Preliminary Results and Lessons Learned Initiating Hemp Research at NMSU

Hanah Rheay[1], Kevin Lombard[2], Rebecca Creamer[3], and Catherine Brewer[1]

[1] Department of Chemical and Materials Engineering, New Mexico State University

[2] Farmington Agricultural Science Center / Department of Plant and Environmental Sciences, New Mexico State University

[3] Department of Entomology, Plant Pathology, and Weed Science, New Mexico State University

Specialty Crops Workshop | June 8, 2023

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What is Hemp?

- Hemp is defined by the USDA as ***Cannabis sativa* L. containing ≤ 0.3% total tetrahydrocannabinol (THC)**

- U.S. re-legalized crop in 2018, following nearly 70 years of prohibition

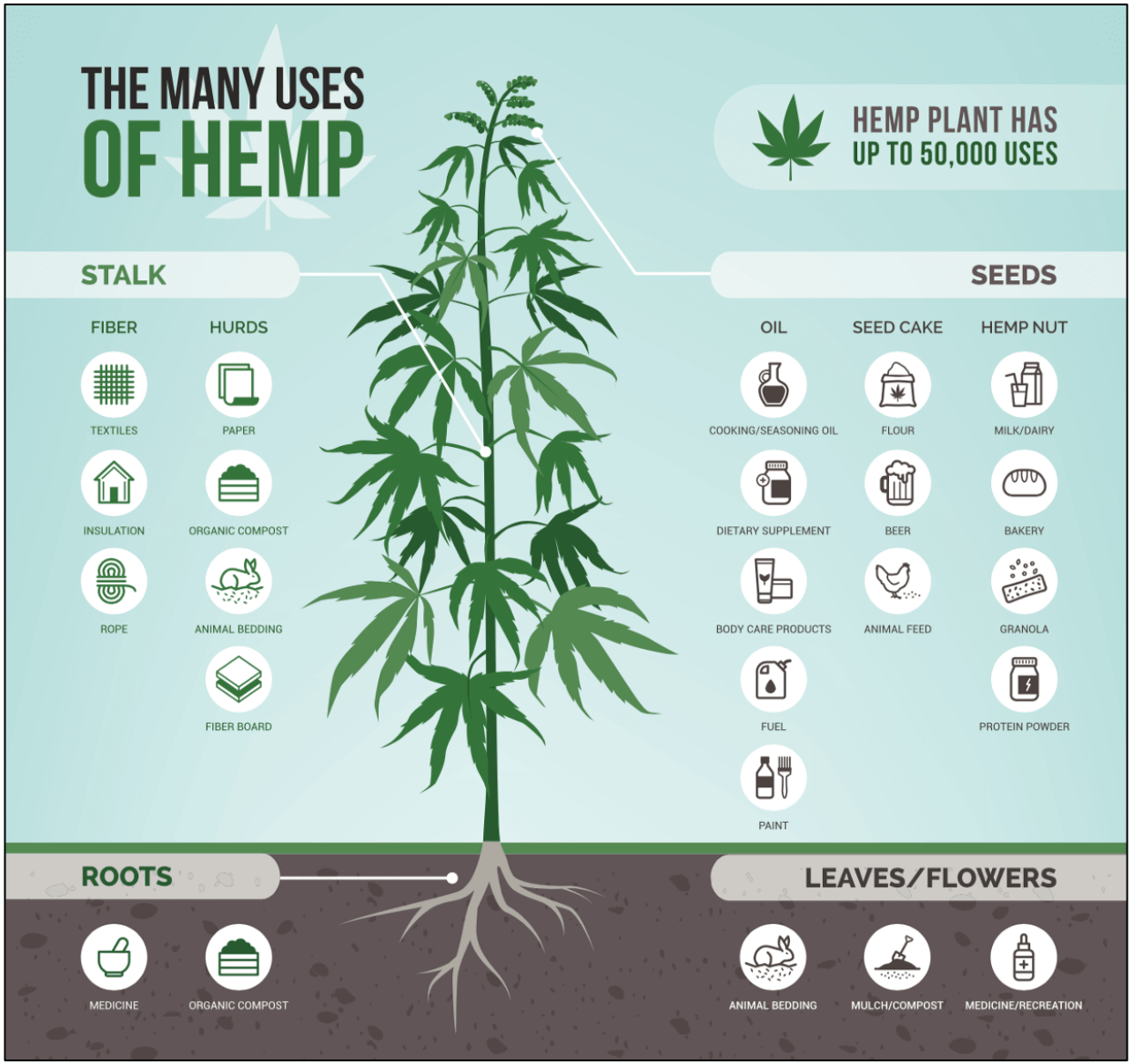


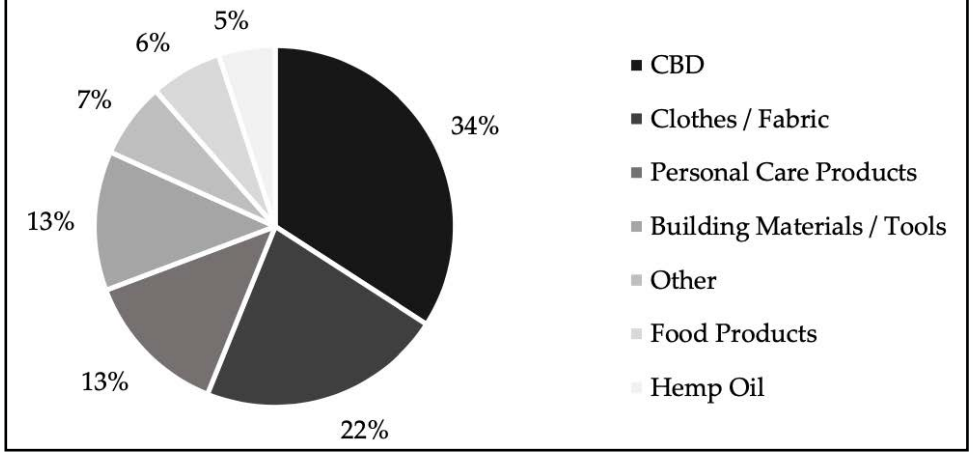
Image from Bloodhound Hemp Farms, 2020

Types of Industrial Hemp

- Types of hemp:
  - Flower (high-cannabinoid or essential oil)
  - Fiber
  - Grain
- US market *initially* dominated by cannabidiol (CBD) products – this is changing!

Different hemp types: (left) CBD-type; (right) industrial-types

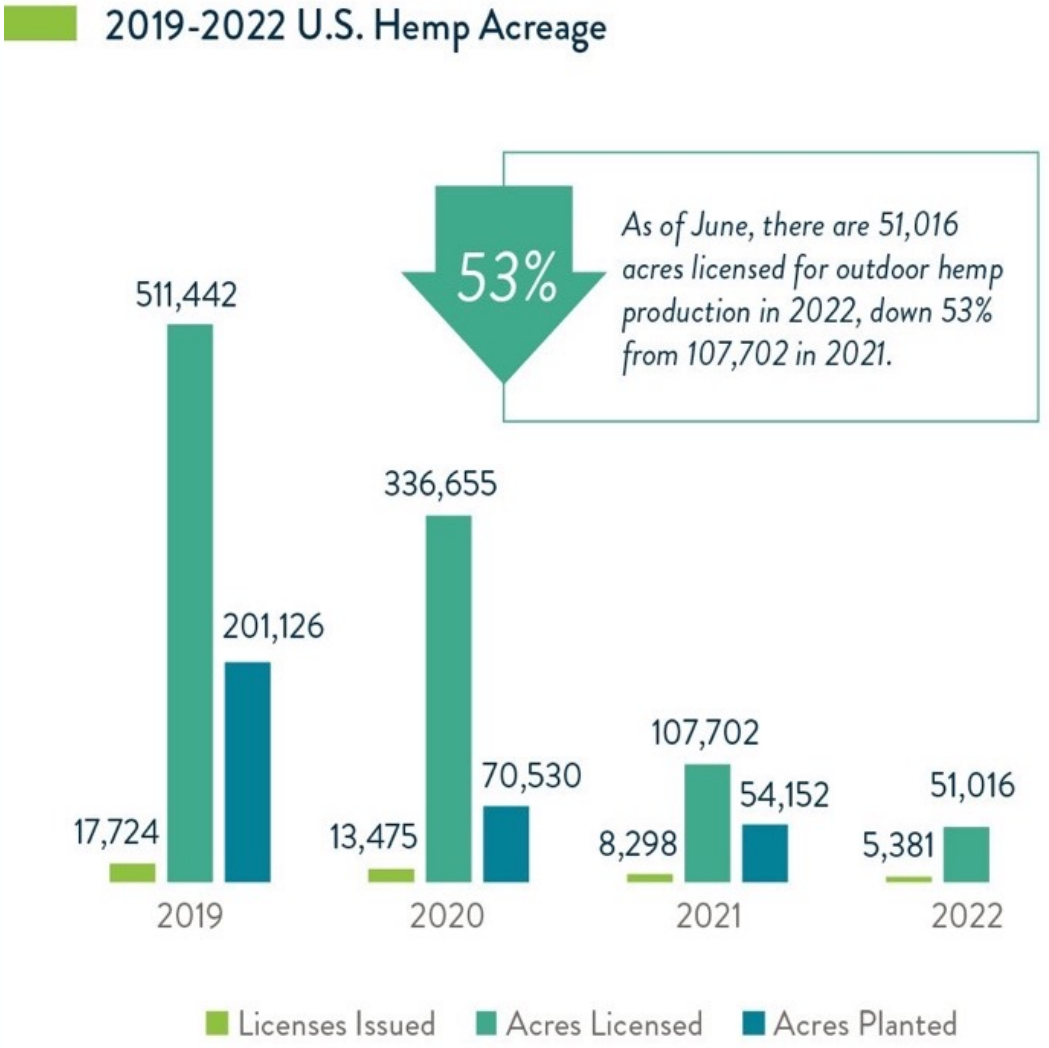
Hemp Products Purchased by U.S. Consumers (Kodilinsky et al., 2019)



Kolodinsky, J., Lacasse, H., & Gallagher, K. (2020). Making hemp choices: Evidence from Vermont. Sustainability, 12(15), 1–15. https://doi.org/10.3390/SU12156287

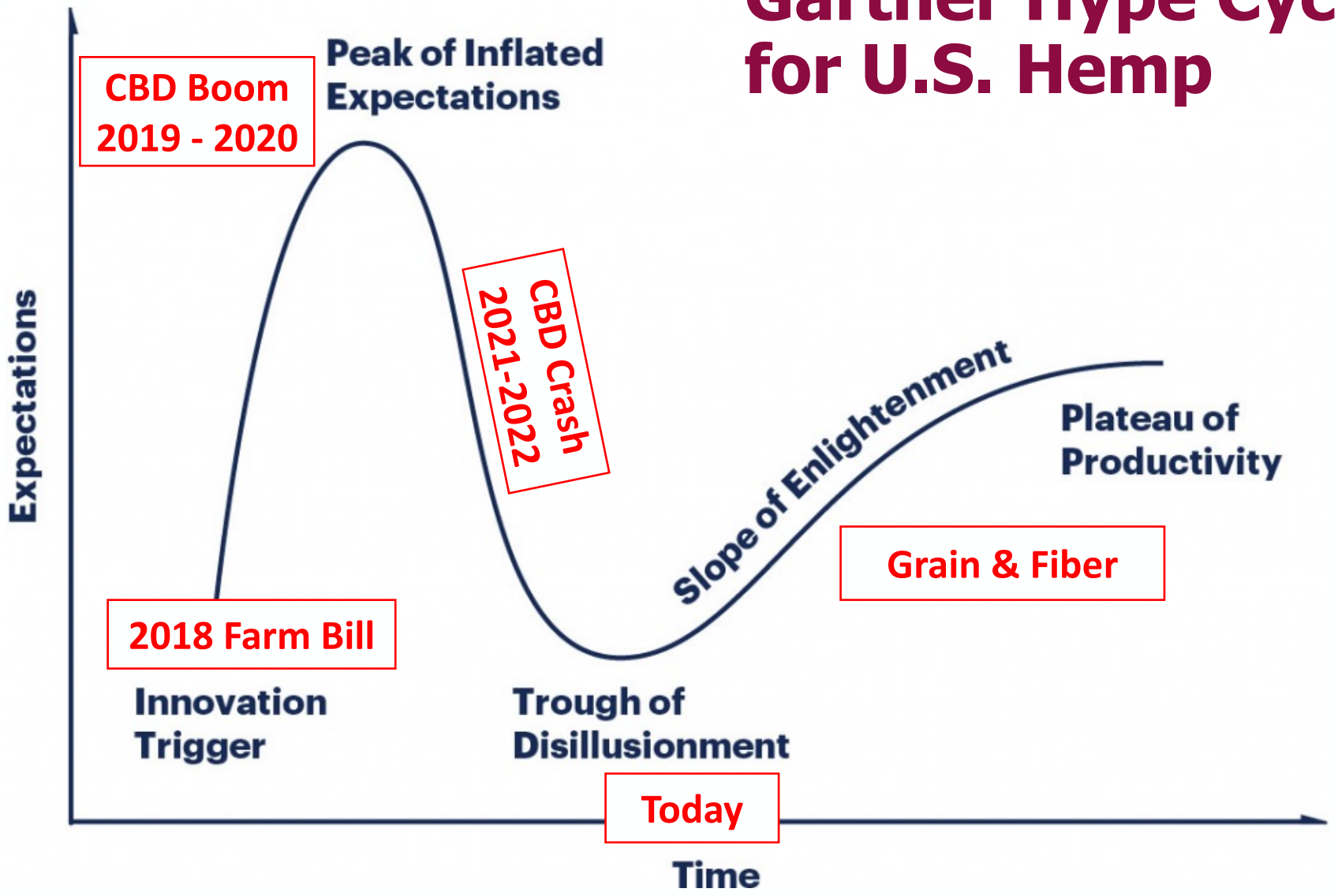
Current State of Hemp in NM

- Decrease in hemp licenses issued in NM mirrors nationwide 53% drop in outdoor production
- NM recreational *Cannabis* sales went live April 1, 2022



Singular, E. (2022). Midterm Review: A 2022 U.S. Hemp Production Outlook. New Frontier Data. https://newfrontierdata.com/cannabis-insights/midterm-review-a-2022-u-s-hemp-production-outlook/

Gartner Hype Cycle for U.S. Hemp



Overview: Hemp Research at NMSU

- Phytoremediation trial (2019-2020)
- NMSU initial variety trial (2019-2020)
  - Farmington
- Expanded variety trials (2021-2022)
  - Leyendecker, Los Lunas, Alcalde

BHP

Rio Algom

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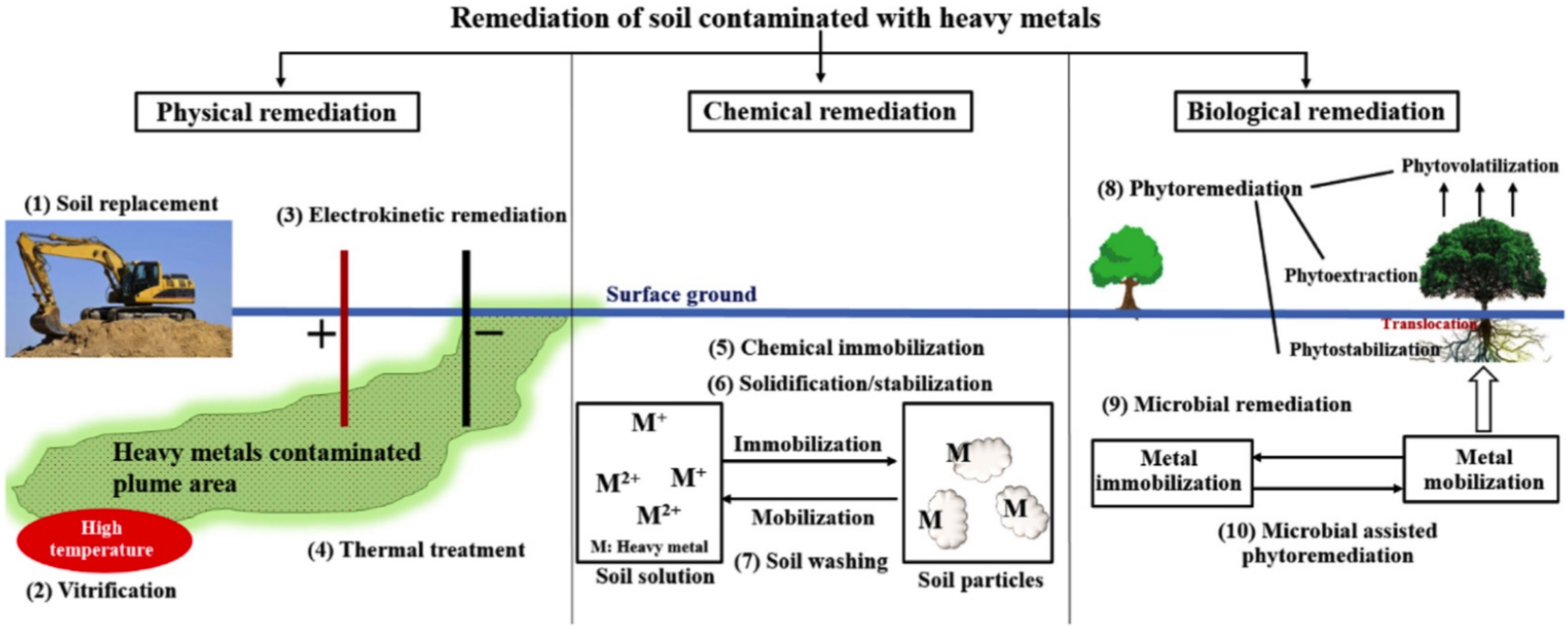
Soil Remediation

- Traditional methods have high environmental impacts
- Interest in improving sustainable biological practices



Gong, Y., Zhao, D. and Wang, Q. (2018). An overview of field-scale studies on remediation of soil contaminated with heavy metals and metalloids: Technical progress over the last decade. Water Research, 147, 440-460. https://doi.org/10.1016/j.watres.2018.10.024

Phytoremediation Technologies

- Issues with large-scale implementation
- High cost without product potential

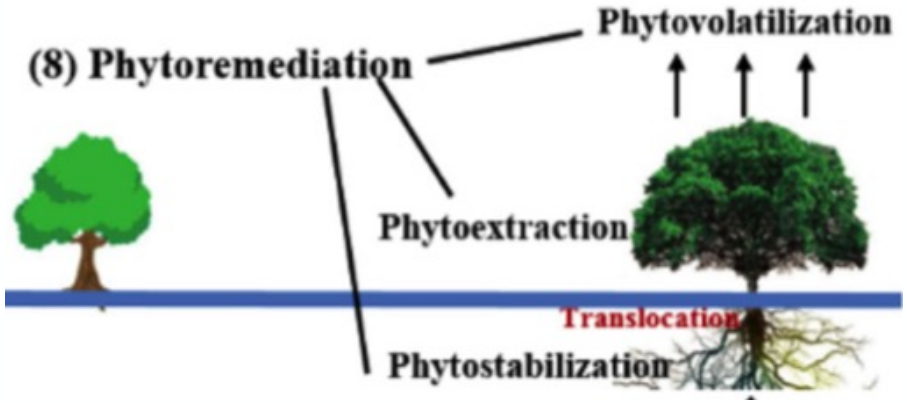


Table 1: Comparison between phytoremediation technologies

Technology	Action on Contaminants	Main Type of Contaminants	Vegetation
Phytostabilization	Retained *in situ*	Organics and metals	Cover maintained
Phytodegradation	Attenuated *in situ*	Organics	Cover maintained
Phytovolatilization	Removed	Organics and metals	Cover maintained
Phytoextraction	Removed	Metals	Harvested repeatedly

Gong, Y., Zhao, D. and Wang, Q. (2018). An overview of field-scale studies on remediation of soil contaminated with heavy metals and metalloids: Technical progress over the last decade. Water Research, 147, 440-460. https://doi.org/10.1016/j.watres.2018.10.024

Greipsson, S. (2011). Phytoremediation. In *Nature Education Knowledge* Vol. 3, Issue 10, p. 7). Nature Education Knowledge. https://www.nature.com/scitable/knowledge/library/phytoremediation-17359669/

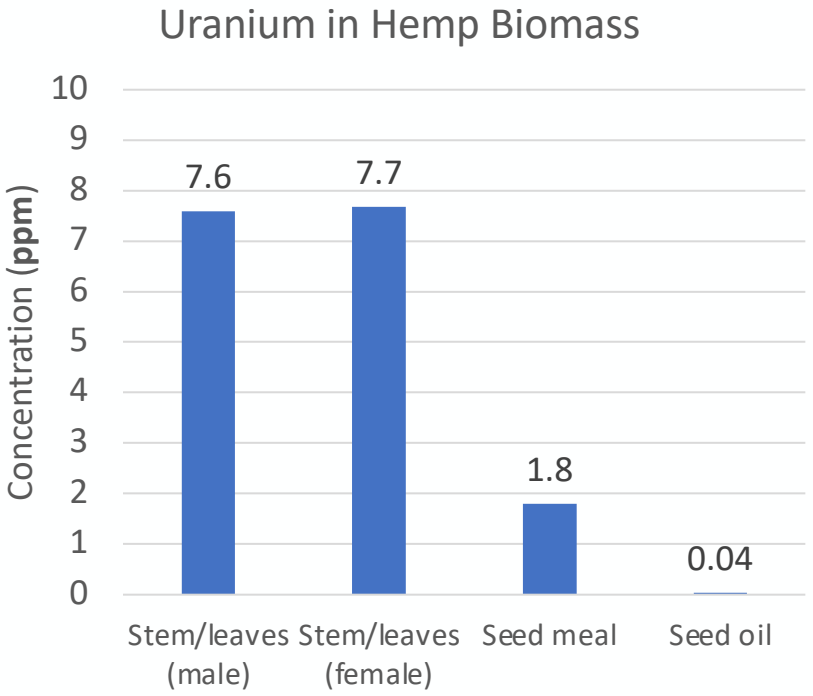
Hemp as a Phytoremediator

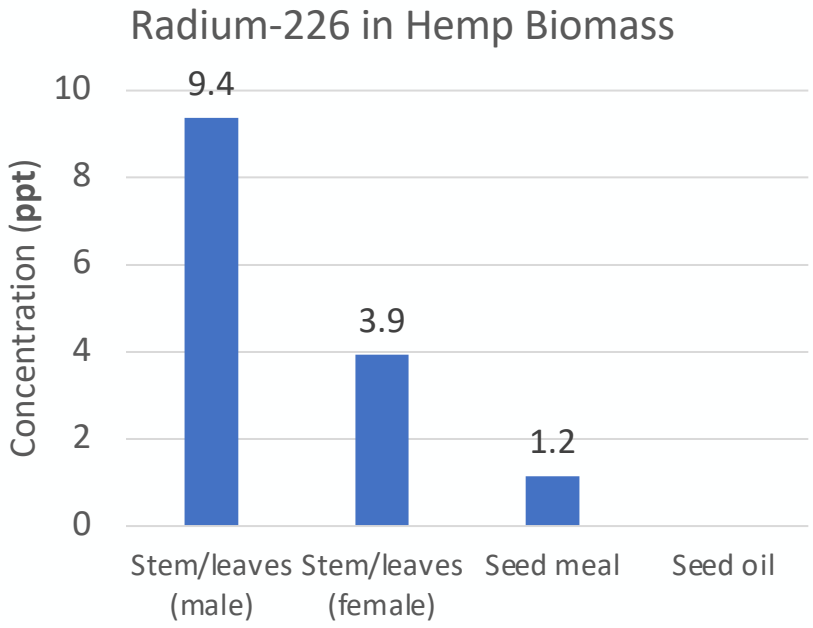
Compound	Literature
Cadmium (Cd)	Citterio et al., 2003; Di Candilo et al., 2004; Linger et al., 2002; Meers et al., 2005
Cesium (Cs)	Szekely, et al., 1994
Chromium (Cr)	Citterio et al., 2003
Copper (Cu)	Meers et al., 2005
Lead (Pb)	Di Candilo et al., 2004; Linger et al., 2002; Meers et al., 2005
Nickle (Ni)	Citterio et al., 2003; Linger et al., 2002; Meers et al., 2005
Radium (Ra)	Soudek et al. 2006
Selenium (Se)	Stonehouse et al., 2020
Strontium (Sr)	Hoseini et al., 2012
Thallium (Tl)	Di Candilo et al., 2004
Zinc (Zn)	Meers et al., 2005; Shi and Cai, 2010

Rheay, H.T., Omandi, E.C., and Brewer, C.E. (2020). Potential of hemp (Cannabis sativa L.) for paired phytoremediation and bioenergy production. *GCB Bioenergy, 13*(4), 525-536. https://doi.org/10.1111/gcbb.12782

Phytoremediation of Radionuclides

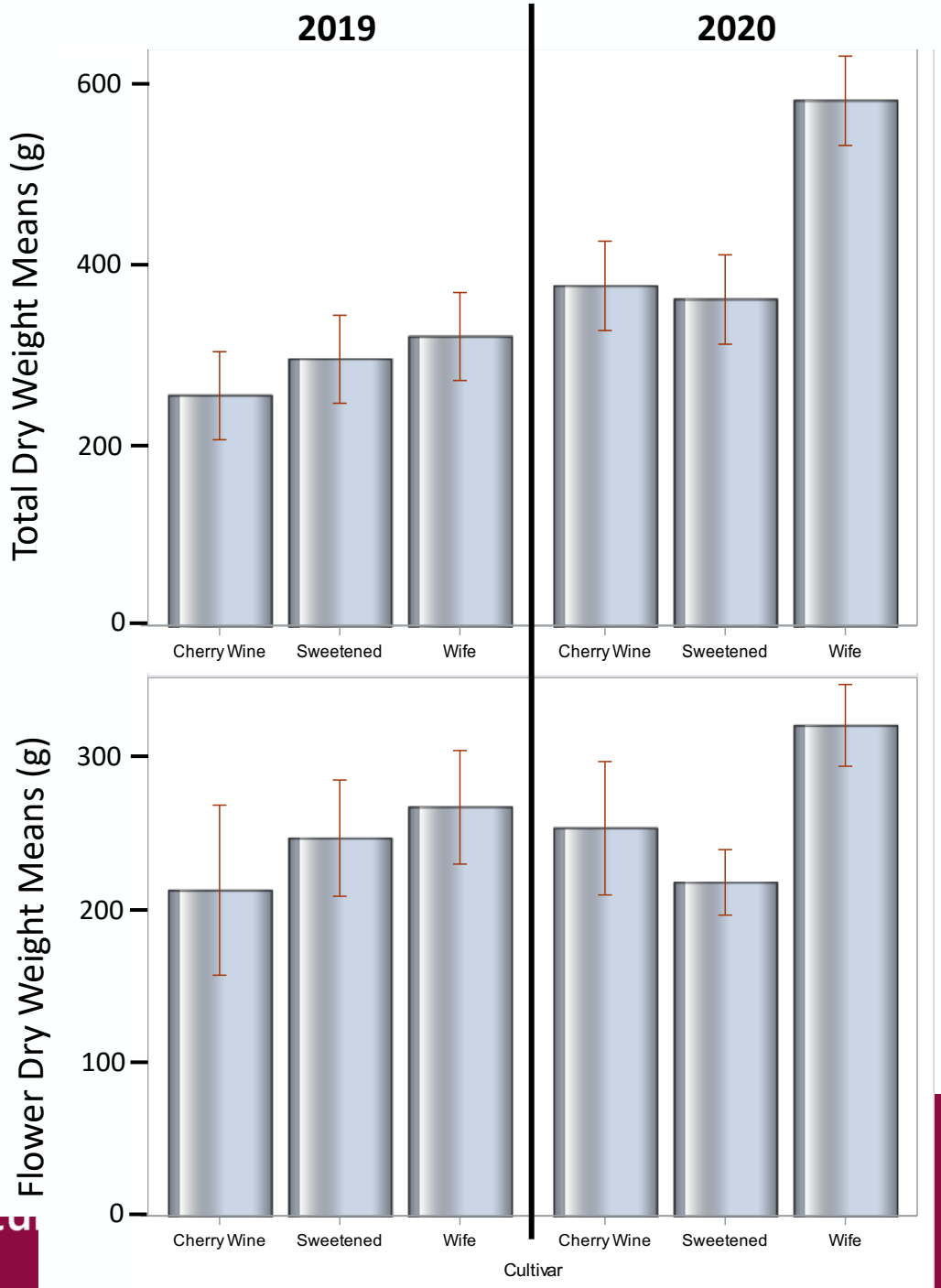
- 100+ years of production to reduce soil contamination to safe levels
- Low concentration of contaminants in oil increase the potential for use in non-food, fuel/material applications





2019-2020 Farmington Harvest Data

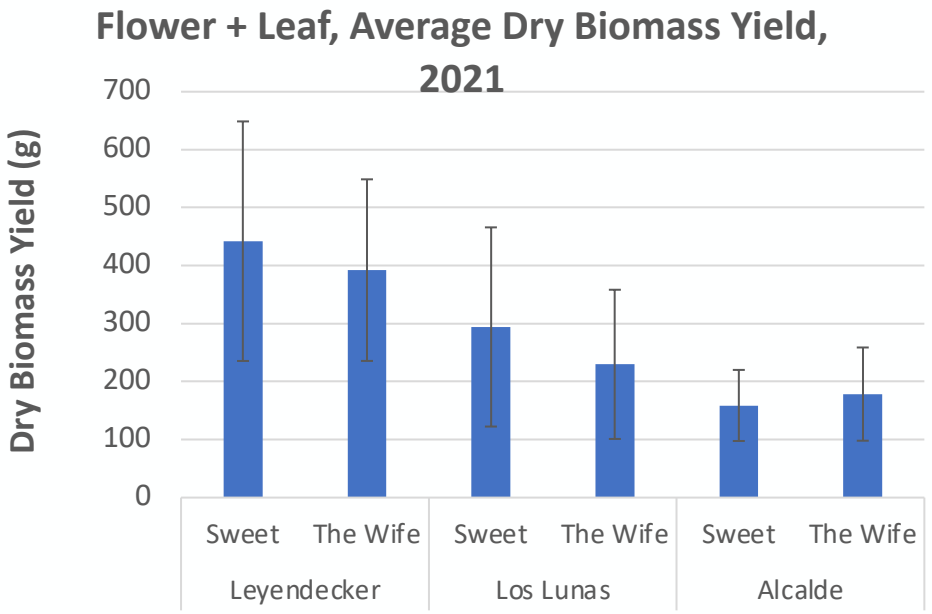
- 2019: over-head sprinkler + hand fertilization; planted mid-July
- 2020: drip irrigation + fertigation; planted mid-June

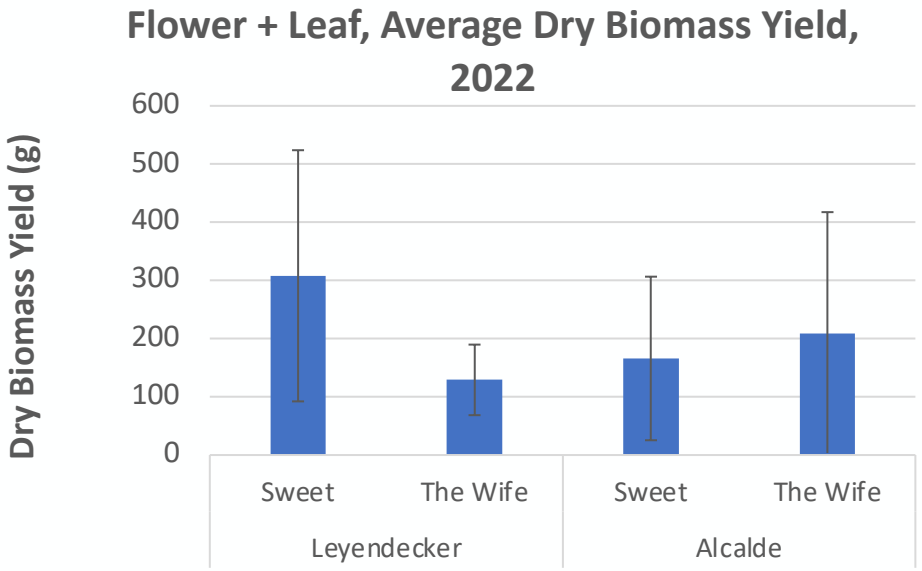


2021-2022 Variety Trials

- Yields are poor compared to indoor potential

- 30-70% of total crop weight was fiber across all sites/varieties





Photoperiod Response

- 6 of 7 varieties exhibited early reproductive behavior
- MS-77 grew normally

Growth Stages Key	
	Sowing
	Vegetative Growth
	Reproductive Growth / Maturation
	Harvest

A. Anka (2021)

Site	Days in Season	April	May	June	July	August	September
Expected	92-113			~75 days			
Leyendecker	111			25			
Alcalde	75				30		

B. Altair (2021)

	Days in Season	April	May	June	July	August	September
Expected	92-113			~ 75 days			
Leyendecker	111			25			
Alcalde	75				30		

C. Earlina (2021)

	Days in Season	April	May	June	July	August	September
Expected	115-120			~ 75 days			
Leyendecker	111			13			
Alcalde	75				22		

D. MS77 (2021)

	Days in Season	April	May	June	July	August	September
Expected		Data not available					
Leyendecker	111			N/A [1]			
Alcalde	75				N/A [1]		

E. Orion 33 (2022)

	Days in Season	April	May	June	July	August	September
Expected	138-143			~ 100 days			
Leyendecker	148		44				
Los Lunas	140			50			
Alcalde	138			55			

F. Felina 32 (2022)

	Days in Season	April	May	June	July	August	September
Expected	133-138			~ 100 days			
Leyendecker	148		44				
Los Lunas	140			50			
Alcalde	138			55			

G. Futura 83 (2022)

	Days in Season	April	May	June	July	August	September
Expected	112-117			~ 100 days			
Leyendecker	148		55				

[1] Plot was harvested before ½ of the plants exhibited flowering; although pollination was observed

NMDA Supervised Destruction

- Plants at Los Lunas tested “hot” (above the legal THC limit)
- Huge variation in sampling and testing methods

Observations & Lessons Learned

- Logistical issues with licensing and material quality
- Early flowering in grain/fiber
- Pests and disease
- Lack of best practices/standards

Looking Ahead: Need for More Fiber/Grain Research in NM

Hemp Grower

Researchers Earn USDA Grant to Study Hemp in Cattle Feed

The $200,000 grant will help the researchers determine the concentrations of cannabinoids in livestock after they've eaten hemp feed.

BUSINESS

Feds Fund Research Into Hemp Fiber Insulation As Environmentally Friendly Alternative

apg-wi.com

Hempcrete may be be more viable option for tribe than CBD oils

USDA Awards $21 Million for Two Hemp Research Projects

The projects were selected as part of the first pool of grant recipients under the organizations Partnerships for Climate-Smart Commodity Program.

NIFA Joins Other USDA Agencies to Establish, Expand Industrial Hemp in the U.S.

Hemp Industry Daily

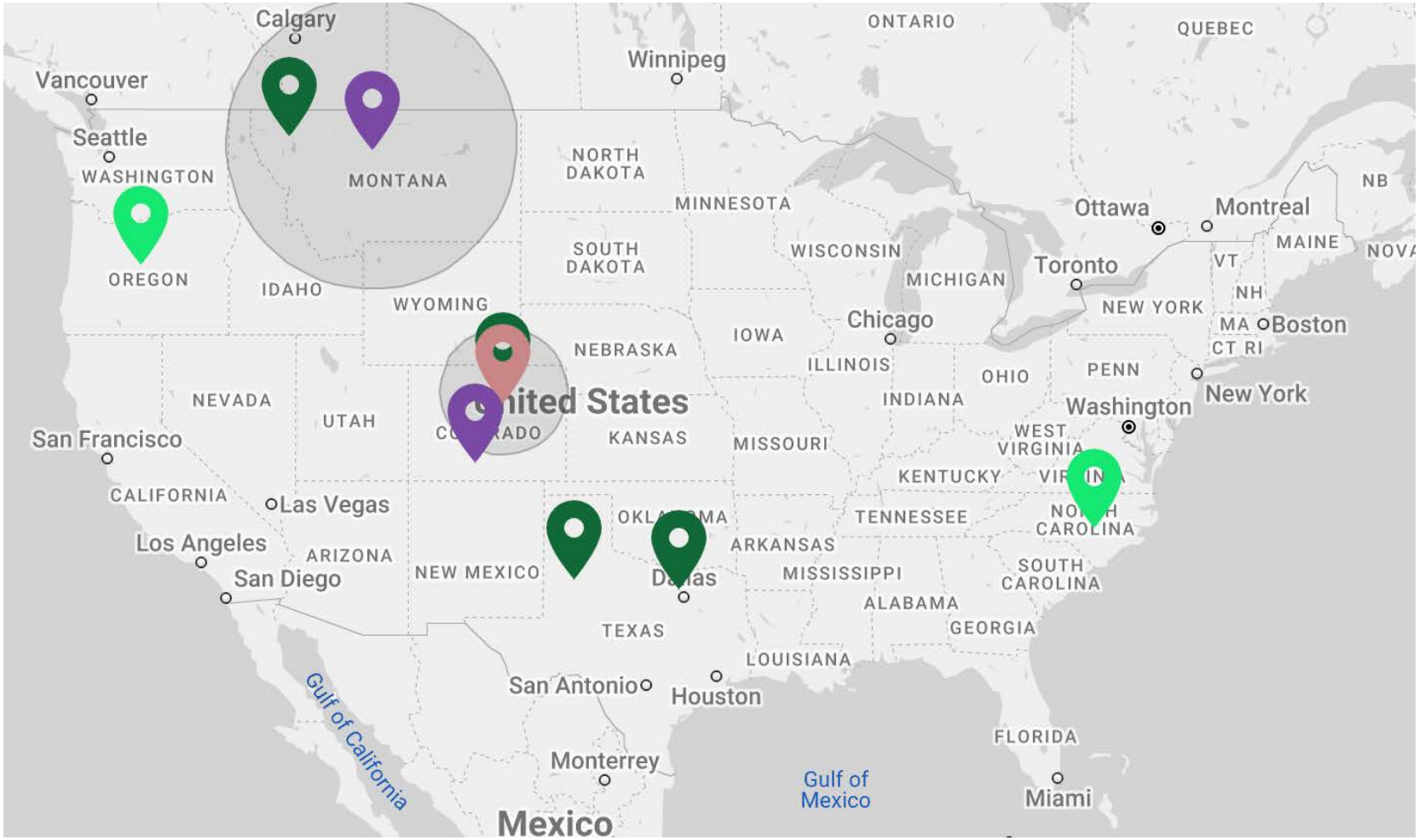
USDA creating hemp germplasm collection, funding lab to ...

A new $66 million Agricultural Research Service lab where scientists will study hemp farming, fiber, and plant breeding. Developing software ...

Major Roadblocks & Challenges to Grain/Fiber Hemp in NM

- Manufacturing Infrastructure
- Pollen Drift
- Photoperiod Response
- Total THC Limits

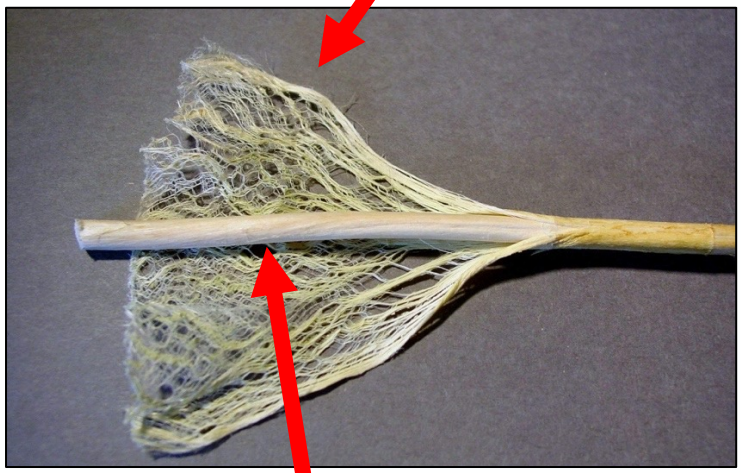
Hemp Fiber - Decorticators



North American Hemp Fiber and Hurd Supply Chain. Interactive Map. (2023). https://thehia.org/hemp-fiber-and-hurd-map/

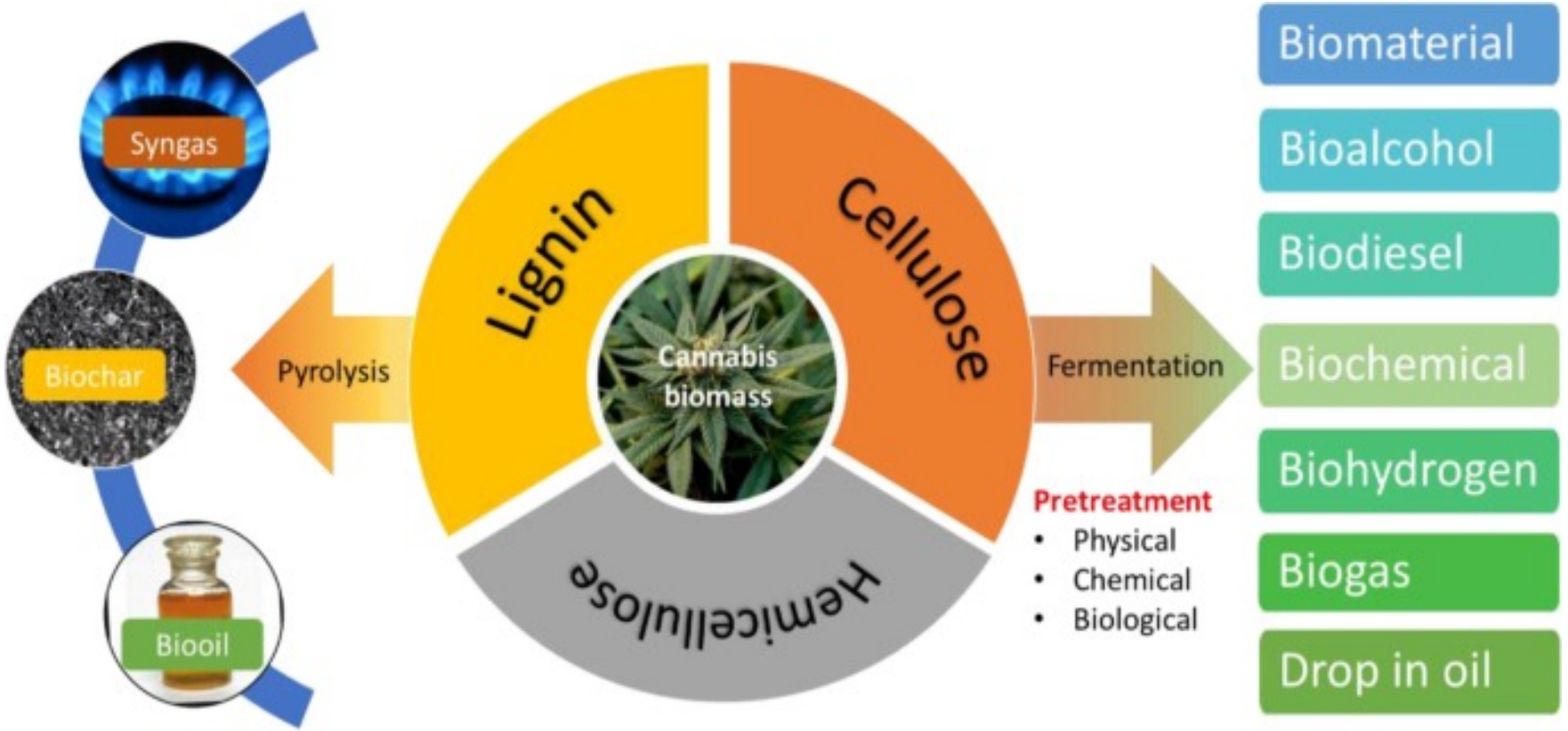
Hemp Fiber – Building Materials

Bast: strong, high-value fibers



Hurd: abundant, woody fiber

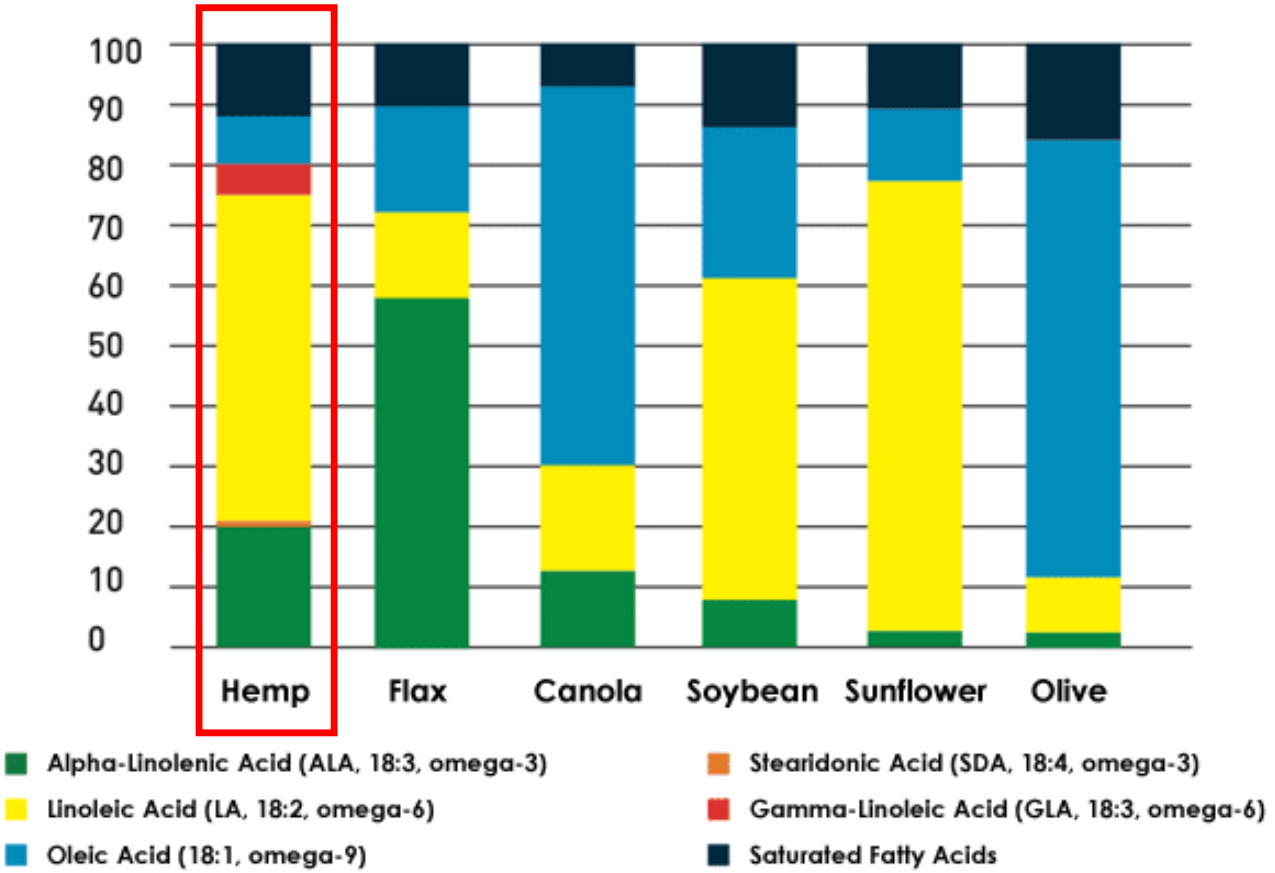
Hemp Fiber – Greater Potential



Brar, K.K., Raheja, Y., Chadha, B.S. *et al.* A paradigm shift towards production of sustainable bioenergy and advanced products from *Cannabis*/hemp biomass in Canada. *Biomass Conv. Bioref.* (2022). https://doi.org/10.1007/s13399-022-02570-6

Hemp Grain

- 20-30% seed oil
- 25-30% protein
- 25-30% fiber
- 20-30% carbohydrates
- *NO CANNABINOIDS*



Nutritional benefits of hemp seeds (2023). https://www.fundacion-canna.es/en/nutritional-benefits-of-hemp-seeds

Hemp Grain

Hemp 101. (2019). Kentucky Hempsters. https://www.kyhempsters.com/hemp101

Hemp's Future at NMSU

- No trials in 2023
  - No ongoing trials at NMSU to continue variety trials
  - Production for CBD should be shifted indoors; focus on outdoor industrial production as an agronomic crop

- Fiber characterization and bio-based chemical processing (ongoing)

- Phytoremediation project – ?

- ***Product research by other NMSU groups (food science, biochemistry) must be supported by cultivation to create a viable state industry***

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Additional Acknowledgements

- Collaborators Barbara Hunter, April Ulery, and Frank Ramos
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Questions?

Contact Information

Hanah Rheay

New Mexico State University

Department of Chemical and Materials Engineering

handsr@nmsu.edu