Applications for Industrial Hemp

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Phillip Alberti, Extension Educator
Commercial Agriculture
NW IL

Phillip Alberti- palberti@Illinois.edu or 815-599-3644 or @NorthernILCrops
What Does Hemp Look Like to You?
Hemp looks like this.

I am hemp. Less than 0.3 % THC, over 75 U.S. manufacturers make hemp products. This hemp car is made of hemp. Hemp is durable. Not illegal to use, not illegal to grow. 

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Talking Points

• Brief History
• Medicinal Uses
• Paper
• Textiles
• Biodegradable Plastics
• Construction Materials
• Fuel
• Food
Industrial Hemp

- **Cannabis sativa**
  - *Hemp vs Marijuana*
- Dicotyledonous Plant
- Primarily Dioecious
- Hemp is Photoperiod Dependent
  - Short-Day
  - 10-12 hours darkness

![Image Credit: Aaron Cadena](image)
Jack Herer’s book *The Emperor Wears No Clothes* is the prime source for the hemp-conspiracy theory. It alleges that in the mid-1930s, when the new mechanical hemp fiber stripping machines to conserve hemp’s high-cellulose pulp finally became state of the art, available and affordable, William Randolph Hearst, with enormous holdings in timber acreage and investments in paper manufacturing, stood to lose billions of dollars and perhaps go bankrupt. Meanwhile, Lamont DuPont in 1937 had just patented nylon and a new sulfite/sulfite process for making paper from wood pulp – so if hemp had not been made illegal, 80 percent of DuPont’s business would never have materialized.

It was said Hearst and DuPont had a multi-million dollar deal in the works for a joint papermaking venture. These two moguls, together with DuPont’s banker, Andrew Mellon, combined and co-ordinated their efforts to demonize ‘marijuana’.

The sheer number of newspapers, tabloids, magazines and film reels that Hearst controlled enabled him to quickly and effectively inundate American media with his propaganda. Hearst preyed on existing prejudices by associating cannabis with Mexican workers who he said threatened to steal American jobs and also African-Americans. With no strong voice to the contrary, Hearst was persuasive in his appeal to prejudice.
The Controlled Substances Act of 1970 (CSA, 21 U.S.C. §801 et. seq.) classifies marijuana as Schedule I controlled substance, placing it among the most harmful and dangerous drugs. Marijuana meets the criteria because of its THC content, which is a "psychoactive hallucinogenic substance with a high potential for abuse."

A key classification made by the CSA regarding marijuana was its broad definition of the drug. The CSA defines marijuana as follows: "The term "marihuana" means all parts of the plant Cannabis sativa L., whether growing or not; the seeds thereof; the resin extracted from any part of such plant; and every compound, manufacture, salt, derivative, mixture, or preparation of such plant, its seeds or resin.

This effectively placed the entire use of the hemp plant, whether for drug use or as industrial hemp, squarely under the control of the CSA. Therefore, the DEA views industrial hemp (even that containing less than 3% THC) as the same as marijuana grown for drug use (which commonly contains a 24% THC level, or eighty times more THC). Strictly speaking, the CSA does not make growing industrial hemp illegal; rather, it places strict controls on the production of hemp, making it illegal to grow the crop without a DEA permit.

Slide Credit: Sean Murphy
HEMP GOES GLOBAL

Approximately 30 countries in Europe, Asia, and North and South America currently permit farmers to grow hemp.

China is among the largest producing and exporting countries of hemp textiles and related products, as well as a major supplier of these products to the United States. The European Union has an active hemp market, with production in most member nations. Production is centered in France, the United Kingdom, Romania, and Hungary.

Acreage in hemp cultivation worldwide has been mostly flat to decreasing, reported at about 200,000 acres globally in 2011. Although variable year-to-year, global production has increased overall from about 250 million pounds in 1999 to more than 380 million pounds in 2011, mostly due to increasing production of hemp seed. Upward trends in global hemp seed production roughly track similar upward trends in U.S. imports of hemp seed and oil, mostly for use in hemp-based foods, supplements, and body care products.

Slide Credit: Sean Murphy
CBD Hemp (Specialty Crop)

- **Planting Stock:** Transplants
- **Planting Method:** Transplanter
- **Planting Rate:** 1000-2000 plants/acre
- **Harvest Method:** Hand
- **Post Harvest:** Plants are hung to dry in drying sheds or warehouse
Cannabinoids

- Cannabis hemp contains at least 85 types of cannabinoids
- Bind to receptor sites throughout our brain and body (65 cellular targets)
- Different cannabinoids have different effects depending on the receptors they bind to

Image Credit: SatiMed USA
Cannabinoids
Cannabinoids

The Human Endocannabinoid System

CBD, CBN and THC fit like a lock and key into existing human receptors. These receptors are part of the endocannabinoid system which impact physiological processes affecting pain modulation, memory, and appetite plus anti-inflammatory effects and other immune system responses. The endocannabinoid system comprises two types of receptors, CB1 and CB2, which serve distinct functions in human health and well-being.

CB1 receptors are primarily found in the brain and central nervous system, and to a lesser extent in other tissues.

CBD does not directly “fit” CB1 or CB2 receptors but has powerful indirect effects still being studied.

CB2 receptors are mostly in the peripheral organs especially cells associated with the immune system.
Cannabinoids

- May help treat symptoms of many medical conditions
  - Mood/Eating/GI disorders
  - Neurological disorders
  - Pain/Sleep disorders
- Different cannabis varieties produce different ratios of cannabinoids
- Pretreatment with CBD significantly reduced anxiety, cognitive impairment and discomfort in their speech performance*

*Image Credit: CBDCrew.org
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*Image Credit: CBDCrew.org
Cannabidiol (CBD)

- CBD is found within the oil/resin glands (trichomes) **NOT** in the seeds
  - Flowers and leaf material
  - **Males MUST be culled**
- CBD is not psychoactive
- CBD is extracted from the plant material
  - Supercritical CO$_2$
  - Butane/Propane
  - Alcohol/Ethanol

Closeup of female cannabis flower
Photo Credit: Steve Tomlins
Cannabidiol (CBD)

- Most lucrative area of hemp production
- Hemp-derived CBD is available in many forms, concentrations due to processing strategies

Closeup of female cannabis flower
Photo Credit: Steve Tomlins

<table>
<thead>
<tr>
<th>Form</th>
<th>CBD Concentration</th>
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<tbody>
<tr>
<td>Full spectrum</td>
<td>~10% CBD</td>
</tr>
<tr>
<td>Concentrated and filtered</td>
<td>~25% CBD</td>
</tr>
<tr>
<td>Isolate powder</td>
<td>~99% CBD</td>
</tr>
</tbody>
</table>

Image Credit: hempmedspx.com
Industrial Hemp

Hemp is harvested for three things:

Stalk  Seed  Flower

Photo Credit: Natrij- Public Domain
Types of Hemp

- Grain
  - Small Grains (Wheat)
- Fiber
  - Forages (Hay)
- CBD
  - Specialty Crops (Tomatoes)
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Talking Points

The Many Uses of Hemp

- STALK
  - Fiber
    - Textiles
    - Insulation
    - Rope
    - Animal bedding
    - Fiber board
  - Hurd
    - Paper
    - Organic compost

- SEEDS
  - Oil
    - Cooking/seasoning oil
    - Dietary supplement
    - Body care products
  - Seed cake
    - Flour
    - Beer
    - Animal feed
  - Hemp nut
    - Milk/dairy
    - Bakery
    - Granola
    - Protein powder

- ROOTS
  - Medicine
  - Organic compost

- LEAVES/FLOWERS
  - Animal bedding
  - Mulch/compost
  - Medicine/recreation
Fiber Hemp (Hay/Forages)

- **Planting Stock**: Seeds
- **Planting Method**: Grain Drill, Broadcast
- **Planting Rate**: 50-70 lbs./acre
- **Harvest Method**: Mower, Baler
- **Post-Harvest**: Bales are stored at 15% moisture

Photo Credit: Canadian Hemp Trade Alliance
Fiber Hemp (Hay/Forages)

- Hemp stalks are the stem of the plant.
- To harvest hemp stalks, you mow them down in the field and gather them into a bale.
- Baled hemp stalks can be transported to a decortication mill to be processed.
Fiber Hemp

• Decortication is a word that comes from how the hemp stalks are processed.
• The goal is to separate the fiber from the woody core of the stalk, so we "DE-core" or decorticate the hemp.
• When you decorticate the stalks, three products are made

<table>
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<tr>
<th>Fiber</th>
<th>Hurd</th>
<th>Dust Pellets</th>
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<td>![Fiber](Photo Credit: Sundstrand)</td>
<td>![Hurd](Photo Credit: Plains Hemp)</td>
<td>![Dust Pellets](Photo Credit: New Age Hemp)</td>
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Hemp Stalk: Bast and Core
Photo Credit: Hemp Gazette
Fiber Hemp

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![Diagram of hemp stalk layers]

- Fiber
- Hurd
- Dust Pellets

Photo Credit: Sundstrand
Photo Credit: Plains Hemp
Photo Credit: New Age Hemp
Fiber Hemp

- Fiber (Bast) is the most valuable product from decorticated stalks
  - Textiles
- Bast fiber from hemp can be refined into traditional textiles, technical textiles, and other new use industrial products.
- Hemp fibers make up about 25-30% of the stalk's weight.

![Fiber Hemp Diagram](image)

**Fiber** | **Hurd** | **Dust Pellets**
--- | --- | ---
![Photo](image) | ![Photo](image) | ![Photo](image)

Photo Credit: Sundstrand | Photo Credit: Plains Hemp | Photo Credit: New Age Hemp
Hemp Fiber

• All raw decorticated products can be further refined into specialized materials that are:
  • Sustainable
  • Durable
  • Hypoallergenic
  • Highly absorbent
  • Mold resistant
Hemp Paper

- Hemp paper lasts longer and is more durable than conventional wood pulp papers
- Trees for paper take many years to mature; hemp takes 4 months
Hemp Paper

Photo Credit: Montbell
Hemp Plastic

- Conventional plastics are petroleum based and not sustainable; take more than 100 years to break down and release harmful gasses
- Hemp plastics are biodegradable
- Hemp plastics are plant based and sustainable

Photo Credit: Return of Hemp
Hemp Plastic

Biodegradation Cycle

Standard Recycling

Photo Credit: Hemp News
Bast Fiber- Cottonized

Photo Credit: HydrogenLink
Bast Fiber - Textiles

Men's Trail Harbor Pocket Tee

Men's Beck Step Shorts

Men's Lightweight All-Wear Hemp Pants

Women's Trail Harbor Tee

Women's Gordon Island Shorts

Women's Garden Island Dress
Core—“Hempcrete”

Photo Credit: OregonHempWorks

Photo Credit: JustBioFiber
Bast Fiber Board

Photo Credit: Kentucky Hemp Industries Association
Bast Fiber- Insulation

Photo Credit: Ecobati
Bast Fiber Composites

Hemp Fiber → Non-Woven Mat

Finished Door ← Pre-Finished Door

Photo Credit: Eric Pollitt
Varnish
Hemp Oakum

Hemp oakum to caulk sailing ships and plumbing.
Rope and Cardboard

Photo Credit: Townsends

Photo Credit: Kentucky Hemp Industries Association
Syngas and Solvents

- **Gas Coal**: Steam reforming, partial oxidation, gasification
- **Biomass**: Gasification, chemical looping
- **Sun/Wind**
  - $\text{CO}_2 + \text{H}_2\text{O}$ electrolysis, $+ \text{rWGS}$

Synthesis gas: $\text{CO} + \text{H}_2$ (syngas)

- **Water-gas-shift reaction**: $\text{H}_2 (\rightarrow \text{NH}_3)$
- **Fischer-Tropsch synthesis**: Synthetic fuels
- **Methanol synthesis**: $\text{CH}_3\text{OH}$ & DME, etc.

Photo Credit: SyngasChem
Biodiesel

Photo Credit: The Hemp News
Ethanol

Photo Credit: True Democracy Party
Grain Hemp (Small Grains)

- **Planting Stock**: Seeds
- **Planting Method**: Grain Drill, Broadcast, Corn Planter
- **Planting Rate**: 25-35 lbs./acre
- **Harvest Method**: Combine
- **Post-Harvest**: Dry grain in aeration bins immediately
Hemp as Food!

- Hemp seeds are located at the top of the hemp plant.
- Most acres of hemp being grown today are grown for hemp seed.
- Harvesting hemp seed can be tricky.
Hemp as Food!

- Hemp seed products are high in complete proteins and healthy unsaturated fats.
- Hemp seeds and oil can spoil quickly if not handled correctly.
- Hemp seed cake can be used as a nutritious animal feed or ground into high protein flour for human consumption.
Grain Hemp

- Hemp seeds are high in complete proteins and healthy saturated fats
- Hemp seed oil (NOT CBD) can be extracted
- Has potential to be used in both animal and human feed
- Storage of both seeds and oil to prevent spoilage is critical
Hemp as Food!

- Hemp seed’s nutritional profile is comparable if not superior to other plant based foods
  - Protein
  - Fiber
  - Iron
  - Magnesium
  - Phosphorous
  - Etc.
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THANK YOU!!!!

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