival at the processing plant, another sample is collected by the processor and assessed for purity and quality. Rejected seed may be returned to the grower.

8. Fibre Harvest

Currently, markets for hemp fibre do not exist in Alberta, although several projects are in the planning/building stages. As each fibre processor may have their own quality requirements, growers should contact these processors to determine fibre harvest and handling.

8.1 Seed/fibre harvest

For dual purpose seed and fibre production, the crop will have either been swathed or straight cut. The target market for fibre will dictate how the left over fibre and stubble will be handled.

For hemp that is swathed and then combined, the fibre will be left in windrows for baling or retting. The retting process may take all winter, so baling may be left until spring.

Straight cut hemp will generally have tall stubble left behind varying from 0.6 to 2.4 m (2 to 8 ft.) high. The remaining stubble should be cut with a swather or haybine within several days if the windrow is going to be baled.



Photo 14: Hemp baling

In Alberta, some growers bale the left over fibre and have found local markets for the straw in feedlots and other applications. Some growers are also stockpiling the straw in anticipation of fibre markets developing.

Hemp stubble and straw fibre is similar to flax and can cause difficulties during seeding the following spring. Some growers burn the stubble and straw as a last resort, but this practice has environmental consequences. Another practice is to leave the hemp stubble

standing over the winter. The stubble decays at ground level and can be raked into piles with heavy harrows in the spring and then burned.

The best approach is to double disc the remaining stubble into the ground to help minimize seeding difficulties the following year. The success of this practice will depend on the type of seeding system the grower uses.

8.2 Fibre only harvest

When hemp is grown for only fibre, the crop is typically harvested around the early flowering stage when fibre volume is maximized, which is generally early to mid-August. This harvest timing may vary by processor.



Photo 15: Stand of fibre hemp

Hemp fibre crops are generally well over 2.4 m (8 ft.) tall and can reach up to 3.5 m (12 ft.) high. Equipment used for cutting hemp must be able to accommodate this large volume. Standard swathers generally can not handle hemp fibre crops. Research by Alberta Innovates Technology Futures and ARD have found that a sickle bar and disc bine work well for cutting hemp for fibre.



Photo 16: Cutting hemp with a sickle bar and swather

A number of companies are looking at Canada as a potential location to source hemp fibre for higher value applications such as textiles and composites. This may result in stronger value propositions for growing varieties that produce better biomass. If these companies commercialize in Canada, farmers may want to consider specialized hemp fibre harvesters. Several Internet videos feature such harvesters, at both prototype and commercial stages.

InCrops hemp harvester

https://www.youtube.com/watch?v=YKVFyZAF_-o

HempCut 3000 and 4500

Rotary header with cutting drum adapted to self-propelled Claas forage harvester

<https://www.youtube.com/watch?v=kwE5-pytRdk>

Tabeco Clipper 4.3 MMH

Cutting bars mounted at three different heights.

http://www.dailymotion.com/video/x738c2_07-09-12-video-clipper-4-3-mmh-3-cu_tech

Kemper

300 and 400 harvest headers

<http://www.kemper-stadtlohn.de/en/home/products/harvesting-headers.html>

Dehondt flax harvest equipment

http://www.dehondt-lin.com/default.asp?file=pg82-1_EN

9. Baling and Fibre Storage

Expedient cutting and baling will minimize fibre wrapping and allow better baling efficiencies. If retting is desired a considerable time between cutting and baling may be necessary. Sisal or hemp twine should be used as poly twine can contaminate the fibre. Plastic net wrapping can be used as it is easily removed. Information from Ontario Ministry of Agriculture, Food and Rural Affairs indicates that stalk moisture should be

less than 15 per cent at time of baling, and should continue to dry to about 10 per cent in the bale. Once moisture is under 15 per cent no more retting will take place. Round bales may be stored outdoors for a number of years in prairie conditions, but big square bales absorb more rainfall and must be stored under cover to prevent rotting.

No observations have been made to date on bales stored under plastic, but experience with hay storage indicates that moisture would be wicked up from the ground and some spoilage would take place unless the bales are separated from the bare ground. This often occurs even on deep gravel floors indoors. Hemp straw also absorbs air moisture quite readily.

Larger round balers, solid or hollow core, and large square balers are adequate for baling hemp straw. Large round bales with hard cores may be the best as they are denser and will not pick up moisture during storage.



Photo 17: Hemp bales stockpiled

Some processors may require large square bales to facilitate easy handling. Because of their large surface area large square bales will absorb rainfall where round bales will shed rainfall. Spoilage is a much larger concern for large square bales if not covered.

10. Retting

Retting is a microbial process that breaks the chemical bonds that hold the stem together and allows separation of bast fibres from the inner white core hurd. Bast fibres are used for textiles, rope, twine, paper, and many other uses. The hurd can be used in livestock

bedding, pulping and building supplies. Retting is used to more easily separate bast from hurd during decortication at the processing plant. After retting, the straw is typically baled and transported to the processing plant, or stored until required.

There are several types of retting, including field, water, chemical and enzyme. Fibre processors may have different retting requirements and should be contacted to ensure the retting process meets their needs.

10.1 Field retting

With field (or dew) retting, plant stems after harvest are left in the field to rot. Although varying weather conditions affect the quality of fibre, field retting has been used extensively in Europe for hemp because it is inexpensive, mechanized, and does not use water. Research into retting time under diverse moisture conditions in different regions of Alberta for production of high quality fibre is needed.

The length of retting time is normally 21 to 28 days when industrial hemp is cut for fibre during the late summer. Dry August weather may require longer retting.

Research is required to determine if the retting process could be improved by turning the swaths during the retting period. Health Canada regulations require leaves to be removed from the stem, and left on the field. Turning of the swath may be required to remove the leaves.

Long cold snowy Alberta winters may be valuable for winter retting. It has potential to combine the benefits of the two traditional approaches including low costs of field retting and the production of high quality bast fibre typically achieved in water retting. Preliminary observations at Alberta Innovates Technology Futures made over the last two years strongly indicate that winter retting could be a viable option for production of high quality bast fibre in Alberta. However, details of practicality and process efficacy need to be experimentally proven.

In Alberta, retting of fibre left over from seed harvest will likely require overwinter retting. In southern Alberta late fall weather is typically very dry and retting may not occur prior to winter. In northern Alberta, seed harvest may be too late for retting prior to winter's onset.

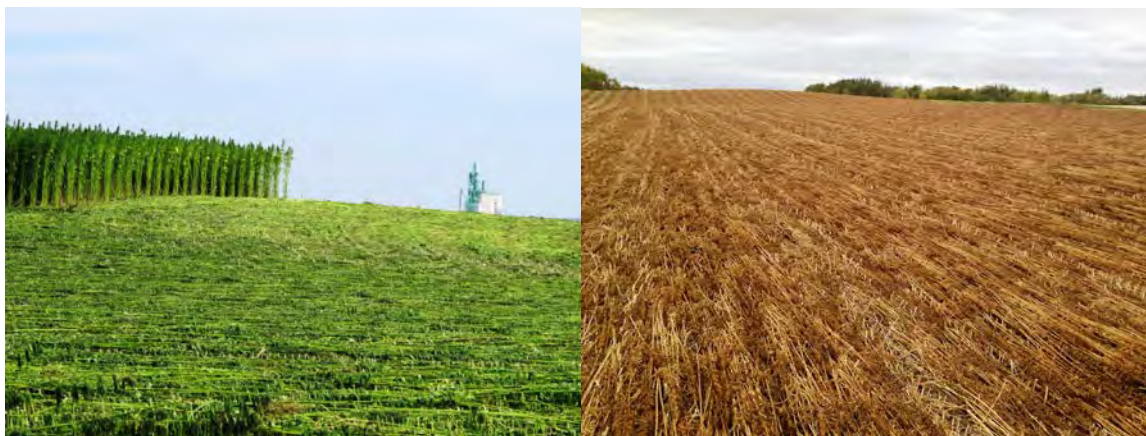


Photo 18: Field retting - beginning of retting and more advanced retting

10.2 Water retting

Water (ponds, rivers, etc.) retting produces more uniform and high-quality fibre, but the process is very labor and capital intensive. Water retting can be done in tanks where water flows in for seven to 14 days. Heating tanks to between 30C to 40C can reduce the time further. Chemical additives may be added to enhance the process. The disadvantage of this process is very high water consumption and considerable effluent production. Further drying of fibre is also required.

10.3 Chemical retting

Chemical retting is commonly performed using a sodium hydroxide solution with or without a chelating agent e.g. EDTA. This method possesses all the advantages of water retting and field retting. It can be accelerated to just a few hours. However, this method is generally expensive and not used widely.

10.4 Enzyme retting

Enzyme retting replaces the bacteria and facilitates fermentation in water retting with enzymes.

11. For Further Information

Industrial hemp is an emerging crop in Alberta. As more growers look into the potential of hemp for food and fibre, a network of information and research is developing.

11.1 Alberta Agriculture and Rural Development

Harry Brook, Crop Specialist

[Alberta Ag-Info Centre](#)

Provincial Building, 4705 – 49 Avenue

Stettler AB TOX 2LO

Phone: 403 742-7955

Fax: 403-742-7527

Email: harry.brook@gov.ab.ca

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)

11.2 Alberta Innovates – Technology Futures

Jan Slaski, Ph.D., P.Ag. (Dist.)

Team Leader – Crop Development and Management

Senior Researcher – Plant/Crop Physiology

Ecosystems and Plant Sciences

Alberta Innovates - Technology Futures

P.O Bag 4000

Vegreville, Alberta, T9C 1T4

Office: 780-632-8436

Fax: 780-632-8612

jan.slaski@albertainnovates.ca

www.albertatechfutures.ca

Byron James

Supervisor Fibre Processing Plant, Pilot Facilities

Bio-Resource Technologies

PO Bag 4000

Vegreville, Alberta T9C 1T4

Byron.James@albertainnovates.ca

Office: 780-632-8219

Mobile 780-632-1006

Fax: 780-632-3829

11.3 Food Processors

Hemp Oil Canada Inc.

www.hemipoilcan.com

Manitoba Harvest

<http://manitobaharvest.com/>

11.4 Web Links

Health Canada Industrial Hemp: <http://www.hc-sc.gc.ca/hc-ps/substancontrol/hemp-chanvre/about-apropos/index-eng.php>

Canadian Hemp Trade Alliance

www.hemptrade.ca

Manitoba Agriculture, Food and Rural Development

Industrial Hemp Production and Management

<http://www.gov.mb.ca/agriculture/crops/production/hemp-production.html>

Saskatchewan Ministry of Agriculture

Hemp Production in Saskatchewan

<http://www.agriculture.gov.sk.ca/Default.aspx?DN=e60e706d-c852-4206-9959-e4b134782175>

Ontario Ministry of Agriculture, Food and Rural Affairs

Hemp in Ontario

<http://www.omafra.gov.on.ca/english/crops/hort/hemp.html>

European Industrial Hemp Association

<http://eiha.org/>

Finola EU

www.finola.com