



# Industrial Hemp: A Guide

Growing, Harvesting, Infrastructure & Costs



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## Industrial Hemp Basics

Industrial hemp is made up of varieties of cannabis sativa that contain less than 0.3% THC. It is an annual broadleaf plant with a taproot and is capable of very rapid growth under ideal growing conditions. The female flowers and seed set are indeterminate, meaning that the seeds continue to develop and mature over an extended period of time. This means there are both ripe and immature seeds on the same plants at time of grain harvest.

When grown as a fibre crop, hemp may grow to a height of 2-4 m without branching. In dense plantings, the bottom leaves atrophy due to the exclusion of sunlight. Male plants die back after shedding pollen.

The stem has an outer bark that contains the long, tough bast fibres. They are similar in length to soft wood fibres and are very low in lignin content. These give the quality and strength for which hemp is renowned. The core contains the hurds, or short fibres, similar to hard wood fibres, that are useful in applications like particle board, building blocks and hemp concrete, etc .

For grain production, the plants may branch and reach heights of only 2-3 metres. Tall plants do not necessarily produce more grain than short ones. Shorter plants are preferred for combining.

In well-structured and well-drained soils, the taproot may penetrate 15-30 cm deep. In compacted soils, the taproot remains short and the plant produces more lateral fibrous roots.

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# Hemp Fibre Advantages And Benefits

Overall, hemp is arguably superior to other natural fibres, both in terms of cultivation and application. Its many advantages include:

- Fewer inputs required to grow and less water needed than cotton.
- Industrial hemp is pest and disease resistant; partly due to the fact it grows so fast
- Low lignin levels enable environmentally friendly bleaching without the use of chlorine
- Far more fibre can be harvested from hemp than cotton or flax using the same amount of land
- It is one of the strongest natural fibres
- Less stretch, so clothing retains its shape
- It's softness increases with use
- When dyed, it retains colour better than cotton
- A great insulator
- Anti-bacterial properties
- Excellent breathability
- High abrasion resistance
- Resistant to mould and mildew
- Superior UV blocking attributes



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# Hemp Varieties

There are several industrial hemp varieties suitable for growing in Southern African nations which have been tested, or are almost at the end stages of tests. These tests are necessary because industrial hemp is a new crop in these countries and there are a variety of unique growing conditions not found in other countries where the crop is grown more widely.

Each industrial hemp variety has its own set of characteristics: small or large seed; higher or lower oil content; different oil composition, etc. Varieties grown for fibre may contain from 15%-25% of bast fibres. As markets develop, contracts to grow industrial hemp may specify the exact varieties that will be grown to meet specific market needs.

There are two types: Dioecious, which have male and female flower parts on separate plants (e.g., Kompolti and Unico B), and Monoecious, which have male and female flower parts on the same plant (e.g., Ferimon and Futura). A third type of cultivar, known as Female Predominant, is a dioecious type that has 85%-90% female plants. It is believed this type can produce a higher yield of grain.

## Dual Purpose Cultivars

Some cultivars, mainly of French and Romanian origin, are suitable for both grain and fibre production. These tall cultivars present some challenges for harvesting. Growers need also to consider that weather conditions after grain harvest may not be suitable for retting and drying of the stalks, so planting dates need to be planned carefully [see Retting and Turning]. The FIN 314 variety, which will grow to a maximum height of 0.9 metres, and other short stalked grain types (1-1.5 metres) are not suitable for dual production. Industry trends seem to be moving toward specific grain or fibre varieties.

**Planting rate is recommended at 45 kg/ha**

## Soil Conditions

Hemp grows best on a loose, well-aerated loam soil with high fertility and abundant organic matter, with a pH of 6.0-7.5. Well-drained or tilled clay soils can be used, but poorly-drained clay or poorly structured soils often results in establishment failures, as seedling and young plants are prone to damping-off. Sandy soils can grow good hemp with adequate irrigation and fertilization but these additional costs often makes production uneconomical, if the grower is reliant on expensive to run diesel powered water pumps and does not take advantage of the fact that hemp can quickly be grown and used as a green manure crop.

Young plants are very sensitive to wet soils or flooding during the first 3 weeks or until growth reaches the fourth internode (about 30 cm. tall). Water-damaged plants will remain stunted, resulting in a weedy, uneven and poor crop.

Conversely, poorly structured, drought-prone sandy soils provide very little natural fertility or support for the plant. Accordingly, extra nutrients and water are required to achieve maximum yields on these soils. Therefore it is important to time planting to take advantage of rainy seasons. Also, to add body, fibre and nutrients to sandy soil, hemp crops may be grown as a green manure before the main hemp crop. The addition of biochar will also increase soil fertility and crop yield for all types of crops.



## Seedbed Preparation and Planting

For optimum germination, industrial hemp seed requires good seed-to-soil contact. The seedbed should be firm, level and relatively fine; similar to that prepared for direct-seeded forages. The soil can be worked and planted as soon as the ground is dry enough to avoid compaction. A shallow, firm seedbed allows seed to be placed at a uniform depth, resulting in a more even seedling emergence. Industrial hemp is normally sown using a standard grain drill. Plant seed at a depth of 2-3 cm. Optimum soil temperature at that depth for fast germination will vary, depending on the variety of seed.

Industrial hemp that is planted for fibre is usually sown in 15-18 cm rows, using every run of the drill. Optimum final stand is about 200-250 plants/m<sup>2</sup>. Early seeding (as soon as soil conditions are appropriate) is recommended. Researchers recommend a minimum seeding rate of 250 seeds per m<sup>2</sup>. Planting rate is recommended at 45 kg/ha. This could be higher if germination is low and seed is large. The table below shows how the seeding rate changes according to seed size and density (weight per 1000 seeds) for most varieties. Seed density is specific to each variety, and is more or less constant from year to year. Seed density information should be available from the seed supplier.

For grain production, desired final plant population is around 100-150 plants/m<sup>2</sup>. Like fibre hemp, seeds are still planted in 15-18 cm rows. Soil temperature determines the optimum planting date.

Seeding rate based on seed size and density

Weight (grams) of 1000 seeds	Seeding rate (kg/ha) to get 100 seeds/m <sup>2</sup>	Seeding rate (kg/ha) to get 150 seeds/m <sup>2</sup>	Seeding rate (kg/ha) to get 200 seeds/m <sup>2</sup>	Seeding rate (kg/ha) to get 250 seeds/m <sup>2</sup>
10	10	15	20	25
12	12	18	24	30
14	14	21	28	35
16	16	24	32	40
18	18	27	36	45
20	20	30	40	50
22	22	33	44	55
24	24	36	48	60
26	26	39	52	65

## Climatic Conditions

Hemp requires a lot of moisture. Measurements indicate the crop needs 300-400 mm of rainfall equivalent. Since that amount of rainfall may or may not occur during the growing season, it is important to plan for rainy seasons and make use of early soil moisture and to obtain early ground cover to reduce surface evaporation, as well as to maintain good weed control.

About half of this moisture is required during flowering and seed set in order to produce maximum grain yields. Drought during this stage reduces seed set and produces poorly developed grain heads. Continued drought results in low yields of light grain.

During the period of vegetative growth, hemp responds to daytime high temperatures with increased growth and increased water needs. After the third pair of leaves develops, hemp can survive daily low temperatures as low as  $-0.5^{\circ}\text{C}$ . for 4-5 days.

Once established, industrial hemp is a very hardy plant, able to be grown in areas where other crops will fail. It can withstand periods of drought, heat and frost and also be cultivated without pesticides or other chemicals in many instances. It does not have huge water requirements or a great need for ongoing care. The plant grows quite quickly, achieving heights of 4 metres in four months, depending on variety.



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# Fertility

Hemp requires approximately the same fertility as a high-yielding crop of wheat. Research is continuing to define the exact nutrient requirements. Apply up to 110 kg/ha of nitrogen, depending on soil fertility and past cropping history. Research to date supports the application of 40-90 kg/ha of potash for fibre hemp. Applications of phosphorus (P205) and potash (K20) applications should be based on a recent soil test from the planting area.

Hemp growers in some places may benefit from adding sulphur. It is important to balance the nutrients applied with the crop requirements and with each other. Excessive nitrogen, combined with inadequate potash, for example, can result in stalk breakage and loss of the crop.

Unlike some crops, industrial hemp can give back to the land, even while it is being grown for cash crop purposes. This can occur when retting hemp in the field for fibre and even when the plant being grown for seed, as the fallen leaves add nitrogen. About 42% of the plants' biomass returns to the soil in the form of leaves, roots and tops. These contain over half of the nutrients applied to the crop. Many of these nutrients will be available to help feed the following crop.



## Weed Control In Hemp Farming

If hemp is planted in well-drained, fertile soil under nearly optimum temperature and moisture conditions, it will germinate quickly and reach 30 cm in 3-4 weeks from planting. At this stage it will give 90% ground shade. Weed growth is suppressed by the exclusion of light from the soil. Rapidly growing hemp, at a final population of 200-250 plants/m<sup>2</sup>, will suppress almost all weed growth.

Weed suppression is not a permanent condition. Weeds may appear on the same field next year if the field is rotated out of hemp production. Perennial grasses may be weakened or killed if hemp is grown a second year on the same ground. However, this practice increases the opportunity for crop diseases to develop.

Under grain production conditions, weed suppression may be less complete. The lower plant population or uneven stands allow more light to penetrate the canopy, aiding the germination of weed seeds. Cross seeding may improve canopy distribution and subsequent weed control where very early, shorter varieties are grown.

Early planting, as soon as the soil is warm enough, is a recommended weed control strategy.



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## Pests and Diseases

More than 50 different viruses, bacteria, fungi and insect pests are known to affect the hemp crop. However, hemp's rapid growth rate and vigorous nature allow it to overcome the attack of most diseases and pests.

As the cultivation of industrial hemp and alternative disease hosts will increase in a given area, the population of disease or pest organisms will also tend to increase. The following pests may possibly, in the future, affect hemp fields in Southern Africa, though this is subject to further research:

Botrytis Cinerea (grey mould) and Sclerotinia Sclerotiorum (white mould) are common moulds affecting industrial hemp. Sclerotinia also affects edible beans, canola and sunflowers. It has been found on more than 10% of plants where industrial hemp followed canola. Sclerotinia spores (sclerotia) may be spread by combines, other harvesting equipment and straw.

Fusarium, the pink mould found on corn and wheat, has been seen on the roots of hemp plants. The effect that an additional host crop will have on the viability of these crops may not be known until industrial hemp is grown more intensively in bean and canola-growing areas.

Crop rotation would appear to be a good cultural practice to avoid disease build-up until more is known about hemp's susceptibility to disease organisms. A 4-year rotation is recommended. Do not grow hemp on the same fields following canola, edible beans, soyabeans or sunflowers.

Wind and hail damage can be significant to the industrial hemp crop. Tall plants with lots of upper leaf mass can be bent quite easily by heavy storms. Broken plants will recover partially if not broken too low. This results in significant variability in plant height and maturity at seed harvest time. Small plants damaged by hail recover quickly and develop quite normally if they are not severed below the first node. Weather stresses may result in higher THC levels in the remaining crop.

Quelea bird swarms can result in significant losses in grain yields where a hemp crop is grown for seeds.

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## Harvesting Hemp

The quality of hemp fibre depends greatly on whether the crop was grown primarily for textiles, or is dual-purpose. Dual purpose crops produce fibre and seed; with the seed being used for food, biofuels and other applications. A crop grown specifically for fibre will generally produce a higher quality product than a dual-use crop.

The time at which industrial hemp is harvested is also crucial in the quality of the fibre produced. Hemp grown specifically for this purpose is usually harvested 70-90 days after seeding; early in the flowering stage and well before seed is produced.

Dual purpose hemp crops are harvested later and the fibre isn't usually used for textiles; but instead for pulp, paper and non-woven products due to the higher lignin content. When harvesting, the plants are cut at 2 to 3 cm above the soil line and then allowed to dry for a few days.

Crop Yields: As an example, air dry stem yields in Ontario, Canada, have ranged from 2.6-14.0 tonnes of dry, retted stalks per hectare (1-5.5 t/ac) at 12% moisture. Yields there have averaged 8.75 t/ha (3.5 t/ac). Northern Ontario crops averaged 6.1 t/ha (2.5 t/ac) in 1998. Researchers feel earlier planting, optimum production management and more suitably adapted varieties can result in higher yields. Approximately one tonne of bast fibre and 2-3 tonnes of core material can be decorticated from 3-4 tonnes of good quality, dry retted straw.

Yield of fibre depends on both the stalk yield per hectare and the fibre content of the stalk. Varieties differ in the amount of actual fibre they contain, and on the ratio of bast fibre to core materials (hurds). Dioecious varieties originating in southern Europe give the highest stalk yields. Further processing may be required to attain the quality of fibre needed for some end uses.

For textile applications, cut hemp in the early flowering stage or while pollen is being shed, but before seed sets. Fibre that is cut after seed harvest will have lignified considerably and is usable only in some non-woven industrial fibre applications. In dioecious varieties, the male plants die back after shedding pollen. This results in lower fibre yields if the straw is cut after grain has matured.

On small acreages, good quality sickle-bar mowers and hay swathers have been used to cut hemp. Frequent plugging has been a constant problem with this equipment. It is important to keep knives sharp and in good repair at all times. As acreage increases, more sophisticated equipment may have to be imported or developed.

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## Retting, Turning & Fibre Separation

Retting is the process of beginning to separate the bast fibres from the hurds or other plant tissues. It is done in the field, taking advantage of the natural elements of dew, rain and sun, or under controlled conditions using water, enzymes or chemicals. The method chosen depends on the end use to which the fibre will be put. Suitable industrial processes for water and chemical retting have not yet been developed.

Successful field retting requires a delicate balance of nightly dews and good daytime drying conditions. Planting date and selection of variety are factors in predicting a suitable harvest date.

The length of the retting process is critical for optimum fibre yield and quality. It normally takes 21-28 days to complete, but dry weather with low dew conditions may necessitate longer retting periods. Occasionally, the process may take as little as 14 days.

The windrows are turned vigorously once or twice with a tedder or rake to facilitate even retting of the windrow and to knock the leaves off the stems. It is important that the retting process be complete before baling, so that the fibres reach the desired colour, and do not rot or discolour in storage. In wet conditions, a third turning may be necessary.

Fibre Separation - In a process called “breaking”, stalks are passed between fluted rollers to crush and break the hurd into small pieces, separating some of the fibre in the process. Once a very involved and labour intensive process, separation of the bast from the hurd has been somewhat simplified through a machine called a decorticator.

Decorticators enable the leaves to be left on the stalks during the breaking, although this makes for a messier process requiring more sorting after completion.

A further process called “scutching” beats and scrapes the fibre bundles, separating more short fibre and the remaining hurd material from the long fibre.

## Baling and Storing

Baling can be done with any kind of baler. Large round, soft-core balers may be most satisfactory in allowing bales to dry more quickly in storage. For some industrial processes, the buyer may require a uniform large, square bale to fit into the processing system. This may present a challenge in preventing spoilage if the bales are stored for later delivery, because square bales are packed more tightly, allowing less air passage, than round bales. Sisal or hemp twine must be used to tie bales because polyester and plastic twines become contaminants in the processing of hemp fibres.

Bales must be stored indoors under dry conditions to stop the retting process before the fibres become rotted. Stalk moisture should be less than 15% at time of baling, and should continue to dry to about 10%. 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.



## Hemp Seed Harvesting & Harvesting The Fibre

When industrial hemp is grown for both grain and fibre, it is necessary to re-cut the tall stalks after combining. A combine can be modified to perform both functions at the same time by mounting a sickle-bar mower under the header to operate close to the ground. It is expected that, as markets for grain and fibre begin to differentiate, dual harvesting will cease to be a common practice. Growers of small acreages will most likely continue to combine and cut stalks as 2 separate operations.

If straw is to be harvested after combining, it is important that the weather conditions must also be suitable for drying the stalks for baling. The fibre from the mature stalks after grain harvest will be lower in quality and high in lignin. Such fibre would be suitable for manufacturing into composites, non-woven mats, particleboard, and possibly for pulping.



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## Fibre Types

The short fibres produced during the separation process are known as tow and the long fibres are called line fibre.

Line fibre can be incredibly long – depending on the height of the plant, a single strand may be up to 5 metres in length.

Once separated, the line fibre is cleaned and carded to size, cut and bailed; ready to be further processed and spun. The tow fibre is just compressed and bailed.

Hemp tow is used for stuffing or coarse yarn spinning and line fibre for higher-end applications such as clothing fabrics, furnishing and floor coverings. Fabrics made from line fibre can have a texture similar to linen; very different to the feel of wearing something akin to a hessian sack that some people may have experienced with hemp clothing



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## Combining Hemp For Seed

Combining hemp provides a special challenge to both the combine and the operator. In tall varieties, large quantities of plant material are put through the combine. Hemp straw contains very tough fibres that tend to wind around moving parts. Fine fibres work into bearings, causing friction that can lead to bearing breakdown and combustion. These factors cause heavy machinery wear, high maintenance costs and a great deal of time loss and frustration on the part of the operator. Early grain varieties are shorter and easier to combine.

Industrial hemp seed is harvested when the seed begins to shatter. At this optimum harvest time, about 70% of the seeds are ripe and about 22-30% moisture. Later combining results in increased grain losses due to shattering, bird damage and lower quality grain. Mature fibres tend to wrap more tenaciously around moving parts on the combine.

Raising the cutting blade to about 1 metre, or as high as the header will cut effectively, reduces the amount of material entering the combine. With shorter varieties use a “closer to normal” header position. The header knife must be kept sharp at all times to minimize winding of fibres on the sickle bar. Replacing the slatted feeder conveyor with a belt helps reduce the amount of fibre that winds on the feeder shaft. Exterior rotating shafts and pulleys that may come in contact with stalks should be protected when harvesting taller varieties.

Proper setting of the combine improves the yield and quality of the grain and reduces wear on the combine. Experiment with ground speed, concave openings, air and cylinder speeds. The following settings are suggested for conventional combines: cylinder speed at 250 rpm, fan speed at 1070 rpm, 3.2 mm sieve and 9.5 mm chaffer, concave set tight. Run feeder housing chain loose in the corn position and close the pre-cleaner. Lower the beater grate, remove the curtains and install a speed-up kit for the beaters. Individual combine operators might find different settings work for their machines. Rotary combines seem to be less satisfactory for harvesting hemp grain because of a tendency to plug more readily.

Reported grain yields in, for example, Canada, have ranged from 300 to 1300 kg/ha at 12% moisture, after harvesting and cleaning. Higher yields may be possible as varieties and production technology improve.



## Equipment & ROI

Industrial hemp is made up of varieties of cannabis sativa that contain less than 0.3% THC. It is an annual broadleaf plant with a taproot and is capable of very rapid growth under ideal growing conditions. The female flowers and seed set are indeterminate, meaning that the seeds continue to develop and mature over an extended period of time. This means there are both ripe and immature seeds on the same plants at time of grain harvest.

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Nominal Nett Profit Per Acre [North Carolina USA] 2016	
Corn/Maize	\$350
Soybeans	\$250
Cotton	\$400
Tobacco	\$1200
Industrial Hemp Fibre	\$800
Industrial Hemp Seed	\$1500
Industrial Hemp Oil	\$2000

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‘Industrial hemp has been scientifically proven to absorb more CO<sub>2</sub> per hectare than any forest or commercial crop and is therefore the ideal carbon sink’

[The Role of Industrial Hemp in Carbon Farming](https://hemp-copenhagen.com)

<https://hemp-copenhagen.com>

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