About the Fiber

There are numerous uses for hemp fiber: textiles, twine, rope, insulation, paper, molding, carpeting, and many more. Hemp is closely related to the flax plant, both producing similar fibers from their bark. Cotton fibers are from the flower of the cotton plant. Cotton is not closely related to hemp and has it own unique properties. As a fiber, hemp has certain attributes which differentiate it from both flax and cotton. These differences extend into the character of the yarn and ultimately the fabrics they produce.

Hemp fiber is one of the strongest and most durable of all natural textile fibers. Its longer length and greater surface area contribute to a stronger yarn or twine when spun or twisted together. Pure hemp yarns and fabrics are stronger than flax, and much stronger than cotton.

Not only is hemp strong, but it also holds its shape having one of the lowest percent elongation of any natural fiber. This means hemp does not stretch out when it is tightly pulled. Hemp is perfect as a natural fabric for upholstery since it can be pulled taut, and remain firm throughout the life of the furniture. Apparel made from hemp won't have "puffy" elbows or knees when worn which is a characteristic of flax linen. Cotton has much more stretch to its fiber which doesn't make it very suitable for upholstery, but useful for making knit fabrics and certain apparel items such as t-shirts and jeans where some stretch is desirable. Hemp has the best ratio of heat capacity compared to flax and cotton, giving it superior insulation properties. This keeps hemp warm in cold weather, and cool in warm weather.

Many of these properties unique to hemp are due to the porous nature of the fiber. Under the microscope, hemp does not look like a flat rod, but rather is filled with nooks, crannies and holes. Hemp has a greater surface area and is more water absorbent. Increased surface area allows the fiber to dye well and retain its color better than any fabric including cotton or linen. This porous nature allows hemp to "breathe," so that it is cool in warm weather. Air which is trapped in the fibers is warmed by the body, making hemp garments naturally warm in cooler weather. This flow of air hinders the growth of anaerobic bacteria, giving hemp antimicrobial properties.

As a fabric, hemp provides all the warmth and softness of a natural textile but with a superior durability seldom found in other materials. Hemp is extremely versatile and can be used for countless products such as apparel, accessories, shoes, furniture, and home furnishings. Apparel made from hemp incorporates all the beneficial qualities and will likely last longer and withstand harsh conditions.

Component %	Hemp	Cotton	Flax
Cellulose	77	90	76
Lignin	9	0.5	11
Moisture	9	8	9
Ash	1	1	1
Other	4	0.5	3

Property	Hemp	Cotton	Flax
Color Range	Yellow-Brown	White	Yellow
Breaking Length (ft./lb.)	86,000	58,000	85,000
Percent Elongation	1.8%	3% - 10%	2%
Average Stiffness (g/gx)	200	56	270
Heat Capacity	0.323	0.319	0.321

Growing, Harvesting, and Processing Hemp for Fiber

There are several traditional steps as well as technical challenges to fully utilize all of the hemp fibers. The first step is the seeding rates and density of the stalks. Most hemp producing countries use a rate of 100-140 kg of seed per hectare that initially produces 500-700 plants per square meter. The high seeding rate increases plant mortality, but closer spacing produces stalks with a smaller diameter and high-fiber content.

Hemp field with plant density of 500-700 plants per square meter to maximize fiber output.

Hemp requires 80-150 days to mature for fiber harvest depending upon the variety and the location. Most hemp varieties mature in 120 days. It is very important that hemp be harvested at the proper time to secure the highest quality fiber. Early harvesting will result in low yields of weak fiber, while delayed harvesting produces stems that are difficult to ret and yield coarse, harsh fiber with little luster.

The second step is cutting down the hemp stalks. Traditionally this is done by hand using the sickle or modified hoe. In many part of the world including China, it is still harvested this way. Modern methods are now being developed which use a large "hedge trimmer" which is mounted to a tractor. This makes quick work of mowing down the hemp stalks and saves much time and money.

Simple tractor with hedge trimmer mounted on front.

Modern harvesting methods make quick work of cutting down the hemp stalks.

The third step is the need to remove the bark from the stalk. The stalks must first be “retted”. This word is similar to the word “rot” which is more descriptive of what is taking place. The hemp stalk need to decompose a bit or “rot” in order for the bark to be easily removed from the stalk. If the hemp is still green, it is nearly impossible to remove the bark effectively. Retting can be done two ways both of which require water and bacteria. There is **dew retting** in where the stalks are left out in the field, and the moisture in the air (dew) acts upon the stalk to break it down.

Hemp stalks left on the field for “dew-retting.”

The other way is **water retting** which the entire stalk is submerged underwater for several days. In both cases bacteria in the water begin to break down the different parts of the hemp stalks at different rates. The middle part of the stalk (hurd) breaks down a bit faster and starts separating from the bark. When retting has been completed, the stalks are dried, and the bark can be peeled away.

Hemp stalks being placed in tank of water to facilitate retting.

Tanks of water can be temperature controlled and the waste neutralized.

The fourth challenge of using hemp fiber is removing the bark from the stalk. Traditionally, this was done by hand and is extremely laborious. in fact, in many parts of the world this is still done by hand.

Hemp fiber is still removed from the stalks by hand in parts of China

Modern machinery to remove the fiber from the stalk have been developed for flax, and this machinery works fine with hemp stalks. One drawback to this machine is the hemp stalks have to be cut to three feet in length to match the shorter height of the flax stalks.

Dried hemp stalks being cut to 1 meter to ready them for machine to remove the fiber

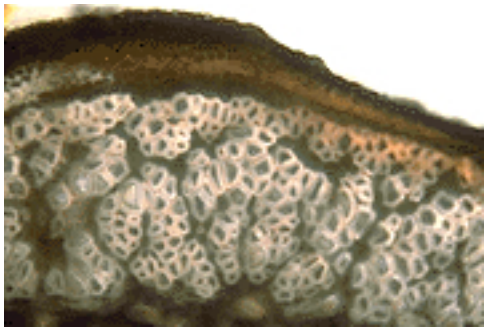
Hemp stalks pass under a series of rollers to break them down. The bast fiber is collected at the top while the hurds are collected at the bottom

Once the hemp bark has been stripped, the fibers need to be separated from one another. This is the fifth challenge. Raw hemp bark looks like long strips of corn husk. The fibers are all held together by lignin which is a type of plant glue which helps give the plants their rigidity. Traditionally this was done by just combing the hemp fibers to physically separate them from each other. Once again this was an extremely arduous task and not very efficient. The majority of the fibers were still stuck together and individual fiber bundles were not divided from one another. These types of hemp fibers are irregular and thick, but have worked well in traditional applications such as twine, rope, and rough canvas cloth used for old-fashioned sailing ships.

Raw hemp fiber

Degummed hemp fiber

Around 1985, technicians in China developed a chemical method to separate the fibers from each other by boiling them in a mild base of sodium hydroxide (NaOH) or “lye”. The method was a major breakthrough in hemp technology, and allowed the hemp fibers to separate completely into their individual fiber bundles. This method is sometimes referred to as **degumming** hemp fiber, or removing the lignin.



Microscopic cross-view of hemp fiber showing individual fiber bundles.

The most important aspect of the fibers are their size, both length and thickness. It is possible for the length of one hemp fiber to be as long as the entire height of the stalks, 14 feet (168 inches). The thickness of the individual fibers is usually determined by the thickness of the stalks. Thinner stalks produce finer fibers, while thicker stalks produce thicker fibers. For textiles, thiner fibers are preferred since they yield finer yarns. This is reason when growing hemp for textiles, it is important to grow the plants very close together to maximize height and minimize thickness. Seed strain is also an important factor. Different strains of hemp can produce thicker or finer fibers.

Both raw hemp fibers and degummed hemp fibers come in all different lengths and thicknesses. This is both a blessing and a bane since it requires the separation of these fibers into different sized groups to achieve uniformity. This means the fibers need to be separated depending upon their length and thickness. Current modern method use a giant combing machines which separate the fibers into their individual lengths.

Combing machine separating the long hemp fibers (top) from the short hemp fibers (bottom).

The longest fibers are cut down to lengths of about 4-6 inches. These fibers are mostly used for making 100% hemp yarns using spinning equipment which was made specifically for spinning longer fibers. This equipment was originally developed for flax. Modified slightly, these machines work just as well for hemp. Most pure hemp textiles sold today use the long hemp fibers to create a strong fabric with a smooth, lustrous surface.

The short hemp fibers which measure in length of about 1/2 to 2 inches are usually blended with cotton to be spun on conventional cotton spinning machinery. It is possible to spin 100% hemp yarns and weave fabrics with the short fiber, but these are not as strong or luxurious as the long fiber hemp.

The term **"cottonization"** of hemp fibers refers to a method to convert ALL the fibers in the plant to lengths of 1/2 to 2 inches so all of it can be utilized on cotton spinning systems. This could be desirable from a business standpoint since it would allow almost 100% of the fiber of the plant to be utilized in spinning, with little being wasted or diverted to other uses. The objective is to be able to break down all the fibers consistently and evenly, so they are short and uniform enough to work on a cotton spinning system. If the fibers are broken down too much, and their length is less than 1/2 inch, the fibers become useless for spinning and could only be used for paper.

*Combed and drawn out hemp fibers are referred to as **sliver**.*

Hemp sliver is spun together to make yarn.

Short hemp fibers may be blended with other fibers to combine their different properties. Blending hemp with other fibers is not a new concept. Mills in China have been blending hemp with cotton since the mid 1990's. Any combination of hemp and cotton can be mixed and spun together from 5% hemp to to 95% hemp depending upon the ratio and properties desired in the finished product. Hemp adds some stability and strength to cotton, making the fabric stronger while lowering its shrinkage. Hemp has also been blended with other natural fibers such as wool, silk, and flax, as well as synthetic fibers such as bamboo, tencel, nylon, rayon, and polyester. Hemp adds strength, absorbency and breathability to these fabrics, while the other natural and synthetic fibers add some stability, flexibility, and smoothness to the hemp.