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Cannabis Commodities – One Plant; More than 25,000 Potential Products

A Closer Look at the Cannabis Derived Products Market

Western Weights and Measures Association
62nd Annual Technical Conference
Park City, Utah, USA
September 10th, 2019
Darwin Millard
Vicechair, D37.04 on Processing/Handling & Co-Chair, D37.07 on Hemp
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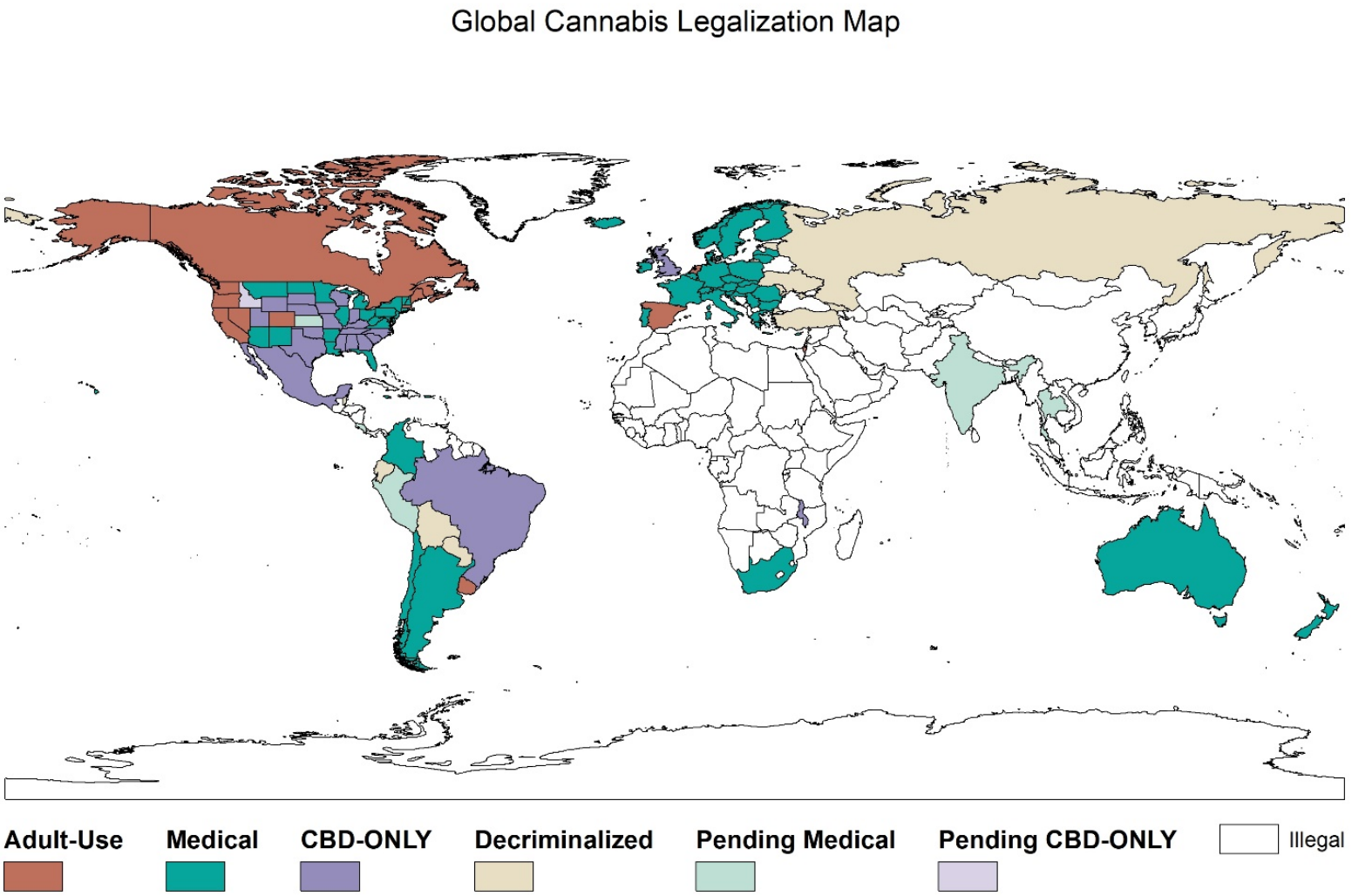
Agenda

- Global Status of the Cannabis Plant
- What is Cannabis?
- Marijuana vs Hemp
- Derivable Products
- Manufacturing Processes
- Packaging & Denominations
- Consumer Base
- Supply Chain Logistics
- Post 2018 Farm Bill Challenges

Global Status of Cannabis



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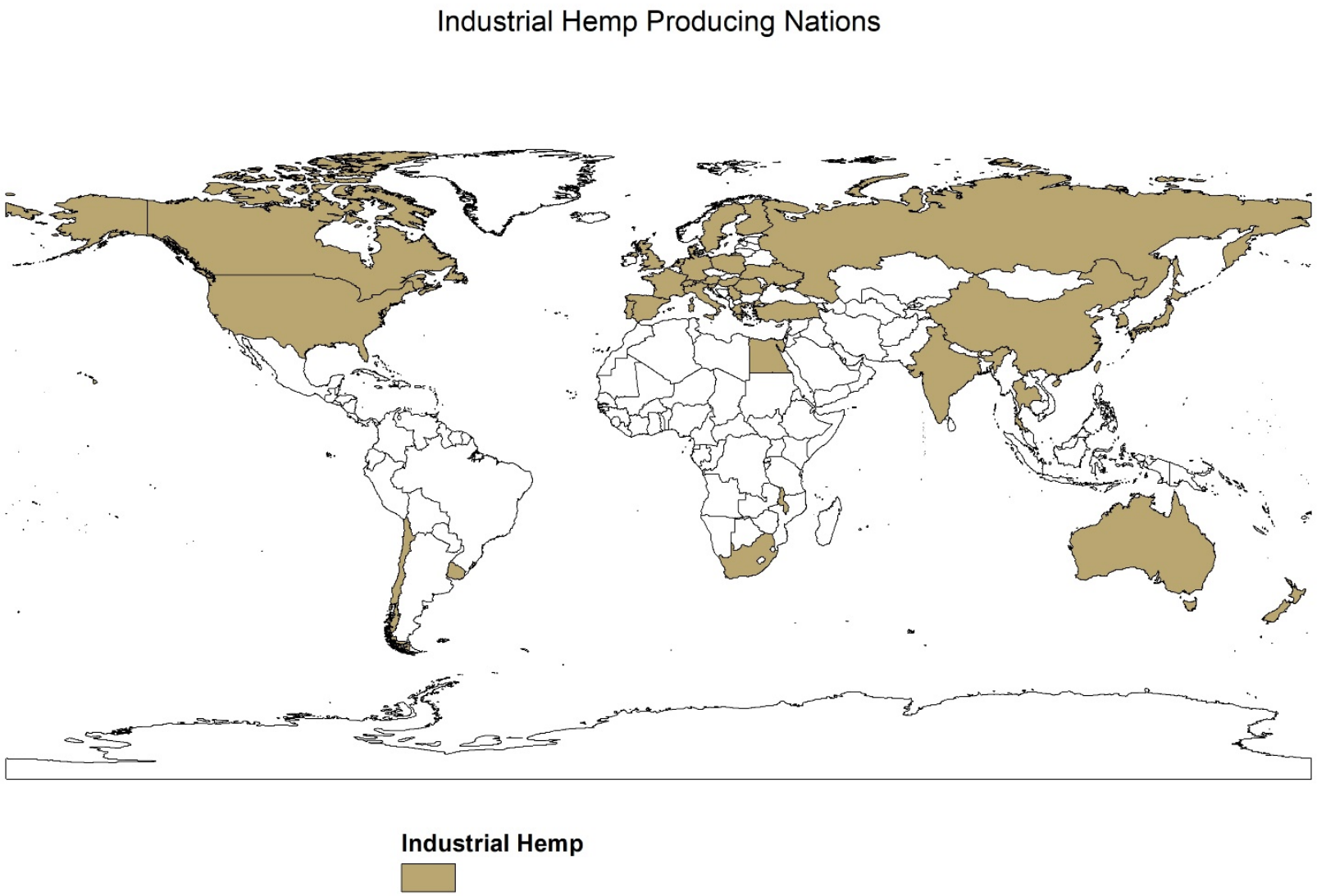

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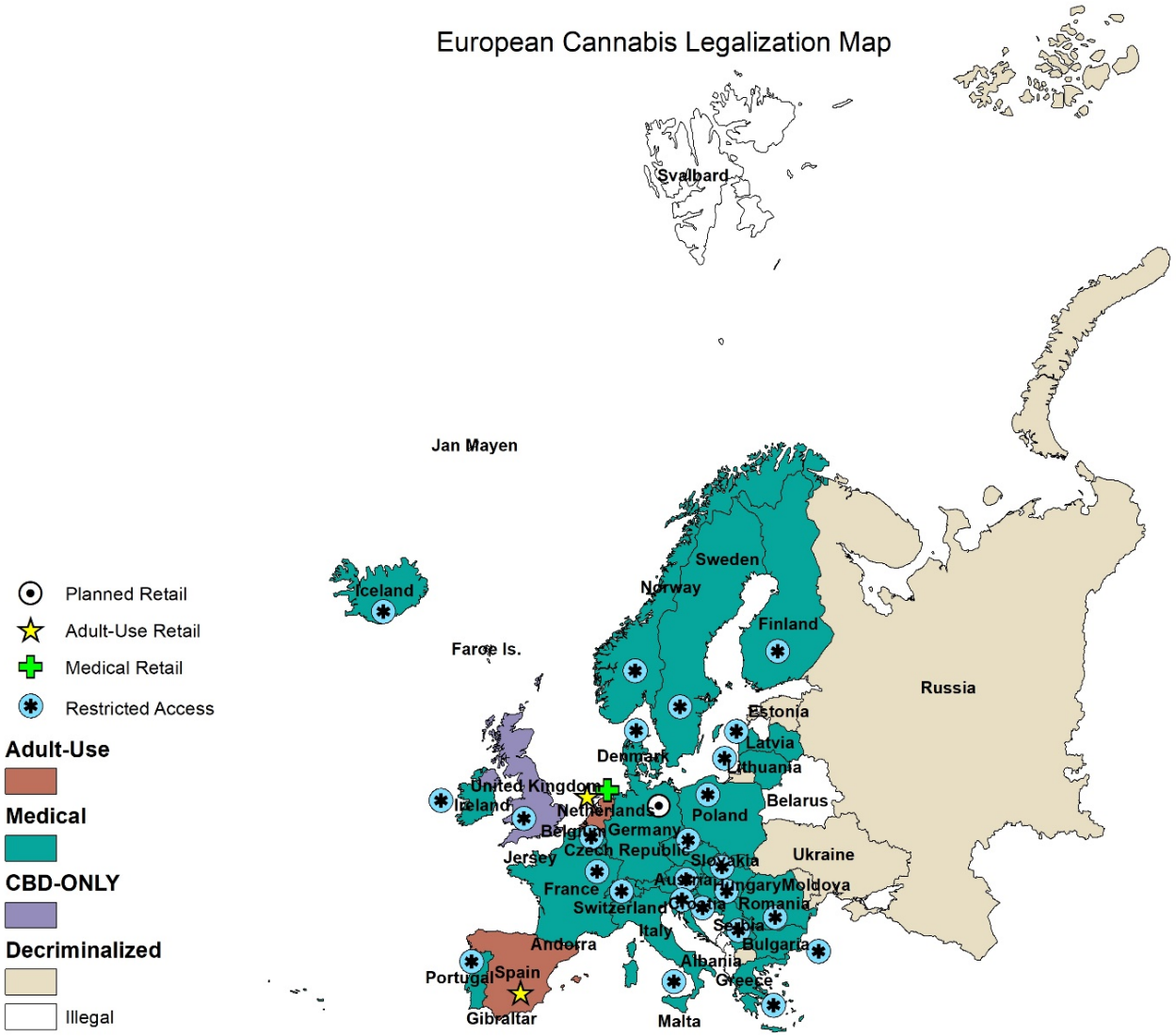

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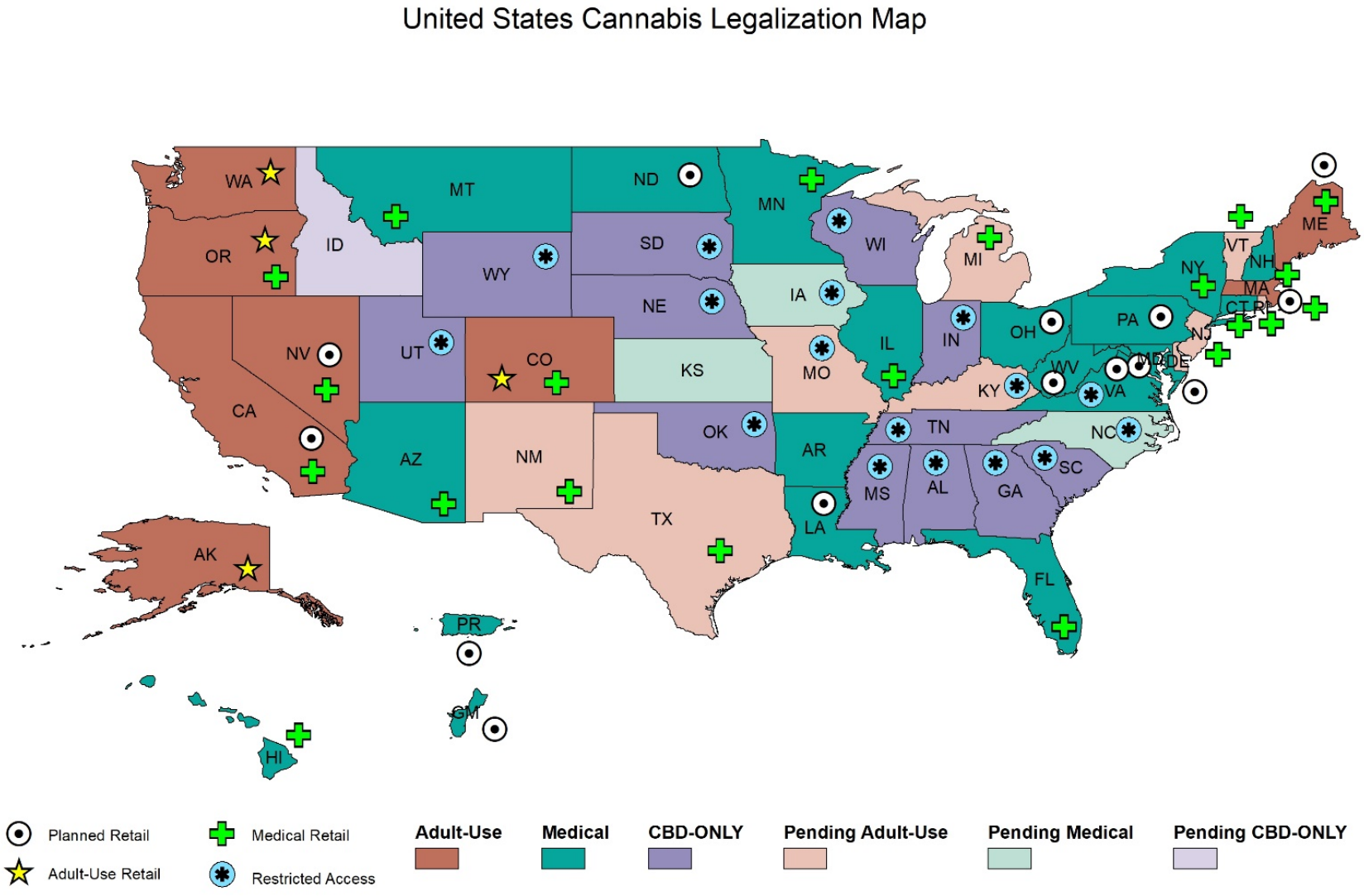
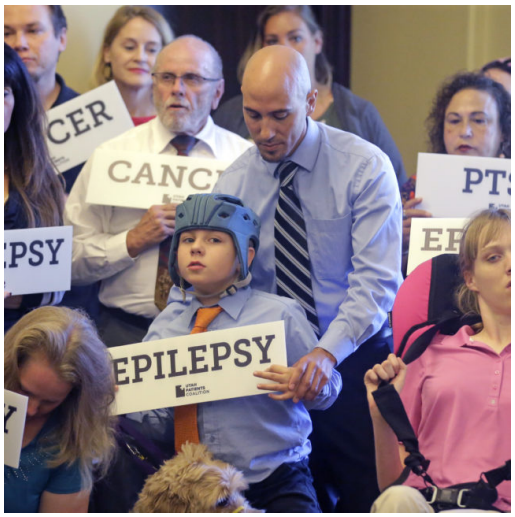


What is Cannabis?

- One of the oldest known domesticated plants
- Many different uses
  - Medicinal
  - Nutritional
  - Industrial
  - Recreational
- Humans have been cultivating, processing, and consuming cannabis and cannabis derived products for more than 10,000 years
- Listed in the US Pharmacopeia up until 1941



Why is the Cannabis Plant Grown?

3 Primary Reasons

– Flowers and resins

– Seeds

– Stalk and fiber

Grown for Seed

Grown for Fiber

Grown for Resin

What Comes from What?

Flower and Resin

Ethanol

Essential Oils

Cannabinoids

Terpenes

Seed

Seed (edible & inedible)

Oil (edible & inedible)

Dietary Fiber

Protein Powders

*Biodiesel

Stalk

Textiles

Composites

Insulative Materials

Paper

Animal Beading

NO CANNABINOIDS IN SEEDS

Marijuana vs Hemp

Marijuana

Cannabis plants grown for flower and resin production

Hemp

Cannabis plants grown for fiber and/or seed production

Post 2018 Farm Bill America

Definition:
The term ‘hemp’ means the plant Cannabis sativa L. and any part of that plant, including the seeds thereof and all derivatives, extracts, cannabinoids, isomers, acids, salts, and salts of isomers, whether growing or not, with a delta-9 tetrahydrocannabinol concentration of not more than 0.3 percent on a dry weight basis.

All cannabinoids other than delta-9-THC have been legalized
– Delta-9-THC-A under debate

USDA regulates cultivation and harvesting practices

FDA regulates food/ drug product quality and safety

Farm bill only addresses cultivation NOT processing

0.3% delta-9-THC
The arbitrary line in the sand?

Marijuana

Cannabis plant ---------- **CBD???** ---------- 0.3% w/w delta-9-THC

Hemp

- 0.3% a number that was influenced by the data at the time
  (0.2% in Europe)
- Is there a better way to distinguish between the different types of cannabis?
- Where does CBD fit?

CBD: Blurring the Lines

Say a cannabis plant contains less than 0.3% delta-9-THC w/w but has a significant concentration of other cannabinoids - Is this hemp or marijuana?

Traditionally hemp has meant little to no resin production
– 2012 marks the normalization of CBD with hemp

The introduction of CBD contradicts the hemp industry's long standing mantra that "hemp is not marijuana"

98% of the "hemp" grown in the US is for CBD production
98% of the "hemp" grown in Canada is for seed
Most of the "hemp" grown in Europe is for fiber
Most of the "hemp" grown in China is for fiber

Fit-for-Purpose Classifications

Where we are now

Marijuana

Hemp

Where we want to get to

Resin cannabis

Nutritional cannabis

Industrial cannabis

Cannabis

Bridging the gap

Classifications of the Cannabis Plant

Resin Cannabis

Nutritional Cannabis

Industrial Cannabis

Fit-for-Purpose Terminology

Resin cannabis, n—any cannabis plant that has been, or is in the process of being, cultivated for the purpose of harvesting or processing the flowers and/or collecting, separating, isolating, or extracting the resins for human/animal consumption or topical use.

– Discussion: High-THC resin cannabis refers to any cannabis plant, raw material, or product containing greater than 1% delta-9-tetrahydrocannabinol (THC) by weight. Low-THC resin cannabis refers to any cannabis plant, raw material, or product containing no more than 1% THC by weight.

Nutritional cannabis, n—any cannabis plant that has been, or is in the process of being, cultivated for the purpose of seed production or any other purpose intended for human/animal consumption or topical use, except for the purposes of producing the flowers and/or collecting, separating, isolating, or extracting the resins.

Industrial cannabis, n—any cannabis plant that has been, or is the process of being, cultivated for the purposes of fiber, textiles, biofuels, bio/phytoremediation, or any other purpose not intended for human/animal consumption or topical use.

Fit-for-Purpose Terminology

Multi-purpose cannabis, n—any cannabis plant that has been, or is in the process of being, cultivated for multiple end uses whether that be for a combination of resin, nutritional, and/or industrial purposes.

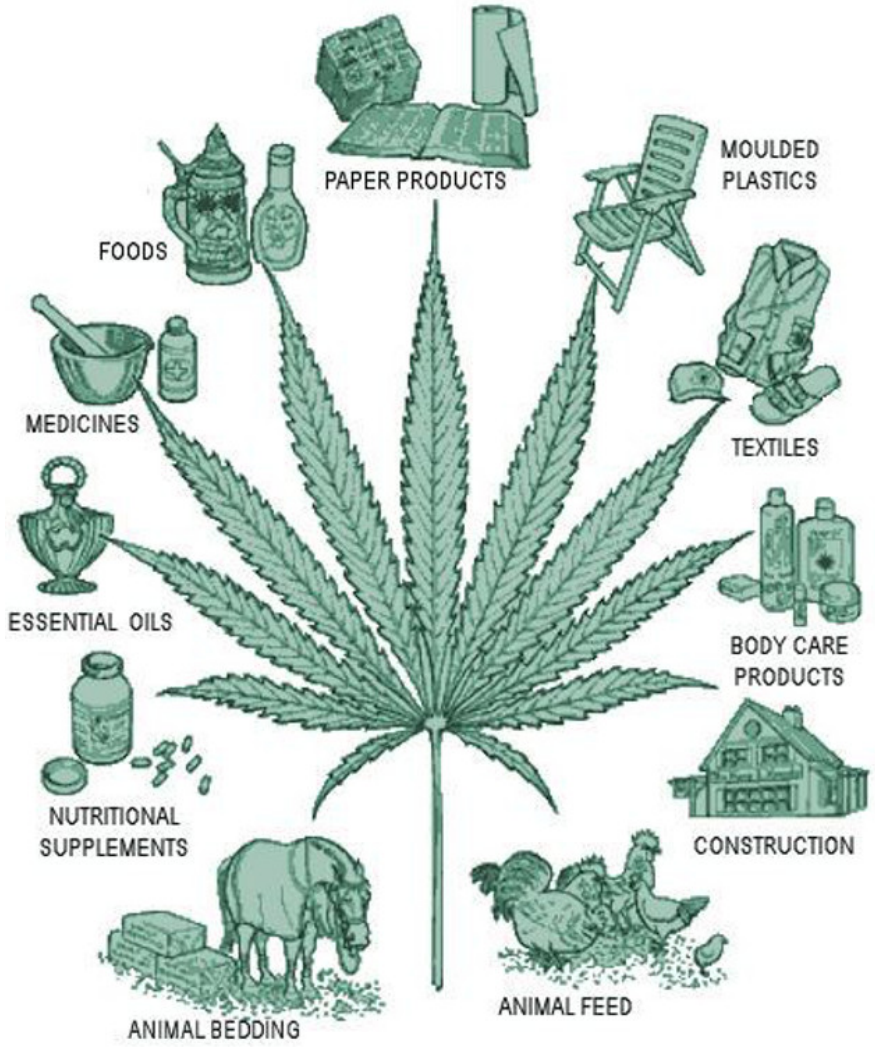
– Discussion: Multi-purpose cannabis should be cultivated and products manufactured therefrom using the standards that apply to the quality and safety of the most stringent “purpose” and/or “use”. Example: Cannabis plants grown for seed and fiber should be cultivated under Good Agricultural Practices, i.e. Food Standards.

Hemp, n—refers to low-THC resin cannabis, nutritional cannabis, industrial cannabis, and multi-purpose cannabis containing no more than the delta-9-THC as defined by the authority having jurisdiction.

Derivable Cannabis Products

Affected Industries

- Aerospace and Shipbuilding
- Agriculture
- Asset Management
- Automotive
- Building and Construction
- Chemicals
- Consumer Products
- Energy and Utilities
- Environment
- Food Processing
- Health Care and Medical Devices
- Information Technology
- Manufacturing
- Metals
- Mining and Mineral Processing
- Oil and Gas
- Plastics
- Quality
- Safety and Security
- Services
- Sports and Leisure
- Textiles and Leather
- Transportation and Logistics



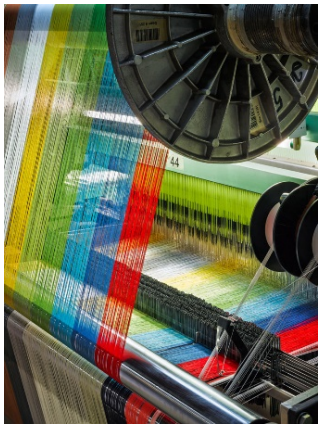
Nutritional Cannabis Products

- Foods
  - Whole seeds
  - Seed kernels (hearts / nuts)
  - Protein powder
  - Dietary fiber
  - Seed oil (raw / refined)
  - Supplements
- Health & Beauty Aids
  - Haircare
  - Skincare
  - Cosmetics
- Animal Feed

Industrial Cannabis Products

- Textiles
  - Fabrics
  - Linens
  - Canvas
  - Rope

- Paper Products
  - Paper
  - Cardboard



- Composites
  - Technical products
  - Molded plastics
  - Bioplastics

Industrial Cannabis Products

- Building Materials
  - Insulation (hempcrete)
- Biofuels
  - Ethanol
  - Diesel
- Animal Bedding

Resin Cannabis Products

- Food & Beverages
  - Confectionary Goods
  - Baked Goods
  - Carbonated Water
  - Soda
- Medicinal Cannabis
- Prescription Drugs

Resin Cannabis Products

- Flower
- Pre-Rolls
- Cigarettes
- Distillate
- THCA Crystals
- CBD Isolate

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Introduction to Seed Processing

Overview of the Various Cannabis Seed Product Manufacturing Processes

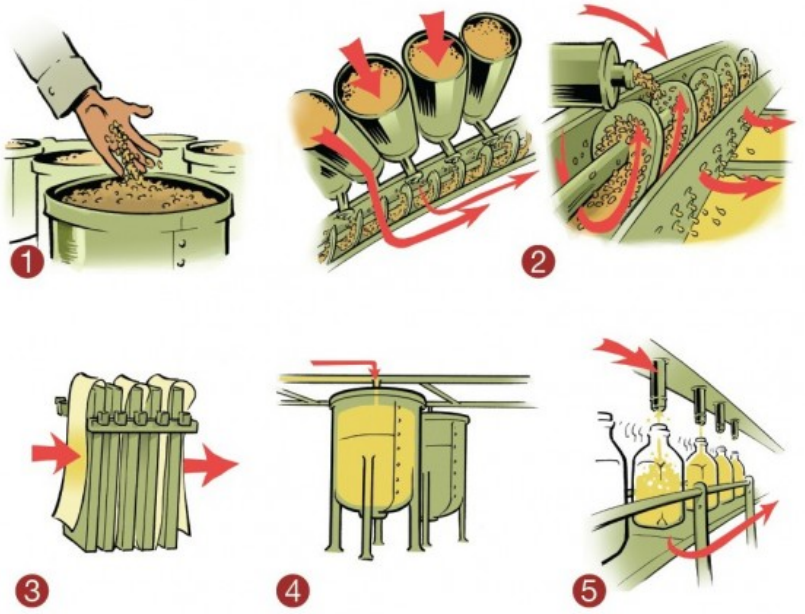
Seed Collection

At the Farm Gate

- Harvesting
  - Threshing
- Cleaning
- Sorting / Grading
- Storage

Seed Oil Manufacturing

- Seeds appropriate for pressing are segregated from those intended for shelling (commercial scale)
- Seeds are cold pressed using expeller presses to extract the oils
- Raw oil is filtered to remove any contaminants (e.g. seed parts)
- Oil can then be further processed to improve flavor, color, and consistency
- Oil is then stored until packaged*



Protein Powder and Dietary Fiber

- Seed cake/meal is produced as a result of seed oil manufacturing
- Recovered cake/meal is ground in course powder
- Powder is refined through a series of sieves and size reduction methods
- Powders are classified based on protein and dietary fiber content
- Protein powders and dietary fiber are packaged in opaque oxygen-deprived containers to preserve freshness

Seed Kernel Manufacturing

- Seeds appropriate for shelling are segregated from those intended for pressing (commercial scale)
- Seeds are feed into a hulling machine which opens the seed
- Seed kernels are separated from the shells/husks
- Kernels are cleaned to remove any dust and shell remnants
- Kernels are packaged in opaque oxygen-deprived containers to preserve freshness

Harvesting for Seed

https://youtu.be/pXfjQFdEaOw

Cannabis Seed Product Manufacturing

https://youtu.be/V6Pn9322jmU

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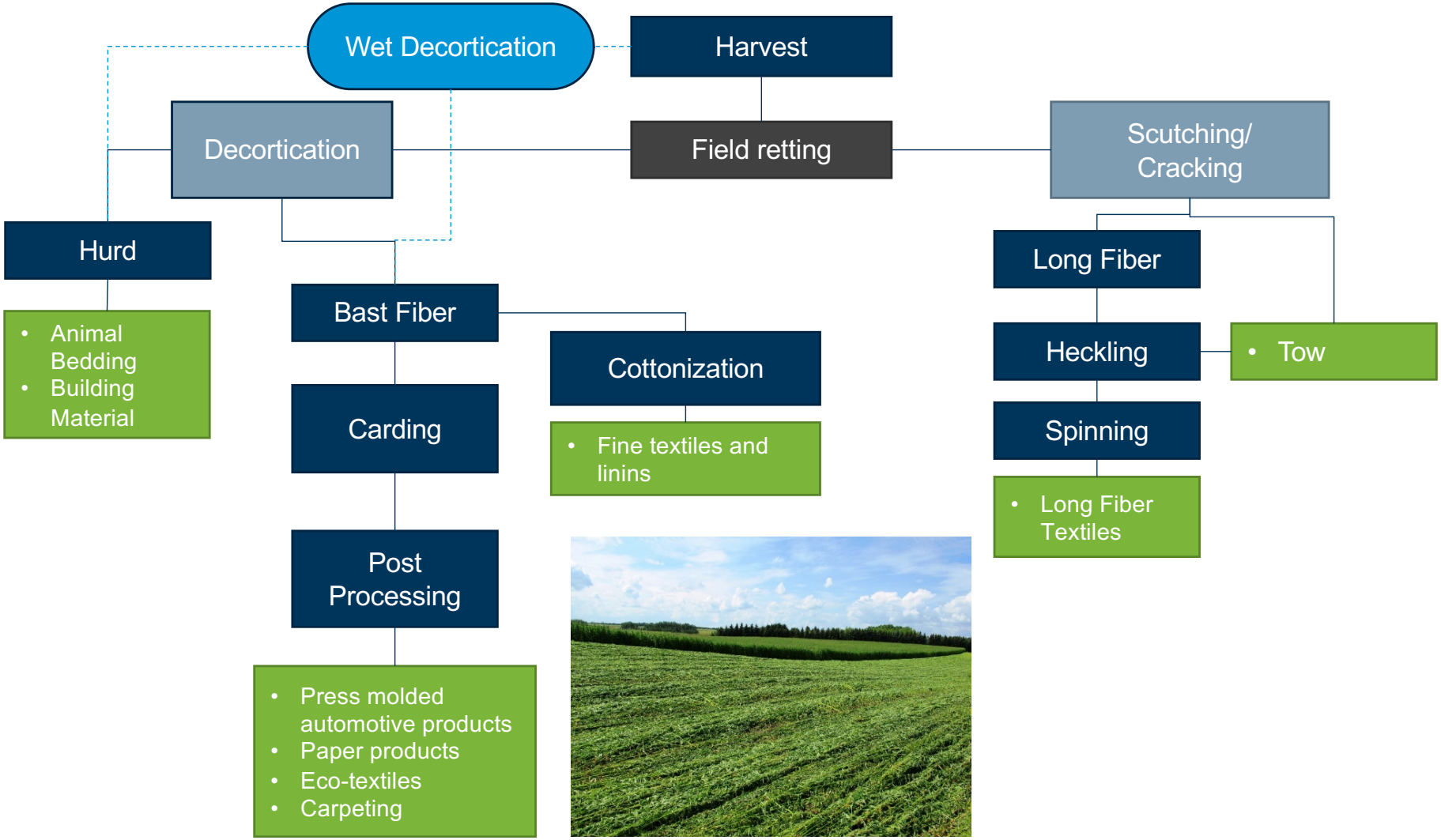
Introduction to Fiber Processing

Process Description and Harvesting Techniques

Cannabis Fiber Manufacturing



Harvesting for Fiber

https://youtu.be/_AKUCvqppy8

https://youtu.be/GJKnz9hlB3Q

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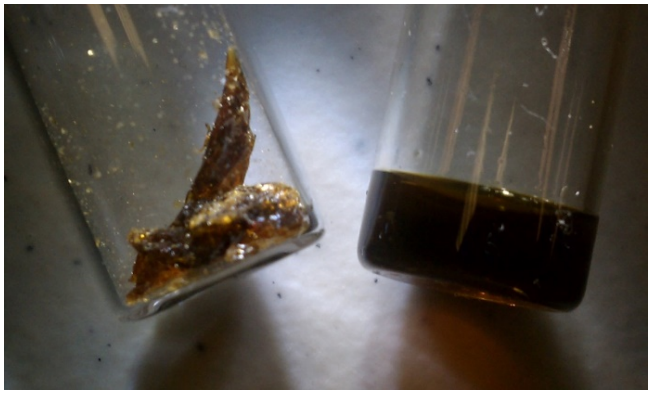
Introduction to Phytocannabinoid Extraction

Extraction Process, Solvents Used & Best Practices

Phytocannabinoid Extracts

Whole Plant

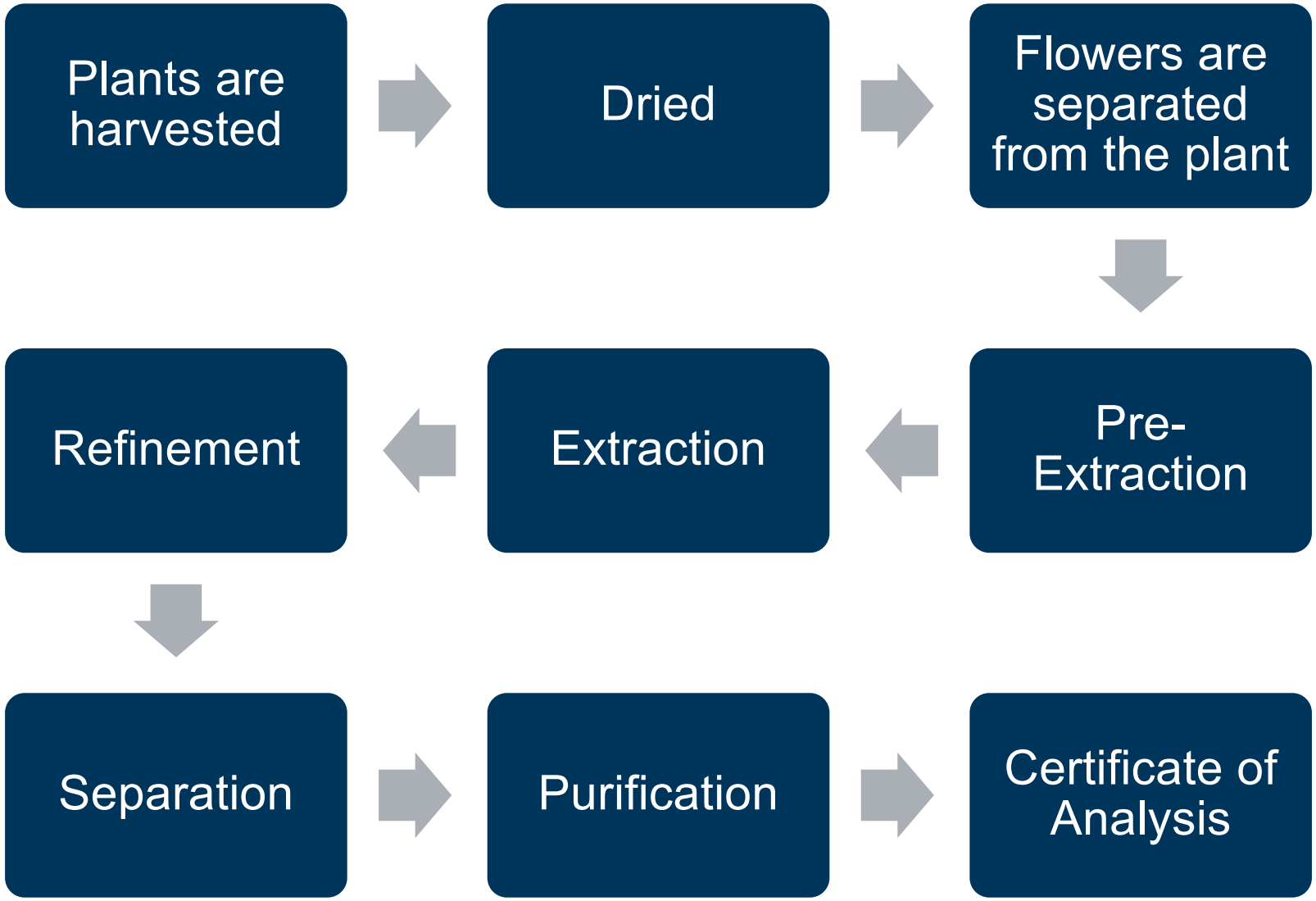
- Multiple synergistic constituents
- Ensemble Effect
- Considered more effective than synthetic cannabinoids and single molecule preparations
- Varying composition
- Concentration: 40% - 80% w/w



Mono-cannabinoid

- Single cannabinoid
- Known composition
- Ideal for formulation
- Concentration: 98+% w/w

Overview of the Phytocannabinoid Extraction Process



Harvesting for Resins (manual)

https://youtu.be/U6-UX4sHTaA

Harvesting for Resins (mechanized)

Whole Plant

https://youtu.be/479x7CWdzro

Destemming

https://youtu.be/UdOG4Ua4Pmc

Harvesting for Resins (continued)

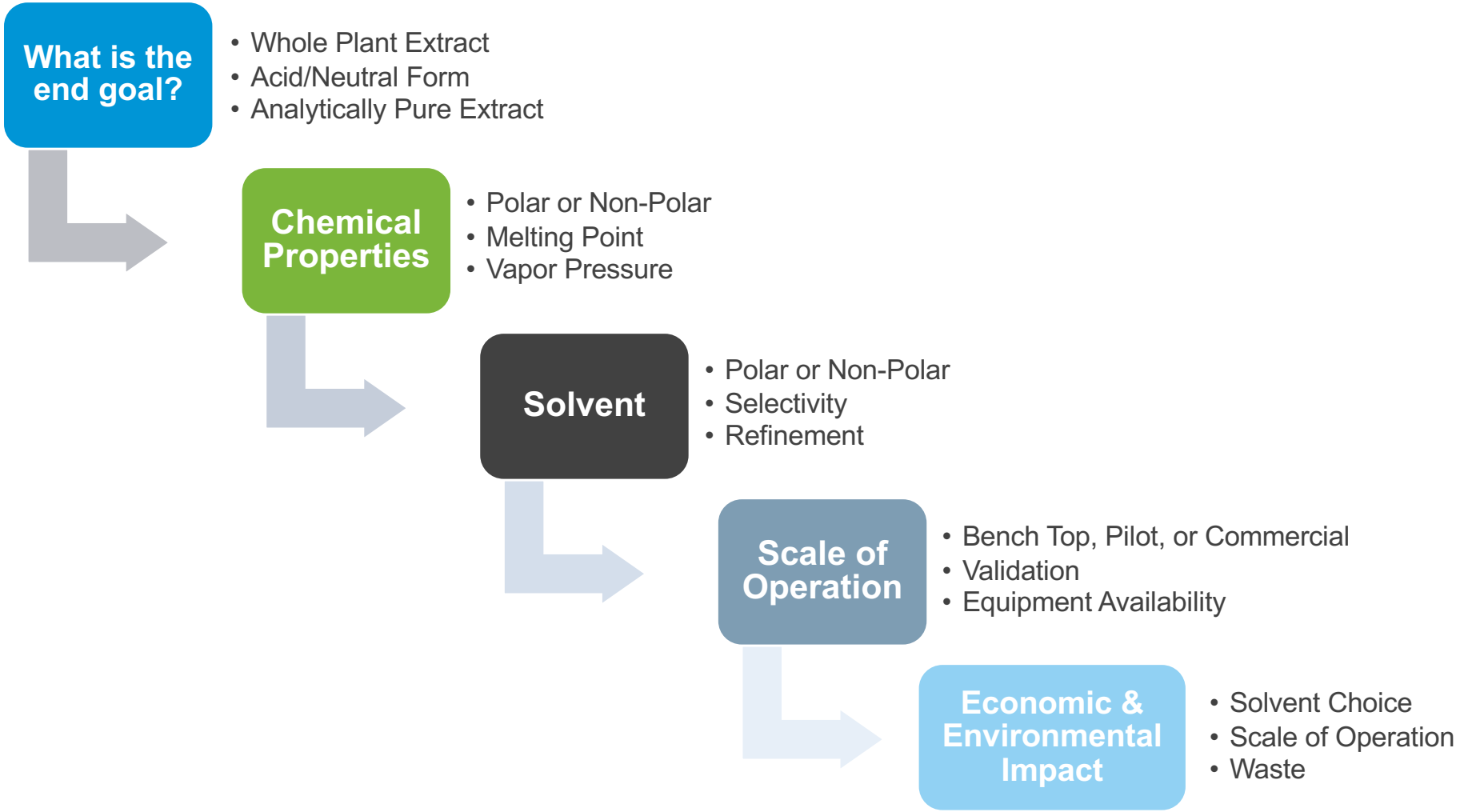
Processing for Flower

https://youtu.be/HizEep0MFeA

Processing for Extraction

https://youtu.be/PgGHXecDzO8

Designing Extraction Trains



Solvents Used in Industry

Organic Liquid Solvents – traditional solvents used for centuries, inexpensive, some waste, 90+% recycling efficiency

– Methanol, Ethanol, Hexane & Cyclohexane, Chloroform

– Some are known carcinogens and poisons, unfit for human consumption, requiring strict safety and handling as well as mandatory residual solvent analysis

CO2 – standard in pharmaceutical industry, inexpensive, carbon neutral, high batch to batch reproducibility, 90+% recycling efficiency

– Highly selective

Propane & Butane – used in no other industry to produce extract intended for human consumption

- Extremely flammable, appropriate HVAC, VOC, and explosion precautions required when operating in an enclosed space

Phytocannabinoid Extraction Considerations

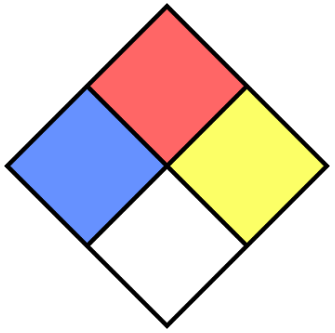
Compliance is key
- Stay on top of globally changing regulations – Single Convention

Know your building, electrical and fire codes
- Mistakes will lead to costly downtimes or worse
- Class 1 Division 1 Requirements (intrinsically safe, explosion proof, spark-less environments) – ATEX Zone 0, I and II and IECEx equivalence

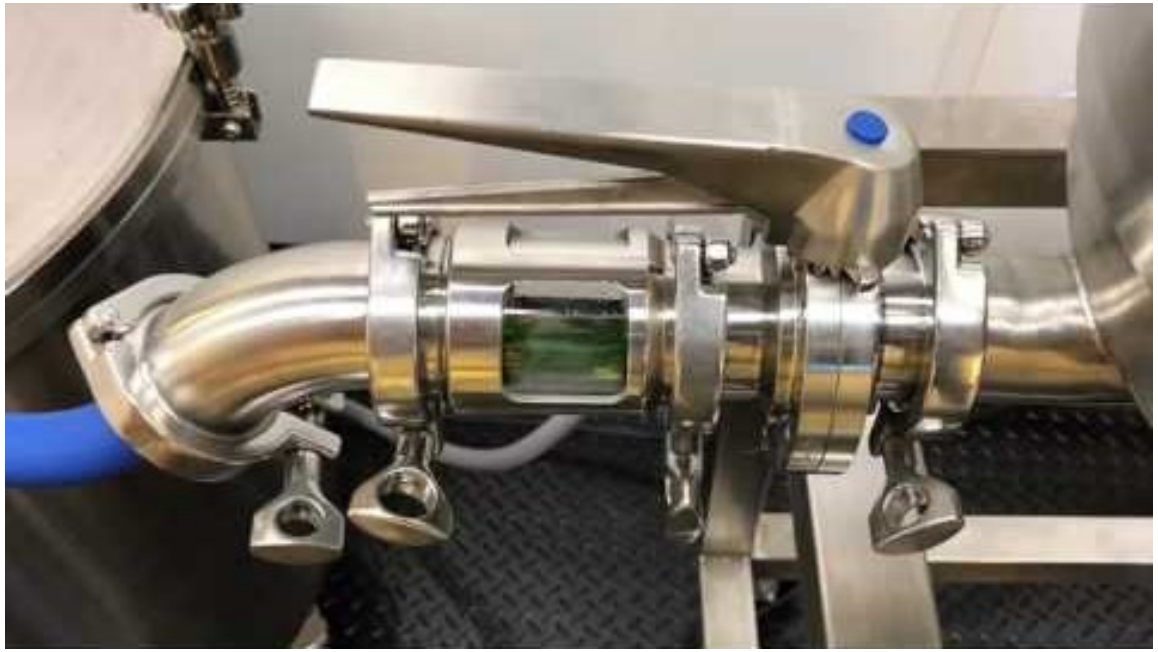
VOC ventilation is critical
- CO2 is a dense gas that sinks to the ground, and expands rapidly causing asphyxiation and death
  - Complete air exchange in under 60 seconds
- Propane < Butane < Air

Not all equipment is the same
- Stamped and Certified pressure vessels and connecting lines are critical (ASME VIII Boiler and Pressure Vessels)

Reclamation of Used Solvent
- Environmental impact
- May contain contaminants
- Must be redistilled prior to reuse



Phytocannabinoid Extraction Process



https://youtu.be/PfgFh6ksBKs

Common Packaging Materials

- Resins
  - Plastic
  - Glass
- Flowers
  - Super sacks
  - Plastic
  - Glass
- Pre-Rolls
  - Hand made
  - Cigarette knock off

Common Packaging Materials

- Seeds & Seed Oils
  - Plastic
  - Mylar bags
- Fiber
  - Super sacks
- Shives
  - Plastic bails

How Are Products Sold?

Resin	Flower	Seed	Seed Oil	Fibers	Shives

• By weight
  • gram
	• By weight
	  • gram
	  • oz.
	  • lb.
	• By count
	  • sacks / totes
		• By weight
		  • oz.
		  • lb.
		• By count
		  • units
		  • sacks / totes
			• By volume
			  • fl. oz.
			  • gal.
			• By count
			  • barrel / drum
				• By count
				  • ft.
				  • bails
					• By weight
					  • lb.
					  • tones

B2B: Consumer Base

Processors

Purchase bulk flower, seed, or stalk from the farmer

Process those raw materials into more valuable commodities

Product Manufacturers

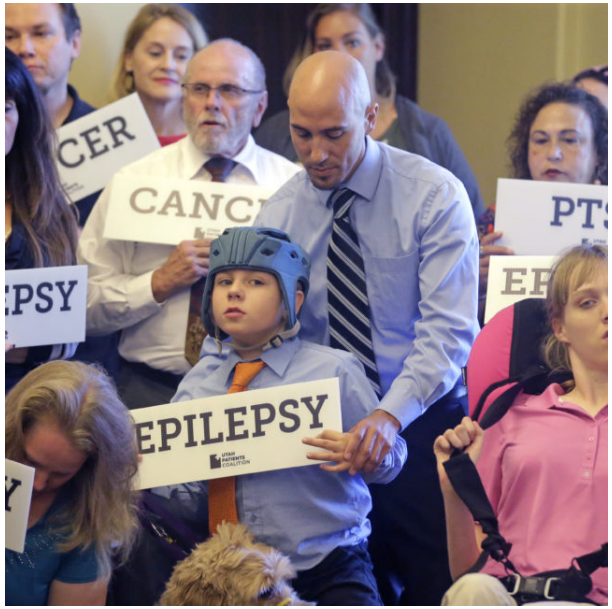
Purchase bulk ingredients or raw materials from processors

e.g. whole seed, seed oil, stalks (bails) raw fibers, shives, extracts, etc.

Retail Outlets

Purchase finished products from manufacturers

B2C: Consumer Base



Cannabinoid Dependent

Reliant on cannabinoid therapies to have a normal life

Health Conscious

Healthy Lifestyle

Vegetarian & Vegan

Meat Substitute

Athletes & Body Builders

Adult-Use

Advocates

Enthusiasts

Naïve Consumer

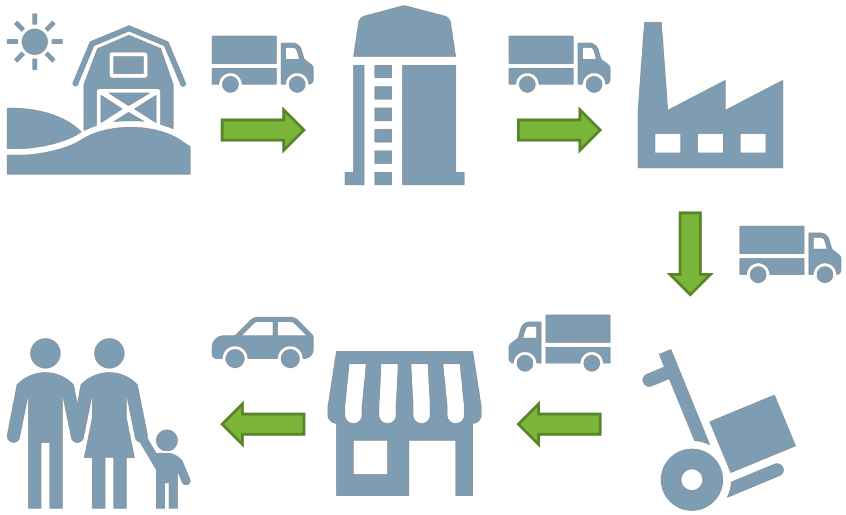
Supply Chain Logistics

- Vertically Integrated Model
  - Expensive to start
  - $30 mm to $50 mm to setup fiber, seed, or flower processing
  - 150 km from the field (seed & fiber)
- Cooperative Model
  - Spilt the cost of startup
  - Work together to process and sell goods
  - Reduce risk
- Outsource Model
  - Lowest CAPEX
  - Requires fully mature market

Supply Chain Logistics

Seed to Shelf

- Farmer
  - Transportation
- Seed Cleaner (if applicable)
  - Transportation
- Processor
  - Transportation
- Product Manufacturer
  - Transportation
- Warehouse/ Fulfilment Center
  - Transportation
- Retail Outlet (or online)
  - Transportation
- Consumer



For More Information

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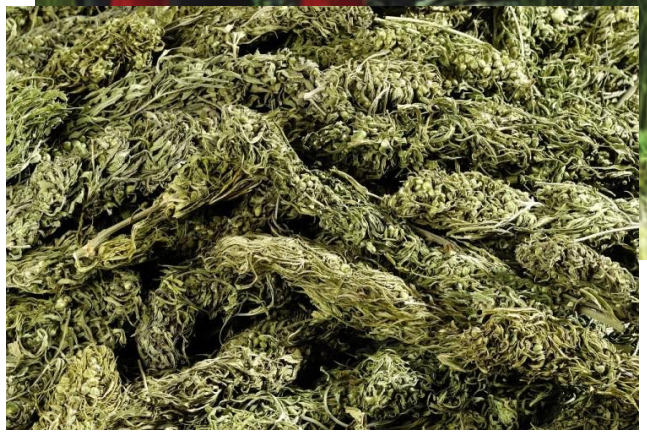
Types of Cannabis

Cannabis sativa

Cannabis indica

Cannabis afghanica

Cannabis Seed Oil Manufacturing



Bioactive Compounds of the Cannabis Plant

- Cannabinoids – 113 known
  - THC, THC-A, CBD-A, CBD, CBN, CBG, CBC, THCV, CBDV…
  - Affect the CB1 and CB2, other ECS and various brain receptors & various liver enzymes
- Terpenes & Terpenoids – 140 known
  - Naturally occurring hydrocarbons based on isoprene unit
  - Terpenoids – related to terpenes, include some oxygen functionality or rearrangement
- Flavonoids - 23
  - Another class of botanical secondary metabolites; act as pigments
  - Cannaflavin A and B – unique to cannabis
- Essential oils
  - Phenols (only 34 non-cannabinoid phenols known)
  - Alcohols, aldehydes, ketones, acids, esters and lactones

Other bioactive compounds

Various Hydrocarbons – 50 known
Nitrogen containing compounds
Carbohydrates
Essential Fatty Acids – Omega 3, 6 & 9
Non-cannabinoid phenols
Phytosterols – 11
Vitamin K
Carotene & Xanthophylls (pigments)
Various elements: Na, K, Ca, Mg, Fe, Cu, Mn, Zn, Hg, etc.

The Brass Tax

Resulting Products:

- Seed Oil = Essential fatty acids
- Seed Cake = Protein, Vitamins & Minerals
- And so much more!

Per Acre Yield
~20.5 gal seed oil
~472.5 lb. seed cake

THC Content in Food Products

How much is too much?

- Varies from country to country
- US:
  - 5 ppm in seed oil
  - 1.5 ppm in hulled seed
- Canada:
  - 10 ppm in seed oil
  - 10 ppm in whole seed
- NOVA-Institute & EIHA Recommendations:
  - 10 ppm in seed oil
  - 5 ppm in whole seed
  - 2.5 ppm in hulled seed
  - 3.5 ppm in flour/protein powder
- What about other foods? Scientifically Sound Guidelines for THC in Food in Europe

Standards for THC content in food products will allow for greater market acceptance of cannabis-based nutritional goods.

Images

More Images