PURDUE UNIVERSITY
INDUSTRIAL HEMP INITIATIVE

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AG RESEARCH AT PURDUE
People Making an Impact
Cannabis sativa in production

Cultivated for over 4,500 years

Hemp
Agricultural Production

- Fiber
- Oil
- Food/Feed

<0.3% THC

Glasshouse Production

Cannabinoids (CBDs)

Marijuana
Glasshouse Production

- THC
- Cannabinoids (CBDs)
Comparison between Hemp and Marijuana

Both are *Cannabis sativa* but have been bred and selected for different uses
### Industrial Hemp developed in Canada

<table>
<thead>
<tr>
<th>VARIETY</th>
<th>COUNTRY WHERE MAINTAINED</th>
<th>EXEMPT FROM THC TESTING</th>
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<tbody>
<tr>
<td>Alyssa</td>
<td>Canada</td>
<td>Exempt in MB and QC only</td>
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<tr>
<td>Anka</td>
<td>Canada</td>
<td>Exempt in ON and QC only</td>
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<td>Cana</td>
<td>Canada</td>
<td>Exempt in MB only</td>
</tr>
<tr>
<td>CanMa</td>
<td>Canada</td>
<td>Exempt in QC and SK only</td>
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<tr>
<td>Carmagnola</td>
<td>Italy</td>
<td>No</td>
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<tr>
<td>Carmen</td>
<td>Canada</td>
<td>No</td>
</tr>
<tr>
<td>CFX-1</td>
<td>Canada</td>
<td>Yes</td>
</tr>
<tr>
<td>CFX-2</td>
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<tr>
<td>Crag</td>
<td>Canada</td>
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<tr>
<td>CRS-1</td>
<td>Canada</td>
<td>Yes</td>
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<tr>
<td>CS</td>
<td>Italy</td>
<td>No</td>
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<tr>
<td>Delores</td>
<td>Canada</td>
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<tr>
<td>Deni</td>
<td>Canada</td>
<td>No</td>
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<tr>
<td>ESTA-1</td>
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<tr>
<td>Fasano</td>
<td>Germany</td>
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<tr>
<td>Fedina 74</td>
<td>France</td>
<td>No</td>
</tr>
<tr>
<td>Felina 34</td>
<td>France</td>
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</tr>
<tr>
<td>Ferimon</td>
<td>France</td>
<td>Exempt in QC only</td>
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Many French, Hungarian, Polish, Romanian, Ukrainian, Russian, Italian, Serbian, German and China cultivars

**NO U.S. CULTIVARS**
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<tr>
<th>Variety</th>
<th>Alberta hectares (ha)</th>
<th>Alberta acres (ac)</th>
<th>Other Provinces hectares (ha)</th>
<th>Other Provinces acres (ac)</th>
<th>Total hectares (ha)</th>
<th>Total acres (ac)</th>
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<td>7,402.5</td>
<td>18,292</td>
<td>6,263.97</td>
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<td>CFX-2</td>
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<td>8.05</td>
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<td>Total</td>
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<td>25,557</td>
<td>33,565.91</td>
<td>82,943</td>
<td>43,908.53</td>
<td>108,500</td>
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Cannabis Biology

- Hemp is a short day plant.
- Hemp is dioecious, meaning plants can be male or female.
  - Think asparagus
- Specially bred hybrids can be mostly monoecious plants and female
  - so-called “all-female,” these generally also produce some hermaphrodites and occasional males.
- No pesticides (insecticides, herbicides or fungicides) are registered for use on hemp in the United States.
Federal Regulation

The first federal law restricting hemp production was the Marijuana Tax Act of 1937

- Pull back of law WWII (~146,200 AC in 1943 to zero by the 1950s)

The Controlled Substance Act 1970 – declared all cannabis varieties as a controlled substance and under the regulatory authority of DEA (Drug Enforcement Authority)

Cannabis (including hemp) declared schedule one narcotic

Marihuana Tax Act of 1937 defined hemp as a narcotic drug, requiring that farmers growing hemp hold a federal registration and special tax stamp, effectively limiting further production expansion
Industrial hemp is grown or cultivated for purposes of research conducted under an agricultural pilot program or other agricultural or academic research; and the growing or cultivating of industrial hemp is allowed under the laws of the State....(2014)

Section 543 / 763 of Public Law 114-113: preclude federal funds from being used “to prohibit the transportation, processing, sale or use of industrial hemp that is grown or cultivated in accordance with” the Agricultural Act of 2014. (Protects hemp research as defined in 7606.)
US Farm Bill sec. 7606

The farm bill established a statutory definition of “industrial hemp” as the plant *Cannabis sativa L.* and any part of such plant, whether growing or not, with a delta-9 tetrahydrocannabinol concentration of not more than 0.3 percent on a dry weight basis.
Indiana
IC 15-15-13-1 to 15-15-13-17
• Authorizes the production of, possession of, scientific study of, and commerce in industrial hemp in Indiana by license holders.
• “Industrial hemp is an agricultural product that is subject to regulation by the state seed commissioner.”
• The state seed commissioner adopts rules and oversees licensing, production, and management of industrial hemp and agricultural hemp seed.
• Sets the standards for application for hemp license and registration.

Kentucky
KRS § 260.850-.869
• Establishes an industrial hemp commission to promote the research and development of industrial hemp, and commercial markets for Kentucky industrial hemp and hemp products.
• Establishes a five year industrial hemp research program, to be directly managed by the University of Kentucky Agricultural Experiment Station to conduct research on industrial hemp for a variety purposes.
• Establishes an industrial hemp licensing program.
• Includes language that "Kentucky shall adopt the federal rules and regulations that are currently enacted regarding industrial hemp and any subsequent changes thereto."

31 States
“Industrial hemp is an agricultural product that is subject to regulation by the state seed commissioner.”

The state seed commissioner adopts rules and oversees licensing, production, and management of industrial hemp and agricultural hemp seed.
Buying seed & the Permitting Process for Hemp

State must allow industrial hemp research

**Licensing**
- Need to meet state requirements for production license
- Need to acquire a DEA Schedule One Research license
- Develop research plan seek approvals with state and local authorities

**Purchase seed**
- Need to find a seed source: International (no US genetic materials) establish MTA
- **Need to apply for a DEA 357 import form** (on-line system)
  - Sources are prescreened by DEA
- Receive permit by US mail from DEA and then send **paper copy** to your seed supplier
- International source, must have internal approvals to export
  - USDA phytosanitation rules MUST BE Met
- Shipping by air fright (min bag size 25kg)
- Entry approval and ground transport to field site -- Field site security
"We are properly permitted"
INDUSTRIAL HEMP

HEMP SEEDS
- Hulling
  - Meat
    - Food
  - Shell
    - Flour
- Pressing/Crushing
  - Oil
    - Food
    - Fuel
    - Paint
    - Personal Care Products
  - Cake
    - Food
    - Beer
    - Feed

HEMP STALKS
- Harvest
- Intermediate Processing
- Decorticating
  - Fiber
    - Primary (line) Fiber
      - Fabric
      - Insulation
      - Carpeting
      - Paneling
    - Secondary Fiber
      - Cordage
      - Pulp
      - Recycling Additive
  - Tow
    - Cordage Bagging Fiber Board
  - Hurd
    - Fiber Board
    - Compost Mortar
    - Paper Filler
    - Absorbent Bedding

Further Processing
- hackling
- scutching

Chemical Feedstocks
- Plastics
- Paint
- Sealant

There are no valuable uses for the fiber end of the stalk if the hemp is cultivated for the purpose of certified seed.

Using a dual purpose method does not allow for primary fiber production.

Due to high processing costs, hemp’s economic advantage lies in high-end, durable products.

Scutching and hackling and processes within the decortication process. A further “combing” process, known as carding, may be performed on the primary fiber.

Figure 4. Hemp Products Flowchart. Processing to End Product Groups. Dustin Mathern, Undergraduate, Jodi L. Young. Department of Agricultural Economics, North Dakota State University, 1998.
**Why Hemp?**

<table>
<thead>
<tr>
<th><strong>HEMP SEED</strong></th>
<th><strong>SAMPLE COMMERCIAL USES</strong></th>
<th><strong>HEMP STRAW</strong></th>
<th><strong>SAMPLE COMMERCIAL USES</strong></th>
</tr>
</thead>
</table>
| ![Hemp Seeds](image) | **Oil**  
- cosmetics  
- foods  
- lubricants  
- paint  
- resins | ![Hemp Straw](image) | **Bast / Fibre**  
- automotive parts  
- bio-composites  
- canvas  
- carpets  
- caulking  
- containers | **Shive / Hurd**  
- geo-textiles  
- insulation  
- packaging  
- paper  
- rope/twine  
- textiles (apparel)  
- animal bedding  
- building materials  
- fibreboards | **Shive / Hurd**  
- insulation  
- stucco/plaster |

[http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex126](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex126)
Hemp as feed or food?

- Hemp seed added is a great source of polyunsaturated essential fatty acids.
  - positive effect on cardiovascular function, organ function, immunity levels, inflammation and muscle recovery.

- 30-40% of weight of hemp seed edible oils
  - Contains all 20 amino acids including 9 essential
  - high in protein and good fatty acids, including the essential fatty acids
    - alpha-linolenic acid (an omega-3 fatty acid)
    - linoleic acid (an omega-6 fatty acid).
Seed/Oil/Meal

- Seed Yield-300-1200 lbs. per acre
- $.40-1.00 per pound
- Specialty oilseed crushing mills that could accommodate hemp seed do exist in the United States.
  - Mostly in North Dakota
Fiber

- Yields 1-5.5 tons per acre of fiber
- 12,000 lbs. straw per hectare = 5,000 pound acre
- 25% of straw = fiber 1215 pounds
- Fiber price $70-$180 per ton
- Fiber $100-$900

- Total estimates $400-$1400
- Best guess $900-$1100

http://www.frankferrisco.com/hemp_casting/hemp_casting_fiber.html
Economic Impact

• The profitability potential is real
  • So are the obstacles to development

• Seed – Contracts
  • Foods Alive

• Processing and Manufacturing
  • Flex Form (Elkhart, IN)

• Oil

• Corn, Wheat, and Soybean Prices to Fall in 2016
World view

• 55,600 metric tons, with China, South Korea and the Russian Federation as the lead producers (none of these countries has ever made industrial hemp cultivation illegal).

• 70% of total world supply.

• Hemp is government subsidized in these countries.
Canada had 38,828 licensed acres in 2011.
Over 80 percent of this was for seed production
Canada estimated gross revenue of between $30.75 million to $34.17 million
Purdue Hemp Research
# Fertilizer Rates

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<tr>
<th>Nutrient</th>
<th>Hemp</th>
<th>Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>100-200 lb/acre</td>
<td>120-240 lbs /acre</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>45-70 lb/acre</td>
<td>25-125 lb/acre</td>
</tr>
<tr>
<td>Potassium</td>
<td>50-70 lb/acre</td>
<td>50-200 lb/acre</td>
</tr>
<tr>
<td>Month</td>
<td>Normal</td>
<td>2015</td>
</tr>
<tr>
<td>-------</td>
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<tr>
<td>April</td>
<td>3.58 in</td>
<td>3.61 in</td>
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<tr>
<td>May</td>
<td>4.76</td>
<td>4.37</td>
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<tr>
<td>June</td>
<td>4.09</td>
<td>10.41</td>
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<td>July</td>
<td>4.21</td>
<td>7.19</td>
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<td>August</td>
<td>3.62</td>
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<td>Sept</td>
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</table>

![Graph showing rainfall data for June 2015 with planting markers]
Yields for 2015  Limited data set

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<tr>
<th></th>
<th>Canda</th>
<th>Alyssa</th>
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<tr>
<td>Seed</td>
<td>1241 lbs of seed/ac</td>
<td>1281 lbs of seed/ac</td>
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<tr>
<td>Oil</td>
<td>172 lbs of oil / ac</td>
<td>253 lbs of oil /ac</td>
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<tr>
<td>THC</td>
<td>Average THC = 0.11%</td>
<td>+/- 0.043</td>
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</table>
Yield Fiber

• Yields can be about 3-5 tons fiber/acre

• Most conventional equipment cannot handle the fibers of hemp, specialized machinery has been developed

(Willie Nelson Peace Research Institute)
Hemp and Disease
<table>
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<th>List of DiagnosisID(s)</th>
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Hemp Foliar Disease

- Hemp is susceptible to several foliar diseases, including:
  - Cercospora leaf spot results in circular, depressed sunken centers.
  - Phoma leaf spot has been reported to reduce yield.
- McPartland (1995) described these and other pathogens, but did not describe the economic impact of these species.
Land races v. ditchweed
All Cannabis is Schedule 1

- Prevents the research needed to sustainably manage hemp.
  - Numerous fungicides used in conventional agriculture are highly effective and are labeled to manage these pathogens on other crops—including tobacco.
  - To date, only those minimum risk pesticides that meet certain criteria are exempt from federal registration under section 25(b) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and can be used for any and all Cannabis production;
  - These pesticides have limited efficacy data against plant pathogens compared to fungicides already approved for other crops
No EPA approval for Hemp Pesticides

- No one knows which pesticides would be effective and safe because no one can do the research.
- States are offering FIFRA 25b pesticides.
- On biological control to manage plant pathogens, the findings of one meta-analysis stated "investigators often attempt unsuccessfullly to compensate for anticipated poor performance in antagonist–disease combinations by making more applications."

Summary

- Hemp is presently a niche market
- Agricultural supply chain needs to be re-established.
- Breeding for varieties with modern attributes are needed.
- Harvesting equipment needs upgrade.
- Processing and manufacturing need to be modernized
- New opportunities identified
THE PURDUE HEMP PROJECT

This website provides information to support 21st century hemp (*Cannabis sativa L.*) cultivation in the Midwest. All crops have issues with respect to production; however, with a crop like hemp, which was banned in the United States for over eighty years, large information gaps have developed with regards to production, pest management and economic impact. Unlike other agronomic crops, U.S. hemp production faces additional obstacles in form of U.S. government drug policies.

The goal of this website is to inform the public about industrial hemp as a crop, and to identify the challenges faced by modern industrial hemp producers in the North Central Region—from the legal production of the crop, to the pest management that will be necessary to produce long-term sustainable yields of hemp. We have tried to use our present experience growing hemp and years of additional experiences with other cropping systems to inform our production practices. What we have learned sometimes conflicts with "conventional wisdom". We hope this website continues to improve on what we know and provides a sound foundation for those interested in growing industrial hemp.

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HEMP AS A CROP
BIOLOGY & BOTANY

HEMP FARMING
BUSINESS DEVELOPMENT
The Science of Industrial Hemp

THE SCIENCE OF
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