2021 Minnesota Industrial Hemp Forum
Industrial Hemp Plant Breeding

2:45 Dr. George Weiblen, Professor, U. of Minnesota

Introduction

2:50 John McKay, Professor, Colorado State U. & co-founder of NewWest Genetics

Cataloging existing variation and rebuilding better Cannabis genomes for new markets

3:10 Tom Michaels, Professor, Horticulture, U. of Minnesota

How feral hemp can enhance contemporary Cannabis breeding

3:30 Chloe Pavely, Ridge Road LLC

Implementing a hemp regulatory program to enable R&D and commercial operations

3:50 Panel discussion

Divergent Directions in Cannabis Genetics

"Ditch Weed"
Naturalization
(unmanaged)

Marijuana
Seed Saving & Sharing
(unregulated or illicit)

Drug Production
(THC & CBD)

Crop Seed Commercialization
& Plant Variety Protection
(regulated & legal)
Industrial Hemp

Grain Production

Fiber Production

Feral Adaptation

Wenger et al. 2020, American Journal of Botany

Grassa et al. 2021 New Phytologist

Agenda

Overcoming Today's Challenges

Technology Platform

Hemp Opportunities

Regulatory Program

Path Forward

Forward-Looking Statements

We have made these forward-looking statements in reliance on the safe harbor provisions of the U.S. Private Securities Litigation Reform Act of 1995. In some cases, you can identify these statements by forward-looking words such as "anticipates," "believes," "continue," "estimates," "expects," "targets," "intends," "may," "might," "plans," "potential," "predicts," "projects," "should," or "will," the negative of these terms and other similar terminology. Forward-looking statements in this presentation include statements about the potential impact of the COVID-19 pandemic on our business and operating results; our future financial performance; product pipeline and development; our business model and strategies for commercialization and sales of commercial products; regulatory progression; potential collaborations, partnerships and licensing arrangements and their contribution to our financial results, cash usage, and growth strategies, including with respect to potential revenue relating to our winter oats, high saturated fat soybean for palm alternative, hemp, high oleic low linolenic soybean, high fiber wheat and improved quality alfalfa; addressable market opportunities; and anticipated trends in our business. These and other forward-looking statements are predictions and projections about future events and trends based on our current expectations, objectives and intentions and premised on current assumptions. Our actual results, level of activity, performance, or achievements could be materially different than those expressed, implied, or anticipated by forward-looking statements due to a variety of factors, including, but not limited to: the severity and duration of the evolving COVID-19 pandemic and the resulting impact on macro-economic conditions; the impact of increased competition, including with respect to our winter oats, high saturated fat soybean for palm alternative, hemp, high oleic low linolenic soybean, high fiber wheat and improved quality alfalfa; disruptions at our or our collaborators' key facilities; changes in customer preferences and market acceptance of our or our partners' products, including our winter oats, high saturated fat soybean for palm alternative, hemp, high oleic low linolenic soybean, high fiber wheat and improved quality alfalfa; competition for collaboration partners and licensees and the successful execution of collaborations and licensing agreements, including on terms consistent with our projections; the impact of adverse events during development, including unsuccessful field trials or development trials or disruptions in seed production; the impact of improper handling of our product candidates by unaffiliated third parties during development, such as the improper aerial spraying of our high fiber wheat product candidate; failures by third-party contractors; inaccurate market sizing and/or price and demand forecasting, including with respect to sales projections used by Calyxt management in determining potential license and other revenues; the effectiveness of commercialization efforts by commercial partners or licensees; our ability to make grain sales on terms acceptable to us; the timing of our grain sales; our ability to collect accounts receivable; disruptions to supply chains, including transportation and storage functions; commodity price conditions; the impact of changes or increases in oversight and regulation; disputes or challenges regarding intellectual property; proliferation and continuous evolution of new technologies; management changes; dislocations in the capital markets; and other important factors discussed under the caption entitled "Risk Factors" in our Annual Report on Form 10-K and subsequent filings on Form 10-Q or 8-K with the U.S. Securities and Exchange Commission. Any forward-looking statements made by us are based only on information currently available to us when, and speaks only as of the date, such statement is made. Except as otherwise required by securities and other applicable laws we do not assume any obligation to publicly provide revisions or updates to any forward-looking statements, whether as a result of new information, future developments or otherwise, should circumstances change.

OVERCOMING TODAY'S CHALLENGES

WHY CALYXT?

The Future Demands Healthy and Sustainable Innovation

Advanced Therapeutics

Renewable Clean Energy

Green Building Materials

Plant-Based Packaging

Animal Nutrition

Functional Nutrition

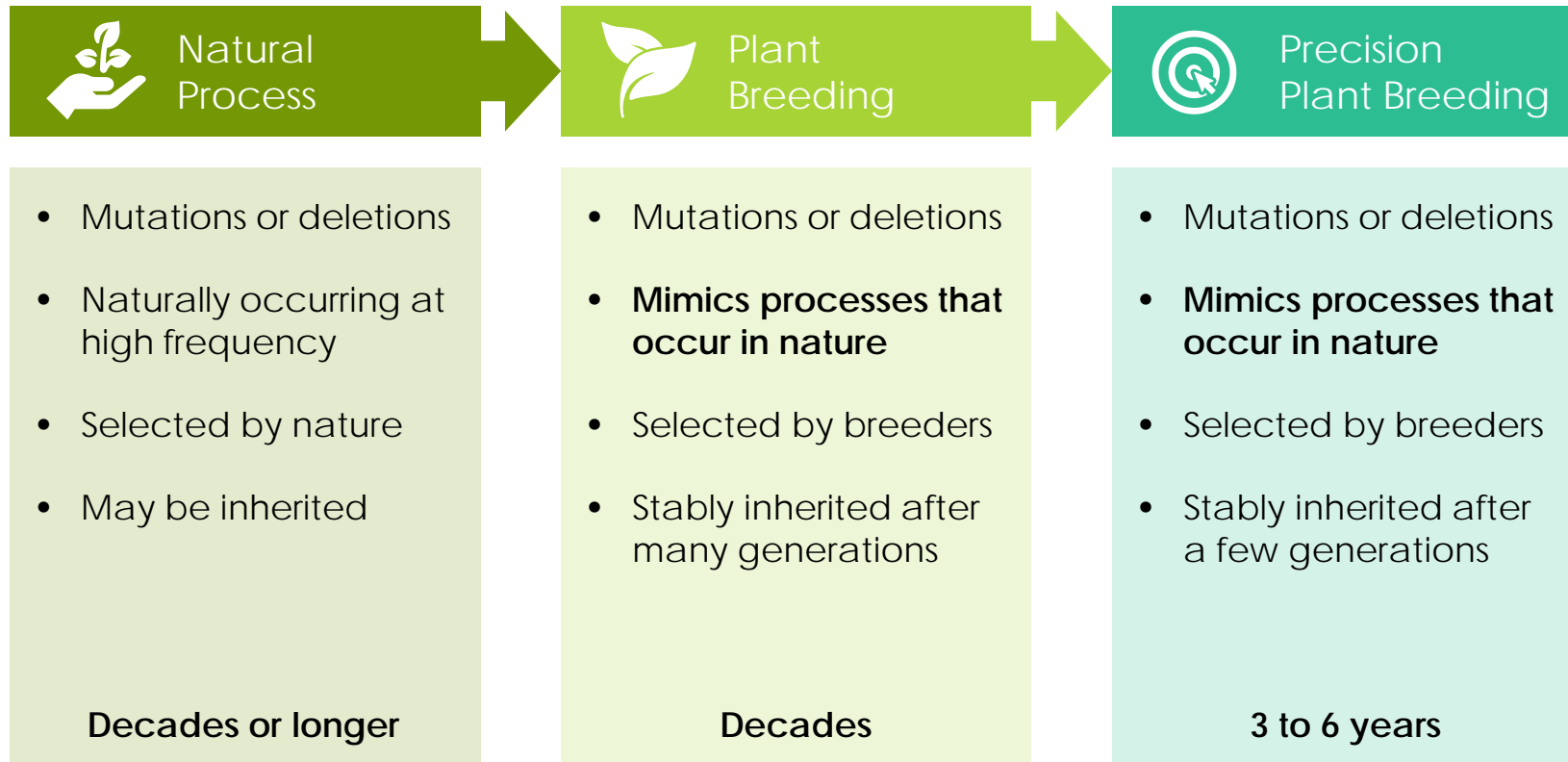Note: Ridge Road, LLC. is a subsidiary of Calyxt dedicated to hemp business.

Plant-Based Technology

Solutions for Hemp Production & Hemp Traits

TECHNOLOGY PLATFORM

Technology Overview

GENE EDITING IS A PRECISION PLANT BREEDING TOOL

Natural Process	Plant Breeding	Precision Plant Breeding
• Mutations or deletions	• Mutations or deletions	• Mutations or deletions
• Naturally occurring at high frequency	• **Mimics processes that occur in nature**	• **Mimics processes that occur in nature**
• Selected by nature	• Selected by breeders	• Selected by breeders
• May be inherited	• Stably inherited after many generations	• Stably inherited after a few generations
Decades or longer	**Decades**	**3 to 6 years**

calyxt®

Proven Regulatory Expertise

LEADING THE WAY

Shifting to a Global Regulatory Strategy

Shifting the Paradigm to Benefits

Leading the Way

HEMP OPPORTUNITIES

Bringing the Possibilities to Life

PARTNERING WITH CALYXT

Under our business model, Calyxt partners with leading companies across industries to ideate and deliver crop innovation by leveraging our technical expertise and their market footprint.

1
Together we ideate

2
We deliver traits

3
They bring a new product to market

calyxt®

Hemp

EXPLORING THE WHITE SPACE IN HEMP

PROBLEM

Many existing obstacles prevent wide-spread commercial planting of hemp

SOLUTION

Partner with leading hemp innovators to stabilize hemp seed genetics to unleash hemp's full potential

Optimizing Hemp

UNLEASHING HEMP'S FULL POTENTIAL

calyxt®

MARKET DEMAND FOR HEMP

Hemp is a valuable crop and evolving regulations are opening opportunities for commercial crop production

- Industrial fibers for renewable materials
- Plant-based protein
- Therapeutic potential

WHY HEMP

A hardy crop, hemp production is less intensive and has broad appeal as it's naturally rich in fiber, protein and beneficial metabolites

- Broad application use across multiple industries
- Soil health benefits
- Emerging crop with growth potential

WHAT WOULD MAKE HEMP EVEN BETTER

Increase the value of hemp by understanding the genetics to optimize performance and enable broad acre crop planting

- Improved genetics to optimize the desired traits
- De-risking the crop

WHAT CALYXT CAN DO

Partner with leading hemp innovators seeking to stabilize hemp seed genetics to unleash hemp's full potential

- Stabilized genetics
- De-risking the supply chain with THC consistently < 0.3%
- Crop uniformity to improve harvest-ability

Hemp

CURRENT PHASE: **PHASE I** | PLANNED COMMERCIAL PLANTING: **2024**

PROBLEM

Many existing obstacles prevent wide-spread commercial planting of hemp

SOLUTION

Improve hemp seed genetics to develop a broad-acre crop

TARGET ATTRIBUTES

Stabilized genetics

De-risking the supply chain with THC consistently < 0.3%

Improve mechanized harvest-ability via crop uniformity

REGULATORY PROGRAM

Implementing Regulatory Processes to Enable Operations

TWO DIFFERENT TYPES OF OPERATIONS

Commercial

- Large field production
- Critical harvest timing
- Fit for Commerce Certificates
- Seed labeling requirements
- Sales
- Traceability

Research & Development

- Small batches/lots in greenhouse
- Frequent plantings, year-round
- "Harvest" for R&D purposes or destruction
- Genetic & phenotypic screening of plants for desired traits
- Small field trials
- Traceability

Enabling efficient operations within the regulatory framework

Establishing Regulatory Processes

REGULATORY COMPLIANCE IS CRITICAL

USDA/MDA Regulations & Guidance

- Obtaining appropriate licenses (e.g., MDA Hemp License, Seed Permit, Processor License)
- Communicating with Regulatory agencies
- Planning
- Record keeping

Establishing Processes

- Understanding R&D and Commercial processes
- Communicating with internal stakeholders (e.g., R&D, Agronomists, Commercial)
- Developing SOPs
- Training
- Record keeping

Monitoring

- Auditing
- Obtaining feedback (e.g., Regulatory agencies and internal stakeholders)
- Continuous improvements
- Record keeping

PATH FORWARD

Path Forward

calyxt

Consolidating the Regulatory Program

- Securing predictability of regulatory scope assessment

- Consolidate processes to enable efficient R&D and Commercial operations while maintaining regulatory compliance

Shifting the Paradigm to Benefits

- Communicate about benefits that innovative products can bring

- Bringing solutions to market e.g., new hemp products

- Calyxt Regulatory expertise and experience

Continued…

- Continue to keep pace with rapid innovation and new product opportunities

- Continue to positively influence the global regulatory landscape

- Continue to demonstrate product safety through rigorous plant breeding and selection (high industry standards)

Thank You!

LEARN MORE CALYXT.COM

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Unrivaled Ag Experience and Expertise

Wendy Mosher
CEO

20 years team alignment, expert in Hemp market & regulatory compliance, investor relations and capital raising

Frank Curtis
COO

30 years for Limagrain, was COO for US ops expert in seed breeding and genetics operations

Dr. John McKay
Director of Genetics

CSU professor of genetics,
20+ years research & publication

Dr. Richard Fletcher
Director of Breeding

17+ years commercial seed business, Inventor multiple plant utility patents

Dr. Daphne Preuss
Chief Business Officer

20 years as AgTech CEO, geneticist, entrepreneur. Led top innovative company in sorghum seed genetics from breeding to market

Jenny Boyd
Director of Bus Dev & Supply Chain

25+ years Global Sales, customer experience and supply chain leader both in row crops and vegetables.

NEW WEST GENETICS

Hemp production styles

Low-density/feminized

2,500 - 5,000 plants/acre

- Horticultural technique
- Single Purpose: cannabinoid
- Maximizes yield per plant

High-density/dioecious

125,000-500,000 plants/acre

- Traditional agronomy
- Dual Purpose: grain and/or fiber, and/or flower
- Maximize yield per acre

Kevin Price – Kansas State

Hemp

- **Variation in Hemp and Cannabis**

- **Genomics of Key Breeding Targets**

- **Breeding for US Production Environments**

Polymorphism and population structure in Cannabis

16 M SNPs
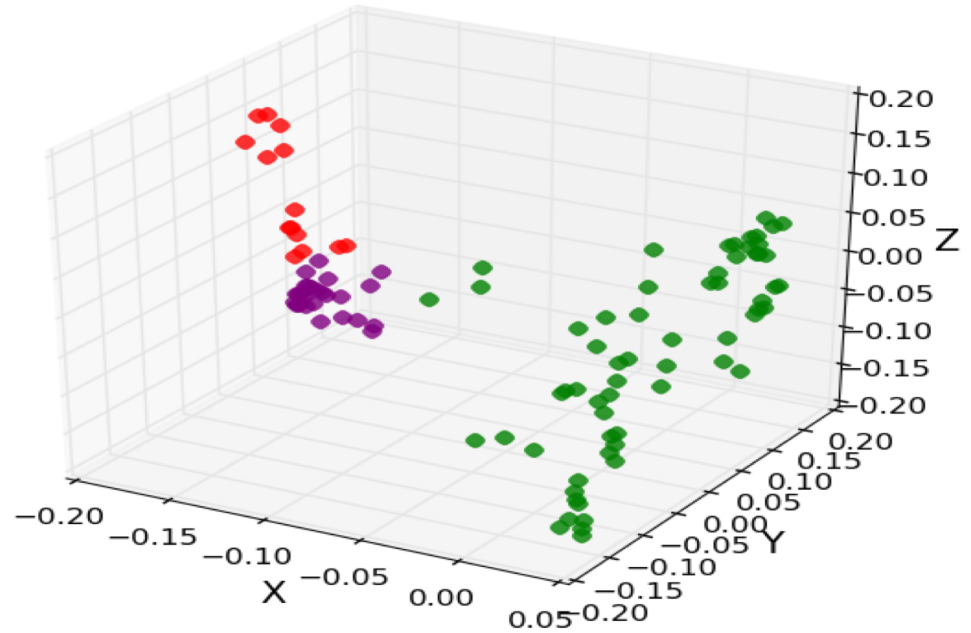
Hemp is a Phenotype
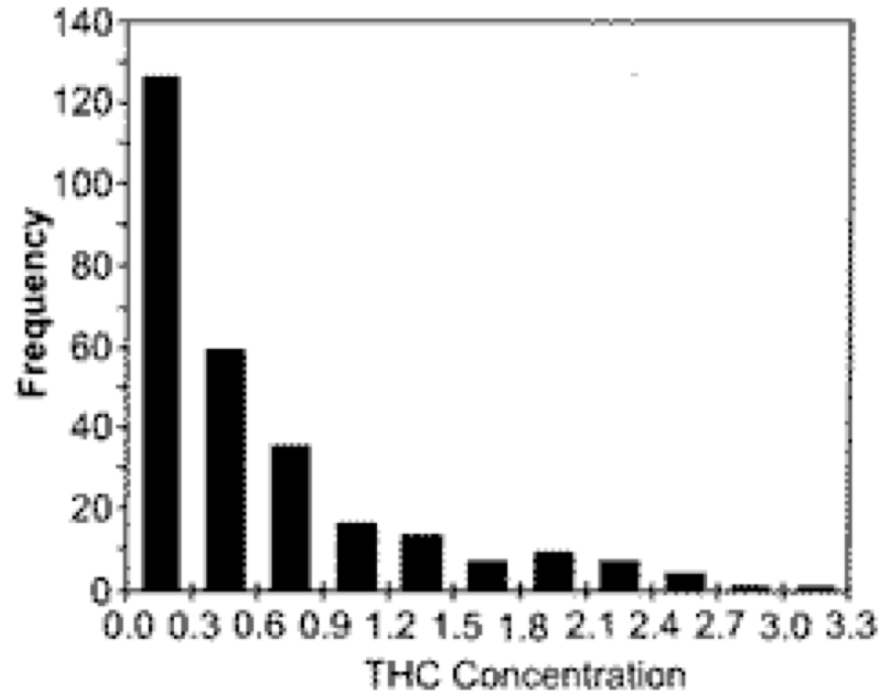
Anon. 1975. Catalogue of the global collection of VIR. Issue 162, Fiber crops. Vavilov Institute, Leningrad, USSR.

THC content is highly predictable

Genetics x Environment of Yield, THC & CBD

Yield

THC

Legend:
- GENOTYPE
- ENVIRONMENT
- GxE
- error
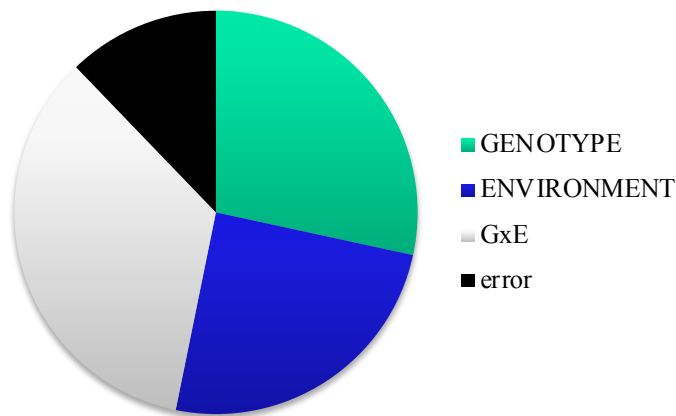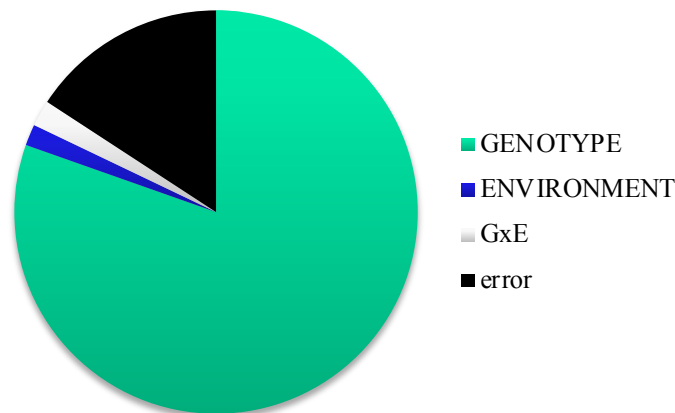
Well-bred seed **will** produce stable, low or no THC

Uses of the crop determine breeding targets
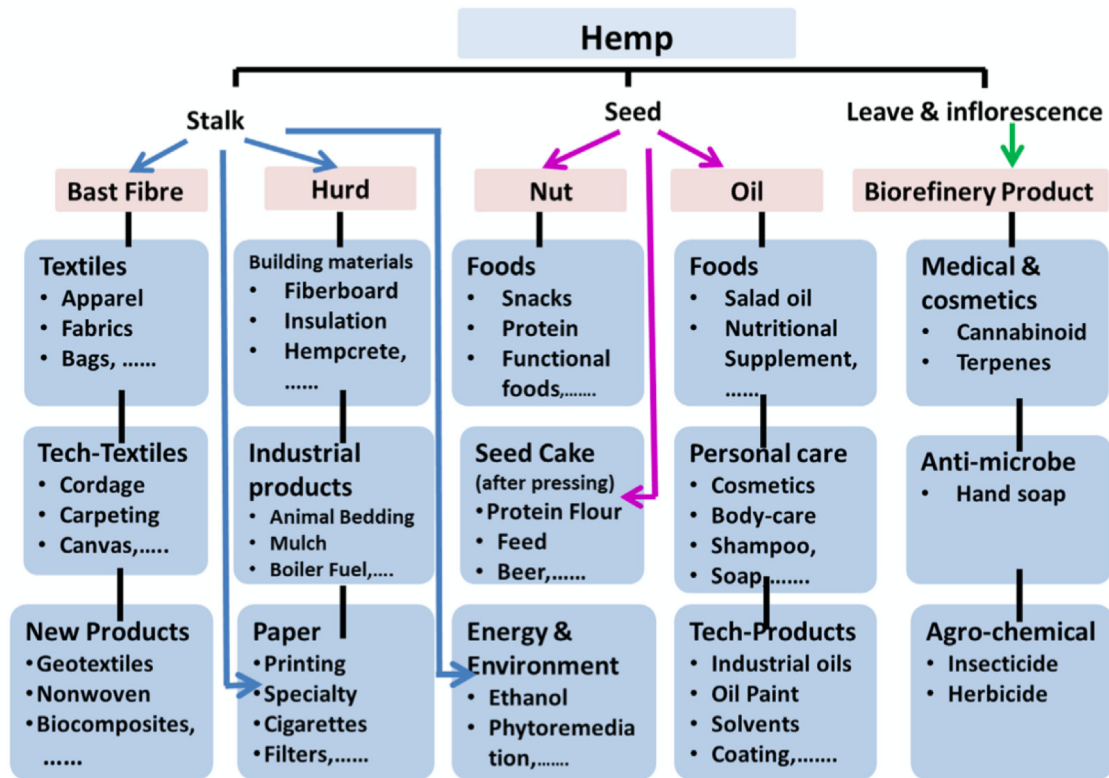
Fig. 1. Flowchart of multi-purpose hemp utilization.

Hemp Grain - Unique Nutrition Profile in Seed, Plant Based Protein

NWG ELITE varieties desired by grain processors for its unique, buttery flavor.

MINERALS
WATER
PROTEIN
5%
6%
25%
CARBS
28%
36%
FATTY ACIDS

Source: J.C. Callaway, 2004
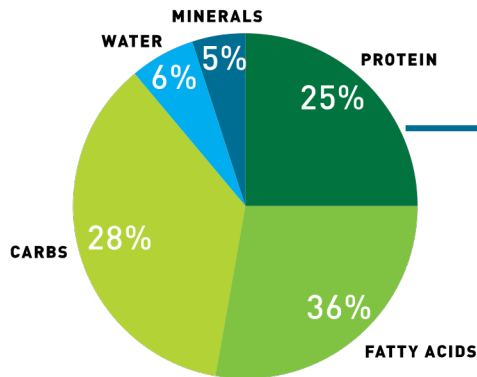
> Competes with soy – same proteins, better fatty acids, competitive amounts of both

> Excellent ratio Omega 3:6
> Plus GLA – at higher levels than any other plant species

HEMP FATTY ACID PROFILES
HEMP OMEGA-6 TO OMEGA-3 RATIO: 2.5/1

- **OMEGA-6** LINOLENIC ACID
- **OMEGA-6** GAMMA-LINOLENIC ACID
- **OMEGA-3** ALPHA-LINOLENIC ACID
- **OMEGA-3** STEARIDONIC ACID
- **OMEGA-9** OLEIC ACID
- **SATURATED FAT** STEARIC & PALMITIC ACID

HEMP   SOY   CORN
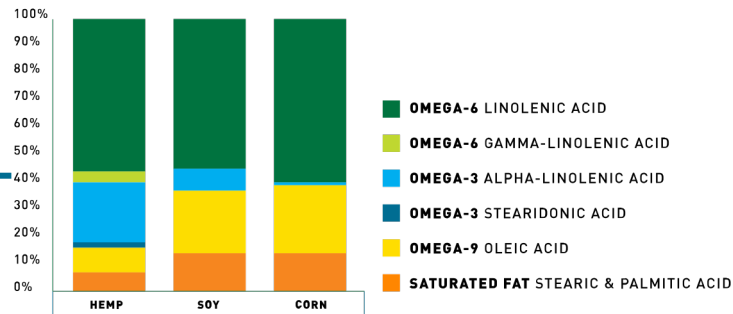
Source: J.C. Callaway, 2004

Approved in Human Foods, approval in Animals Feed expected to begin 2021, large demand from consumers for animal feed

NEW WEST GENETICS

Hemp

- **Variation in Hemp and Cannabis**

- **Genomics of Key Breeding Targets**

- **Breeding for US Production Environments**

Genotype by Environment Interaction
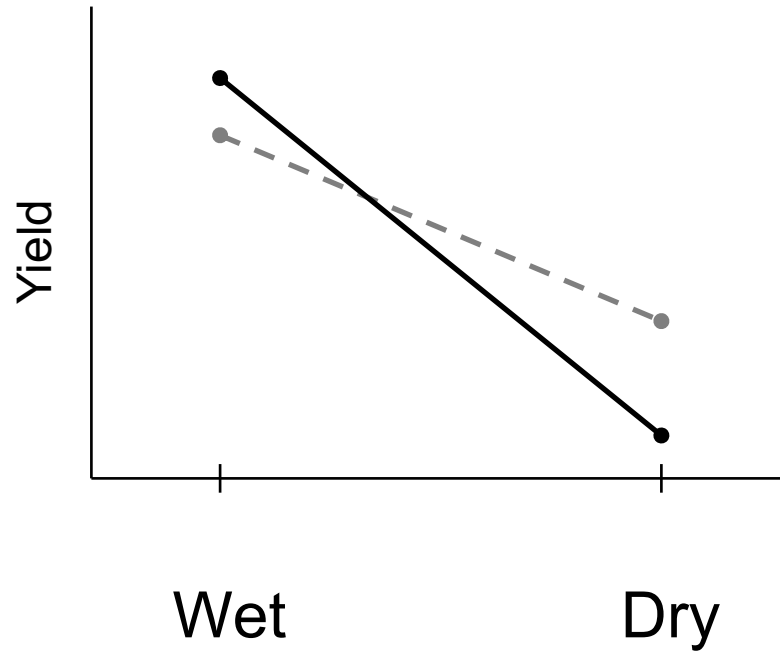
Genotype × Environment Interactions of Industrial Hemp Cultivars Highlight Diverse Responses to Environmental Factors

Brian J. Campbell, Abdel F. Berrada, Chris Hudalla, Stefano Amaducci, and John K. McKay*

Genetics of Complex Traits
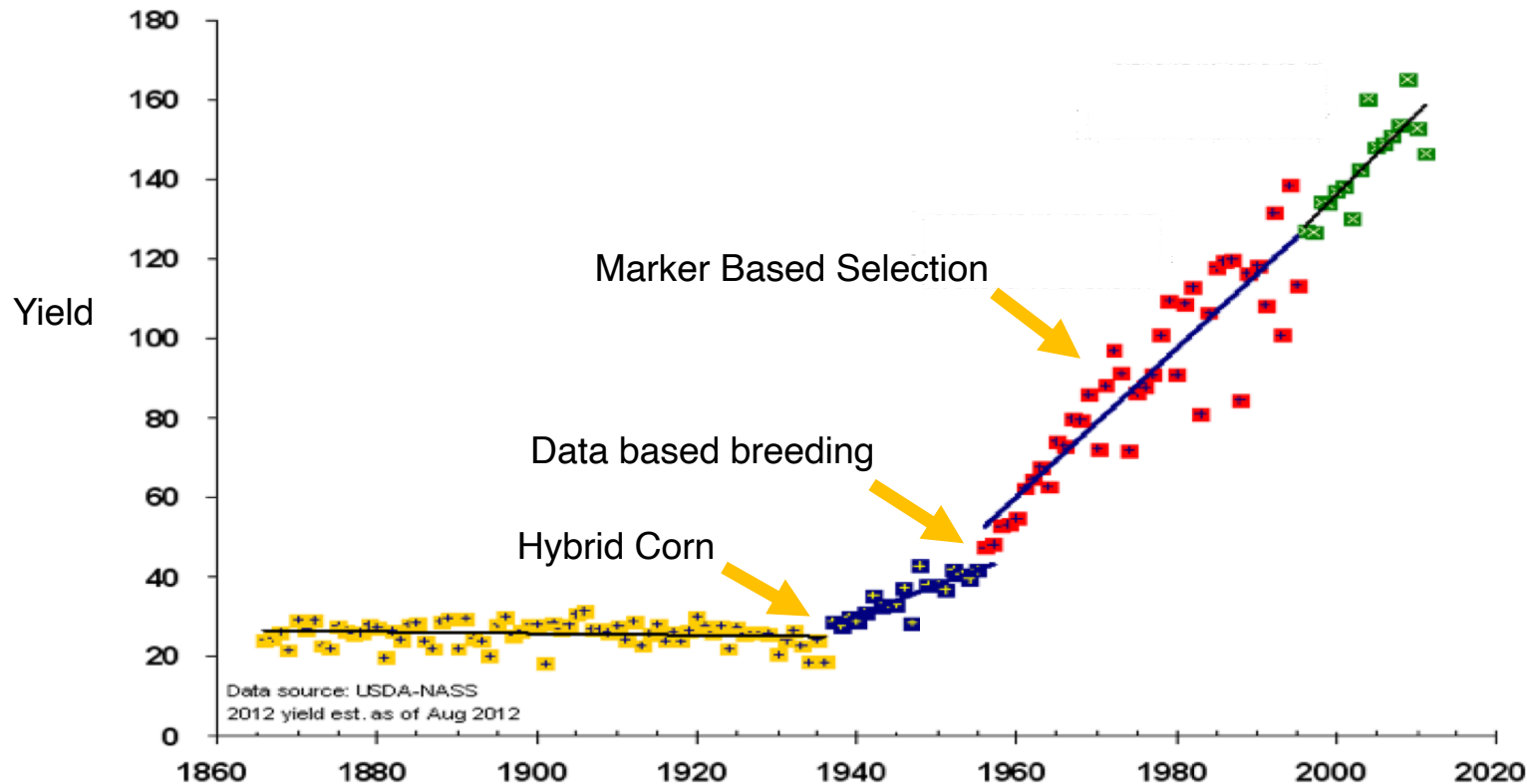
P = G + E + GxE + error

Trait	Percent Variance Explained			Significance		
	Genotype	Environment	G x E	Genotype	Environment	GEI
Grain Yield (kg ha^{-1})	28.4	24.8	34.6	***	***	***
Dry Biomass (kg ha^{-1})	11.5	61.5	12.9	***	***	***
DTM (Days)	97.3	0.0	1.0	***	NS	***
PLHT (cm)	35.9	37.8	9.0	***	***	***
Stem Diameter (mm)	36.1	8.3	14.9	***	***	*
Stand Establishment (%)	24.2	51.1	6.6	***	***	*
δ13C (μg mg^{-1})	23.9	46.4	28.9	***	***	***
Total THC (%)	80.4	1.7	2.1	***	**	NS
Total CBD (%)	82.7	6.0	1.7	***	***	NS
CBC (%)	50.0	0.0	16.8	***	NS	*
α-pinene (%)	54.2	2.7	12.2	***	*	**
β-pinene (%)	50.3	0.2	12.0	***	NS	*

DTM=Days to maturity, PLHT=Plant Height at maturity, δ13C=carbon isotope ratio, THC=total potential Δ9-tetrahydrocannabinol, CBD=total potential cannabidiol, CBC=cannabichromene

p-values:*= <.05   **=<.01   ***=<.001

Hemp Genome Collaboration

USO 31

Colorado State University Pueblo
Sang-Hyuck Park, **Brian Vanden Heuvel**

Colorado State University
Patrick Woods, John McKay

University of Colorado
Nolan Kane, Daniela Vergara

Front Range Biosciences
Keith Allen, Reggie Gaudino

Huazhong Agricultural University,
Wuhan, China -Jianwei Zhang

Phase Genomics

Carmagnola

DNA with PacBio and HiC, RNAseq 10 chromosomes, 29k gene models

Genetic Mapping Population

CBDA Production is a Polygenic Trait

CBDA = Q1 + Q2 + Q3 + Q4 + Q1:Q4
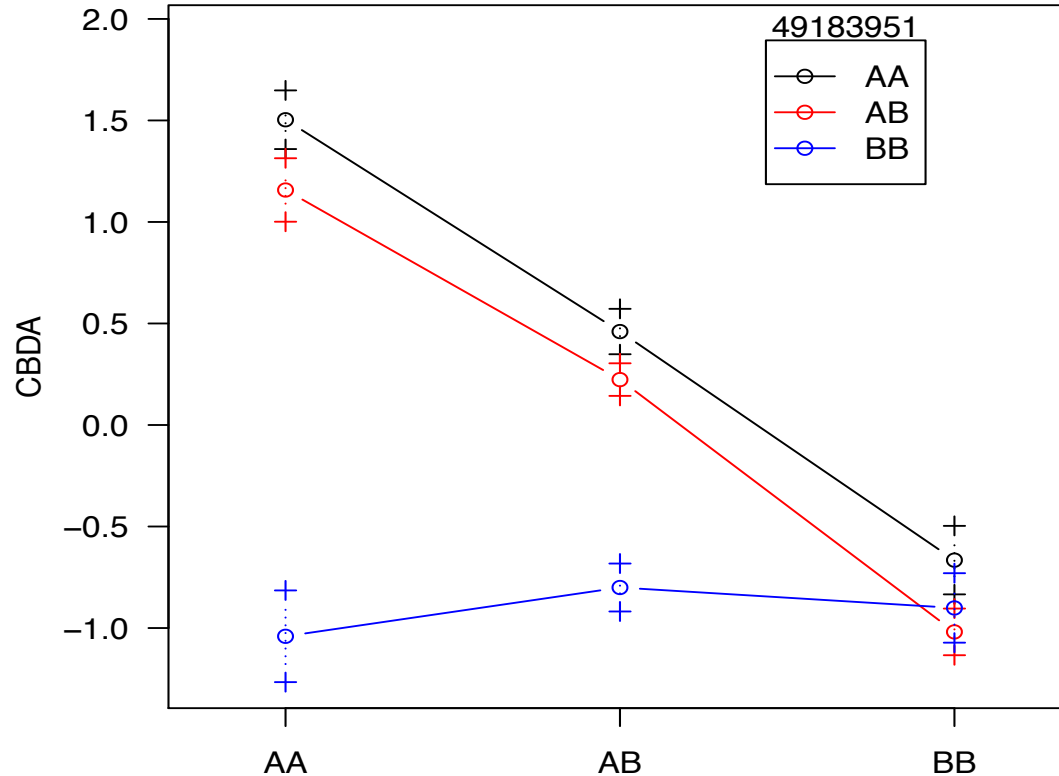
Hemp

- **Variation in Hemp and Cannabis**

- **Genomics of Key Breeding Targets**

- **Breeding for US Production Environments**

Breeding + Genetics Accelerate Innovation & Value

Because of prohibition, there is much work to do with hemp genetics.

Yield

Marker Based Selection

Data based breeding

Hybrid Corn

Data source: USDA-NASS
2012 yield est. as of Aug 2012

Marketing Samples

High Performing ABOUND® Varieties

2020 ABOUND Results			
	Yield: Pounds / Acre		
Varieties	Grain	Flower	Fiber
NWG 2730	1,346	1,930	5,241
NWG 4000	1,938	1,938	3,032
NWG 4013	1,968	1,938	2,721
NWG 2463	1,892	2,416	3,867

New Varieties
Higher CBD Content
Stronger Agronomic Traits
Colorado Dept of Ag Certified THC Compliant

NEW WEST GENETICS

2021 Season: ABOUND® Trial Program

4x4
Field Trial Program

Plant 4 Acres - We will pay half
At least 3 varieties

Test and Track
Follow NWG Protocol

Work with your Experts
Agronomist or University Extension

*Credit applied to 2022 purchase

JBoyd@newwestgenetics.com

New West Genetics 4x4 Trial Data Registration and Data Capture Sheet		Varieties Planted
Grower Name:		
Grower Address:		NWG2730
Grower City / State:		NWG4000
Field 1 GPS Coordinates:		NWG4113
Field 2 GPS Coordinates:		NWG2463
Pre-Planting	Soil Type (soil test recommended)	
	Previous Crop	
	Irrigation (Y/N)	
	Tillage Method (if any)	
	Field Preperation Method(s)	
Planting	Planting Date	
	Planting Depth	
In-Season		
	Weed Control	
Harvest	CBD% Pre-Harvest (sample taken within 3 days pre-harvest)	
	THC% Pre-Harvest (sample taken within 3 days pre-harvest)	
	CBD% Post-Harvest (sample taken within 1 day post harvest)	
	THC% Post-Harvest (sample taken within 1 day post-harvest)	
	% Moisture of Grain Pre-Harvest (sample taken within 3 days pre-harvest)	
	% Moisture of Flower Pre-Harvest (sample taken within 3 days pre-harvest)	
	% Moisture of Grain Post-Harvest (sample	
	% Moisture of Flower Post-Harvest (sample	
	Post Harvest Soil Test (recommended)	
	Grain Yield (pounds)	
	Flower Biomass Yield (pounds)	
	Harvest Machinery Used	
NWG Representative Signature		Grower S

Test and Track
Grower data sheet

NEW WEST GENETICS

Robust Product Pipeline for Continued, Long-Term Yield and ROI Increases

NWG PRODUCT	2020	2021	2022	2023	Trait Benefits
Elite® *GRAIN VARIETIES* ™ ✓	Gen 1 Launch	Commercial Production	Gen 2 (Yield / Gender Skew)	Commercial Production	• High Yielding Grain
ABOUND® *DUAL PURPOSE – GRAIN/CBD* ✓	Gen 1 Launch	International Launch	Commercial Production	Reduce Production	• High-yielding CBD
ABOUND® *DUAL PURPOSE – GRAIN/CBD* ✓	Breeding	Breeding	Gen 2 Launch	International Launch	• Even higher CBD yield
All **THCØ**™ ✓	Breeding	Breeding	Breeding	Gen 1 Launch 2024	• No THC • No costly THC separation
All **Gender Skewed THCØ**™ ✓	Breeding	Breeding	Breeding	Gen 1 Launch 2025	• Increases yield • Genetic driven feminization
Frost Tolerant *Rotation* ✓	Breeding	Breeding	Breeding	Gen Launch 2023	• Regional • Enables early crop rotation

✓ Patent pending

NEW WEST GENETICS

https://www.youtube.com/watch?v=pzu2-Mc-Uyo
Youtube New West Genetics
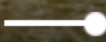
How feral hemp can enhance contemporary Cannabis breeding

Prof. Tom Michaels

Department of Horticultural Science

University of Minnesota

michaels@umn.edu

Outline

- A brief history of feral hemp in MN
- What can feral hemp offer us?
- Feral hemp collecting
- Our 2020 field nursery
- Our 2021 objectives
- Summary

Brief history of feral hemp

- Domesticated in central Asia
- Grown in NA since colonial times
- Pre 1900 hemp in US had European genetic background (Italy, Hungary, Russia)
  - Compact plants, large flower clusters, high seed set
- Post 1900 central Chinese background
  - Tall, lanky plants, dispersed flower clusters, high fiber quality
- 1800s - 1940s most seed produced in Kentucky – source of "Kentucky Hemp" seed
- Kentucky Hemp seed was a melting pot of genetics

# Three waves of KY Hemp seed introduction to MN

1. Early settlement
   - History of Fort Snelling published in 1898 noted "luxuriant growth" of wild hemp that was identical to Kentucky Hemp
   - Late 1800s inmates at Minnesota State Prison in Stillwater made baler twine from local hemp

2. 1934 & 1935 crop speculation
   - 689 farmers grew 8443 acres in SE/SC Mn

3. 1943 WWII crop
   - Planned 60,000 acres and 15 hemp processing plants in 14 counties
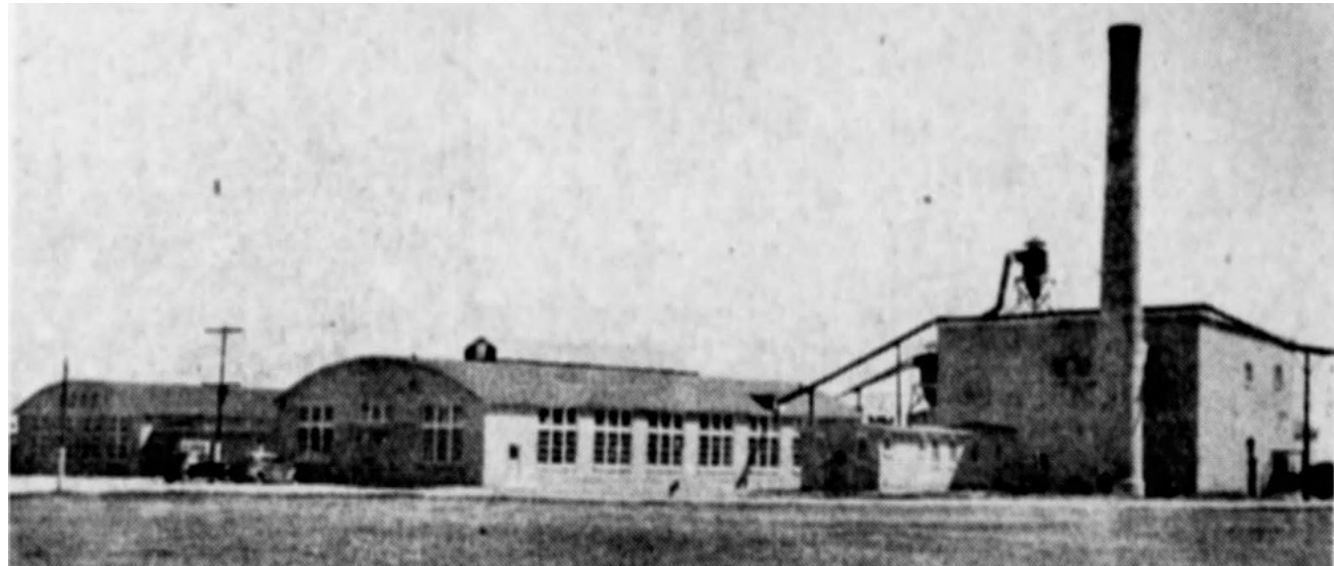
Our stands of feral hemp descend from seed that "escaped" from cultivation

Minnesota College of Ag Released 1st US variety

1913 Lyster Dewey, USDA Botanist – "Until 1903 no well-planned and continued effort" to improve hemp in US.

Minnesota College of Ag hemp breeding project initiated in 1903

- Prof. Coates Bull and his student Fritz Knorr selected within Chinese-background Kentucky Hemp
- Minnesota No. 8 released in 1913

Dewey subsequently released at least 5 additional varieties

- Used Minnesota No. 8 as a parent

All of these varieties disappeared into the melting pot of Kentucky Hemp.

Jackson County Pilot (Jan 1943) – "There is a great variation in the appearance of the plants…"

Brief history of feral hemp - Summary

- Kentucky Hemp was genetically diverse and expressed both European and Chinese characteristics

- Our feral hemp in Minnesota descends from the Kentucky Hemp grown here

- Therefore, I expect that the feral hemp in MN is a storehouse of the genetic diversity that was in Kentucky Hemp

What can this diverse feral hemp genetics offer us?

77 years of natural selection
- Tolerance to regional stresses: temperature, insects, diseases, low fertility
- Survival characteristics: Seed dormancy and shattering

Our targets
1. Early flowering and seed maturity
   - Daylength insensitivity - early planting, early flowering and maturity
2. Plant habit that matches the type of crop
   Long internodes, reduced branching for fiber, compact for flower and grain
3. Flower density that matches the type of crop
   High density for grain and flower crops, low density for fiber
4. Monoecious – fiber and grain types; hybrid production

Feral Hemp Collecting

Uncultivated sites near fields

- Old pastures
- Rock piles
- Grain bins
- Old equipment

The plant's appearance doesn't reflect its potential on good land

2020 Field Nursery

Male pollen shed
July 8, 2020

2021 objectives

Create unique populations targeting specific crop types

- Grain type: early maturity dense inflorescence

- Fiber type: early tall

- CBD type: early compact, branchy

- Monoecious fiber and grain types

Develop controlled crossing system in the greenhouse

- Pollen containment, Female isolation

- Crossing and sib mating

How can feral hemp enhance contemporary Cannabis breeding?

- Diverse genetics

- Tolerance to regional stresses

- Early maturity, possibly daylength insensitive

- Fiber, grain and cannabinoid type plant and flower characteristics

- Techniques for crossing

- Strategies for hemp variety improvement

michaels@umn.edu

DEPARTMENT OF AGRICULTURE

UNIVERSITY OF MINNESOTA
Driven to Discover®
Crookston Duluth Morris Rochester **TWIN CITIES**

End