



(Otis & Clever Leaves, 2019)

Cannabis sativa L.

Monograph - Agricultural Sciences

Martin Bueno Duque

Colegio Bolívar

Cali, Colombia

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Dr. Wojciech Waliszewski

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Chapter 1: Introduction & Importance

C. Sativa is one of the most popular and revolutionary plants. Its story is extremely interesting and it has collected many different stigmas through the ages, good and bad. But with its newly found popularity in popular culture, it is only right that the truth behind the plant is discovered. In this monograph all aspects of *C. Sativa* will be explored. The first informational chapter: Chapter 2: Ecology of *Cannabis sativa* will describe its taxonomy, origins and factors that affect its growth. Chapter 3: Biology of *Cannabis sativa* will also cover the biological components of the plant; therefore, also exposing how to properly grow and manage the plant. Chapter four will cover the management of *C. sativa* and how to propagate and grow it, with the last chapter exploring the plant's impact on the global consumer market and how it can be used. With Cannabis being legalized in countries like Uruguay, Holland, Canada and major US states like Colorado and California for both medical and recreational uses. The science behind the plant is just starting to come out, exposing the truth about the many physical and mental benefits found in the plant. That is why it is reported that there are over 182, 999, 999 regular consumers of Cannabis worldwide. (McClure, 2020)

Chapter 2: Ecology of Cannabis Sativa

2.1: Affinity

Kingdom: Plantae

Subkingdom: Tracheobionta

Superdivision: Spermatophyta

Division: Magnoliophyta

Class: Magnoliopsida

Subclass: Hamamelididae

Order: Urticales

Family: Cannabaceae

Genus: *Cannabis* L.

Species: *Cannabis sativa* L.

(CABI, 2019)

Cannabis sativa can both be grown indoors or outdoors, depending on how much time you are willing to wait for your bud to flower. The best soil to use is one which can hold and release oxygen, water, and nutrients without becoming water-logged or rotten. The best mix of soil to use is a soil based on peat, mixed with coco coir. Coco coir is a dry coconut fiber mix that provides drainage and air circulation to your soil. (FVKASA, 2018). To optimize the growth of the plant it is best to not plant it in extremely dry land or wetlands, because of its extensive root system that may get damaged in such conditions. Therefore the best soil for Cannabis Sativa is a nutrient-rich, well-drained soil with high organic matter.

Cannabis Sativa is a nitrophile which means it needs to grow in soil that contains a lot of nitrates and many nutrients, with a pH level of 6.0 or 7.0. To produce fiber crops, *Cannabis Sativa* requires high levels of nitrogen and potassium and a healthy dose of calcium, phosphorus, and magnesium. (Frank and Rosenthal, 1978; Futura-Sciences, n.d.).



Figure 1: Cannabis Sativa: A leaf of Cannabis Sativa (Wikipedia, 2020)

2.2: Fossil Record

Despite the fact that Cannabis Sativa has been used by many cultures and humans throughout history, there is not enough information for it to have a fossil record. No fossils of the plant have officially been found, but thanks to some experiments which focused on analyzing pollen left behind by Cannabis Sativa plants on rocks and soil; therefore, some people speculate that Cannabis Sativa originated either from the High Tibetan Plateau or central Kazakhstan. Thanks to the analysis of fossil pollen, scientists have found pollen of the Cannabis genus that's at least 19.6 Ma (million years old) in modern-day Tibet and other parts of Asia. The studies also found pollen from Cannabis diverged from Humulus, a plant from the Cannabaceae family used to make beer around 28 million years ago suggesting that the origin of Cannabis Sativa is not yet clear and still unknown. (Weisberger, 2019; Sensi Seeds, 2019).

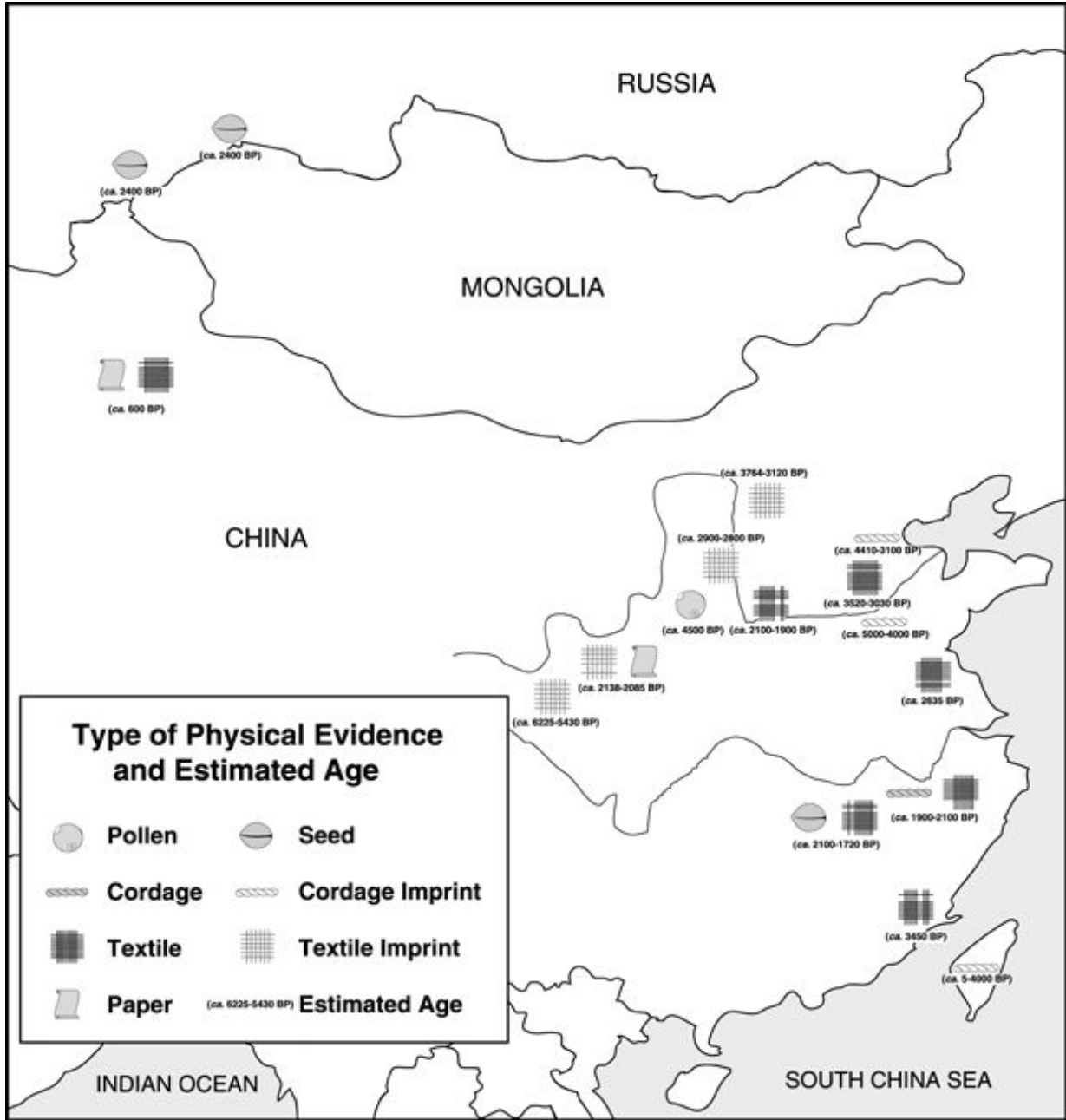


Figure 2: A map of North-East Asia that shows the types of physical evidence of *Cannabis sativa* found and how old it is (Fleming & Clarke, n.d.)

2.3: Origins

The oldest known record of Cannabis Sativa being used is from the Chinese Emperor Shen Nung in 2727 B.C. While in the middle east, the use of Cannabis spread throughout the Islamic empire. Not only that but other ancient civilizations such as the Greeks and the Romans were familiar with the use of Cannabis. But Cannabis would not get to the western hemisphere until 1545 when the Spanish imported it to its colonies in Chile to be able to use it as fiber and create rope, clothing, and paper. (DEA Museum and Visitors Centre, n.d.)

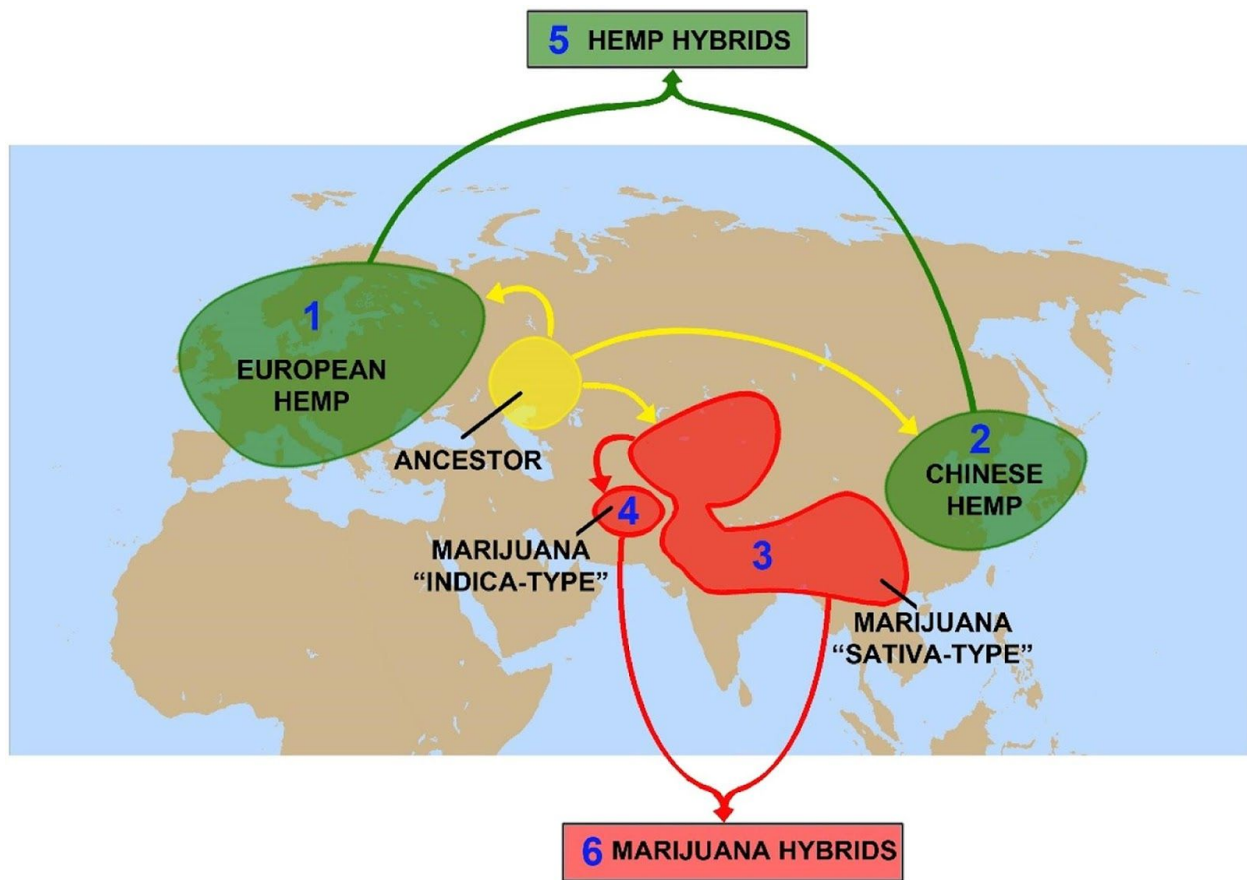


Figure 3: Shows a map with the regions where Cannabis Sativa, Cannabis indica and their ancestors were first discovered. (Grof, 2018)

2.4: Present Distribution

Sadly the distribution or cultivation of Cannabis Sativa is poorly documented. But the ODCCP lists 120 countries that grow and distribute the plant. Cannabis sativa can be seen a lot in almost all of Asia, especially in the following provinces of China: Anhui, Hebei, Heilongjiang, Hunan, Jilin, Liaoning, Nei Menggu, and Shandong. Also, there has recently been a surge of distribution of Cannabis Sativa in the US, in states such as Illinois, Indiana, Iowa, Kentucky, Missouri, Wisconsin. Other than that Cannabis Sativa can also be spotted in Chile and most of eastern and western Europe. (Frank and Rosenthal, 1978)

2.5: Elevation And Climate

Cannabis Sativa can grow from sea level to 3700m in altitude. But the perfect latitude for Cannabis Sativa to grow in is between 40-55 degrees. For the growth of Cannabis Sativa it has been determined that the perfect temperature would be 14.3 degrees Celsius. With these conditions the seed of Cannabis Sativa can germinate in 3-7 days after absorbing water. At first the growth will take its time but later on growth can become quite rapid. To make said growth fast the plant needs to receive a lot of nutrients since it's a nitrophile. Among those nutrients

there should be high amounts of nitrogen and potassium, and in a lesser role calcium, magnesium, and phosphorus. But most importantly, the habitat must remain untouched. If there is an ecosystem change or a habitat alteration the plant will most likely die. Since a habitat change would rob the plant of the nutrients it is used to receiving and kill it, the place where the seed is planted can not be altered until the plant is fully grown. (Frank and Rosenthal, 1978)

2.6: Soil And Geology

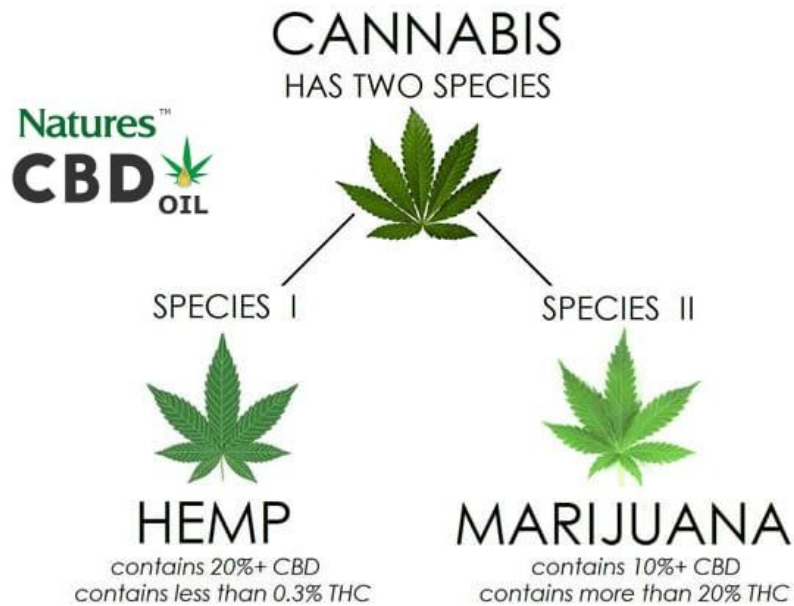
With the right environmental factors the plants genetics can be interacted with to express a huge range of terpene profiles and cannabinoid percentages. But for that to happen the plant needs to be situated in the perfect soil. Cannabis sativa is an annual plant, which means it only stays in the ground for one growing season. To grow Cannabis sativa you would need fish hydrolysate, kelp, and crab meal for its ocean essence. Also geologically older rock minerals provide conditioning, an extra layer of oil. While earth's biological elements make it easier for the plant roots to interact with these realms. With the right soil, microbes that facilitate nutrient intake and hormone regulation will help determine how the plant synthesizes nutrients to modulate its cannabinoid profile. (Stone, 2019; CHA Education, 2019)

Chapter 3: Biology of Cannabis Sativa

3.1: Chromosome Complement

3.1.1: Chromosome Number & Data

Female and male *Cannabis sativa* plants have XX and XY chromosomes with 18 autosomes, respectively. Additionally even though *C. sativa* has been cultivated for many years much remains unknown regarding its genetics, including its molecular determinants of cannabinoid content. But what we do know is that the cannabinoid biosynthesis genes are generally unlinked. By studying the genetic encoding of Tetrahydrocannabinolic acid synthase (THCAS) and Cannabidiolic acid synthase (CBDAS); (cannabinoids found in Cannabis sativa), it can be determined if the cannabis's chemotype is either drug or hemp. This type of chromosome structure is not that different to those in grains such as wheat, that's why it's gonna be easier to find out more about *Cannabis sativa* in the future since there's a genetic map which can be followed. (Lavery et al., 2019)



Natures Pure CBD Oil is an Organic Hemp extract that is concentrated in cannabinoid CBD strains without the THC. THC is the part of cannabinoids that gets you high. Natures Pure CBD has all the good properties of Cannabis without getting you high.

Figure 4 shows the different components of *Cannabis Sativa* as Hemp and as Marijuana (Homero, 2019)

3.2: Life Cycles & Phenology

Cannabis sativa is a dioecious species, which means it can have either female or male organs. The sex of the plant is determined by the X and Y chromosomes. A male plant is the heterogametic sex (XY), while the female is the homogametic (XX). But interestingly there can also be hermaphrodite *Cannabis sativa* plants. *Cannabis sativa* plants start revealing their gender when the leaves on the fourth node start to emerge. (Moliterni et al., 2004)

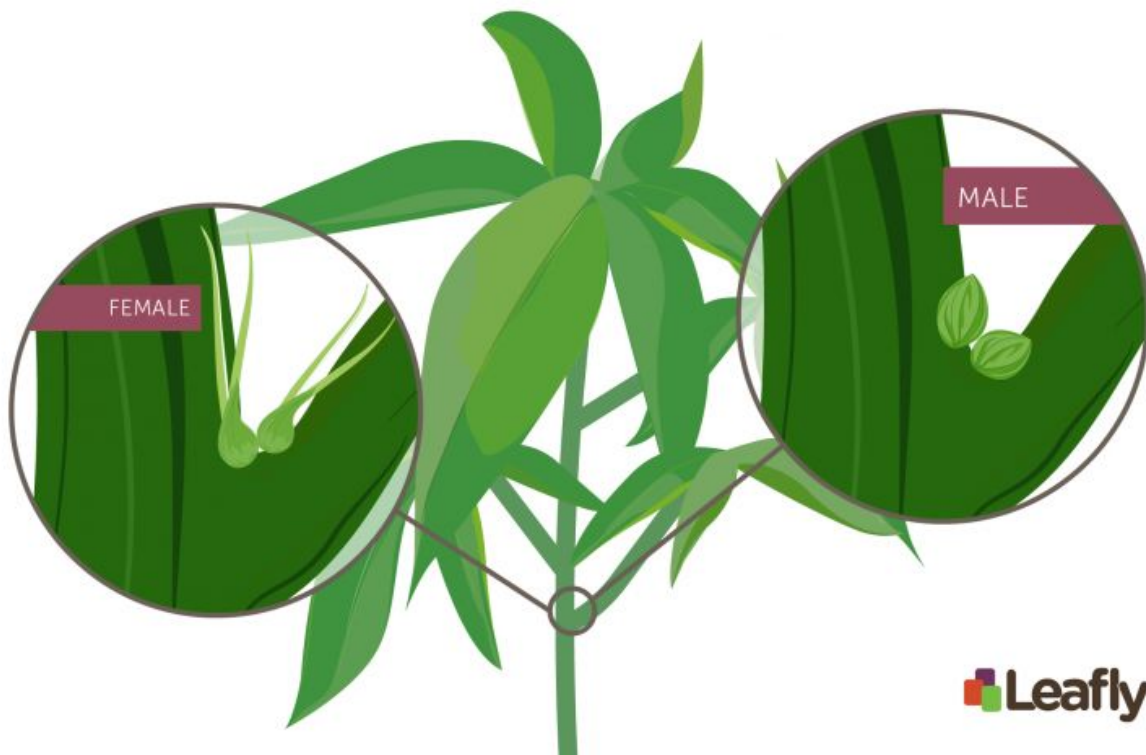


Figure 5 shows how the bud found in female plants is different from the seeds found in male plants (Phung & Hennings, 2020)



Figure 6 shows how hermaphrodite plants are different from single sex plants (Phung & Hennings, 2020)

3.3: Productivity & Biology

Cannabis sativa is a dioecious plant, which means that male or female organs appear on different plants. Generally the males are kept away from the females, as introducing the male plant to a garden in its late vegetative state and its early flowering will result in pollination. Which will make females create more seeds. By removing the males the females can produce seedless buds (*sinsemilla*). Seeded buds are regarded as low quality since it takes away from all the different cannabinoids in the plant. Cannabis plants show their sex by what is growing in between their nodes, where the branch starts out of the stem. The male plant will develop pollen sacs to spread

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seeds and to develop a stigma in the females to catch pollen. While the female grows pure buds. The sex of a plant can be spotted weeks before their reproduction cycle starts, these are called “pre-flowers”. Pre-flowers begin to develop around four weeks into growth, and by the sixth week you will be able to identify the sex of the plant. (Rana & Choudhary, 2010)

Chapter 4: Propagation and Management

4.1: Propagation

Cannabis sativa has multiple cannabinoid profiles derived from a single seed source, P.1. 378939. *C. Sativa* can be successfully propagated by vegetative cuttings, to increase uniformity of cannabinoid concentrations. Vegetative cuttings is when a new plant is produced from the leaves, stems, and roots of the original plant. Many plants can naturally reproduce this way, but it can also be artificially induced. (Vegetative Plant Propagation, n.d.). Vegetative cuttings developed greater lateral branch growth, which therefore led to an increase in foliage when comparing new plants to the parent plants. (Coffman & Gentner, 1979)



Figure 7: *C. Sativa* buds going to the stages or vegetative cuttings (Lata et al., 2009)

4.2: Planting

4.2.1: Seed Germination

Cannabis sativa plants go through different stages as they grow. Different stages call for different amounts of light, nutrients, and water. Generally it takes about 4-8 months to grow Cannabis Sativa. Even though *C. sativa* can be grown indoors, it's better to plant them out in the open. When Cannabis sativa is grown indoors it can either be forced to flower when it's too small

or wait till it's too big. At first the seed is left soaking in water, for it to germinate. At this point the seed is dormant and water needs to be used as an activation agent. The planted seed needs to get around 18 hours of lights during this germination process to succeed. As the seed pops, it can be placed in the soil so the tap root will drive down while the stem grows upward. (Mediavilla et al., n.d.)

4.2.2: Seedling

Out of the stem two rounded cotyledon leaves will grow out, while the plant continues to grow out of the protective shell of the seed. As the roots develop the leaves will develop into the iconic “fan” shape, at which point your cannabis plant can be considered a seedling. The seedling stage takes 2-3 weeks where again the plant will need to be exposed to 18 hours of light. As a seedling the plant is developing, as the leaves grow and more blades will grow onto each leaf, until eventually every leaf will have a matching amount of blades. It is key to add the right amount of water to the soil since a lot can drown the small roots and too little won't be enough for them to grow. (Mediavilla et al., n.d.)

4.2.3: Vegetative Stage

When all leaves are fully grown that means the plant has entered the *vegetative stage*. Which again needs 18 hours of light and lasts 3-16 weeks. At this point the plant will need higher amounts of water and high levels of nitrogen rich soil, so the flower can fully grow. After the

roots have grown enough and all the leaves are done developing, the plant enters the flowering stage. (Mediavilla et al., n.d.)

4.2.4: Flowering

The flowering stage will last between 8-11 weeks and requires 12 hours of light. During this stage the flowers begin to grow in between the leaves. At this point the plants start developing their reproductive organs. Which means you need to separate the male from the female, so the male does not pollinate the flowering females. Male plants will produce small round balls of pollen at the nodes and the female grows tiny hair like strands of bud. Bud is the flower of the weed, and what is considered the final product when you're talking about *Cannabis Sativa*. If you don't separate them the male plants will pollinate the females and fertilize it. (Mediavilla et al., n.d.)



Figure 7 shows the *Cannabis sativa* going through every stage of its planting cycle. (Phung & Hennings, 2020)

4.3: Irrigation Management

When implementing irrigation control using cumulative water potential (cWP) and cumulative vapour pressure deficit (cVPD) thresholds, it results in reduction in water and fertilizer use. For *C. sativa* the first half of the flower cycle is rapid vegetative growth, causing the accuracy of the cWP and cVPD to be reduced. While the second half of the flower cycle has improved accuracy, because the plant is now producing bud. cVPD can be applied and controlled using an automated system such as Argus Control. The relationship between cWP and cVPD will ensure proper water relations within the crop. Which indicates that reduced water use and consistent irrigation frequency measured through cVPD and no root zone flushing are the most desired elements for proper irrigation. (Stemeroff, 2017)

Chapter 5: Markets and Uses

5.1: Markets

In 2014, about 3.8% of the world population had used Cannabis in that previous year. (United Nations Office on Drugs and Crime, 2016). *C. Sativa* is also experiencing a boom in popularity in the agricultural world since it needs little to none pesticide, less industrial post-harvest, and low environmental impact. *C. Sativa* is farmable on most agricultural land, since it's not a “seasonal crop”. With this rise in popularity, *C. Sativa* has become a wildly popular commodity. Bud and other cannabis based concentrates like shatter, wax, oil, and hash have become leaders in global cannabis market research. That's because of the rise in demand for this particular supply. (Fortune Business Insights, 2019)

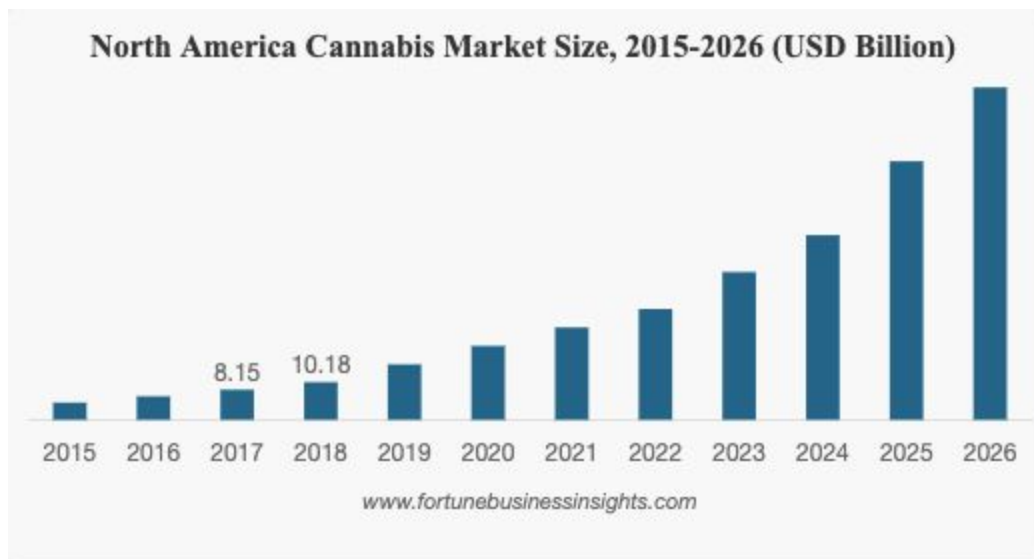


Figure 8 shows the result of market research for legal Cannabis in North America in the future. (Fortune Business Insights, 2019)

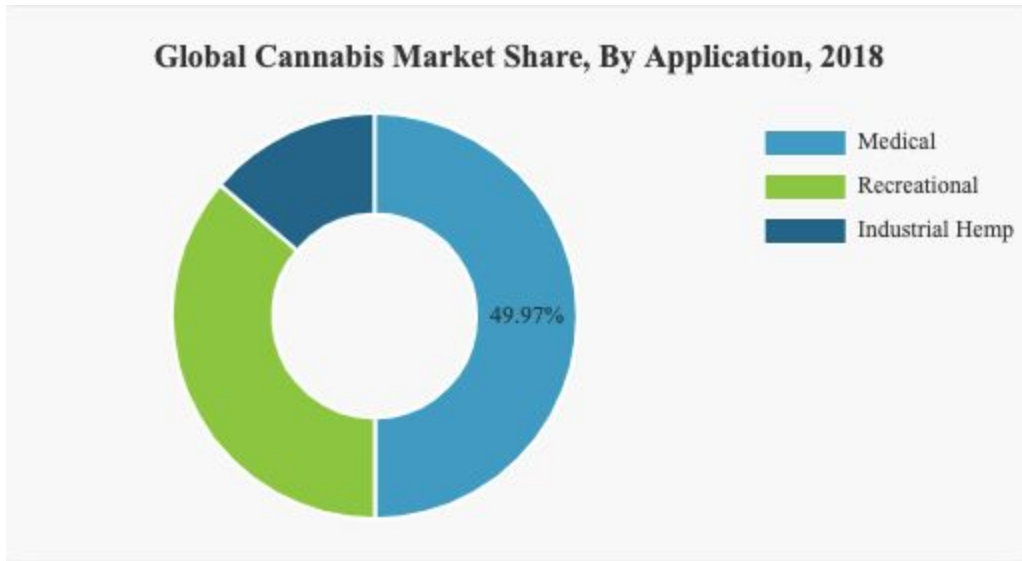


Figure 9 shows the three categories that Cannabis in the legal marketplace is used for. (Fortune Business Insights, 2019)



Figure 10 shows how much the legal Cannabis market is worth in North America. (Fortune Business Insights, 2019)

5.2: Uses

5.2.1: Recreational Use

C. Sativa is the most often used illegal drug in the US, thanks to its psychoactive chemical component called TetraHydroCannabinol, THC for short. THC is found on the leaves and flowering shoots of the plant. (Perez et al., n.d.). *C. Sativa* can be consumed in many ways, from smoking the dry herb to edibles. Ever since the 1960's there has been a boom in popularity and usage of the drug. Its stigma has been reduced with time, to the point where it has been normalized in some parts of the world. Many people choose to use the drug because of its symptoms, which include euphoria, relaxation, increased appetite, false sense of time, and loss of coordination. (Hash Marihuana & Hemp Museum, n.d.)

5.2.2: Medical Use

Over 50% of states in the US have legalized the drug for medical uses. The chemicals or "Cannabinoids" found in the plant can be used to treat diseases or conditions. The *C. Sativa* plant contains over more than 100 different Cannabinoids, each affects the body differently. The conditions that *C. Sativa* currently is being used for Alzheimer's, appetite loss, cancer, crohns, anorexia, epilepsy, glaucoma, Post Traumatic Stress Disorder, muscle spasms, nausea and pain.(Lava, n.d.) Cannabinoids are similar to chemicals in the body that control memory, pain,

movement, appetite, and memory. To get access to medical *C. Sativa*, a written prescription that states you suffer from a chronic condition. Each state has different laws and requirements to be a medical *C. Sativa* patient. The prescription has to be issued by a licensed doctor.

5.2.3: Textile Use

Hemp fabric is made from fibers from the stalks of *C. sativa* plants. Hemp fabric has a similar texture to cotton but it feels like canvas. The fabric is also not susceptible to shrinking or pilling, since the fibers are long and sturdy. The fabric is also very soft and durable, a hemp fabric t shirt lasts triple the time of a cotton t shirt, which lasts 10 years. It's also extremely lightweight and breathable, making perfect for hot climates. It also facilitates the passage of moisture from skin to the atmosphere. It is highly resistant to harmful microbes like mold or mildew, and it's extremely easy to dye the fabric. The fabric softens each time it's washed, and its fibers don't degrade. (Hodakel, n.d.)



Figure 11 shows organic hemp fibers woven into fabric. (Hodakel, n.d.)

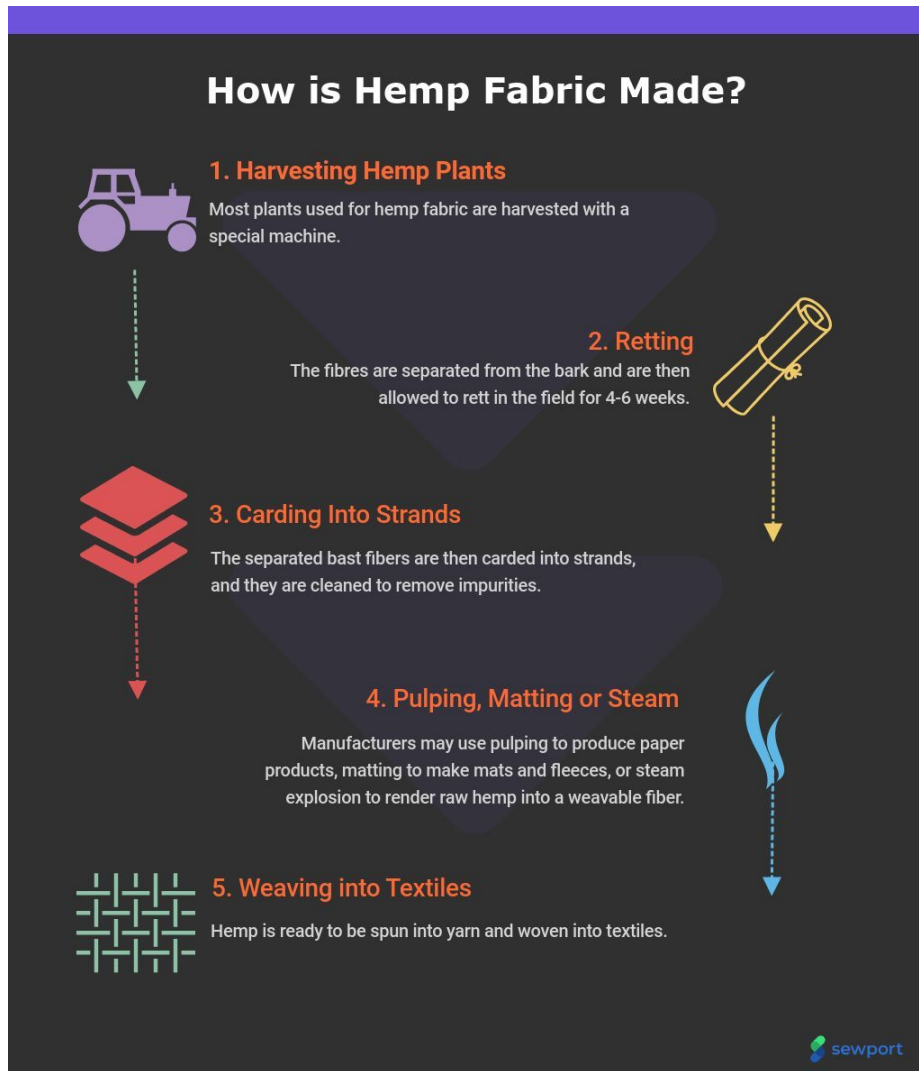


Figure 11 shows the process of making Hemp Fabric. (Hodakel, n.d.)

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