



Proceedings of the 2nd Australian Industrial Hemp Conference

by Stuart Gordon
June 2020



Proceedings of the 2nd Australian Industrial Hemp Conference

Fremantle, Western Australia

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May 2020

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Publication No. 20-038
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Foreword

The industrial hemp industry is experiencing strong growth as new technologies improve production and a range of value-added products are developed. Industrial hemp currently has a wide range of applications including textiles, paper, rope, fuel, oil and stockfeed, as well as, building materials, cosmetics and pet food. The hemp industry in Australia is equipping itself to increase the size and scale of production predominantly through improved agronomy.

AgriFutures Australia has been increasing investment in industrial hemp to improve production to address a global market demand. Key to improved economic growth of the sector is to build capacity and knowledge through member networks from the industrial hemp value chain and access to 'experts', both within Australia and around the world.

AgriFutures Australia supported the Australian Industrial Hemp Conference, held in Fremantle, Western Australia in February 2020. The event served as a forum for growers, government, agribusiness, researchers, processors and industry representatives to discuss issues of importance and share the latest findings in industrial hemp research. The conference covered a diverse range of topics and facilitated discussion of industrial hemp production and marketing.

This record of conference proceedings offers an opportunity to extend the information from contributors to a broader audience. It reflects the combined desire of many in the industrial hemp value chain to further develop the industry and capitalise on the enormous potential that industrial hemp offers. I wish to thank all authors and participants for their contributions to this publication.

This report is an addition to AgriFutures Australia's diverse range of research publications and it forms part of our Emerging Industries R&D program, which aims to identify and supporting the emergence of agricultural industries that can reach or exceed a \$10M per annum threshold in the next five years.

AgriFutures Australia's publications are available for viewing and download at: www.agrifutures.com.au.

Michael Beer

General Manager, Business Development
AgriFutures Australia

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Executive Summary

Despite the calamitous summer and the then, at the time, looming shadow of the COVID-19 pandemic preceding the second Australian Industrial Hemp Conference went very well in the end. The organizing committee were grateful for the window of opportunity that opened between the summer's fires and the pandemic. This Conference was marked by increased numbers of delegates, presenters and exhibitors and by the very warm hospitality of our Western Australian hosts. The Hon. Alannah MacTiernan WA's Minister for Agriculture and Georgina Wilkinson President of iHempWA deserve special mention for their commitment to seeing the show arrive in WA and for their kind, welcoming hospitality.

Two hundred and seventy seven delegates, 47 expert speakers and 20 exhibitors had a great four days together at the Esplanade Hotel in Fremantle, including workshops on the Tuesday, two very full days of presentations on the Wednesday and Thursday and a memorable trip to the South West on the Friday to visit DPIRD's industrial hemp varietal trial site and businesses in the SW utilizing hemp crop products in housing, clothing and food. Many delegates from the first Conference in Geelong returned to renew friendships and welcome newcomers.

Unfortunately, COVID-19 meant some overseas guests were unable to make it to Fremantle. Despite this the number of overseas delegates was the same as the first Conference. Conference organizers were very grateful for the efforts of the large Chinese delegation from Heilongjiang, who unable to make the Conference due to COVID-19, provided local representatives to speak on their behalf.

Speakers presented across 10 sessions over two days with parallel sessions held in the middle of the second day on the health, hurd, food and fibre products from this crop. Importantly, each session included a chaired Q&A time at its conclusion and a hemp inspired tea, coffee and food break so conversations could continue.

The introduction of topics on CBD production, processing and regulation was important given the investment rush to this area. Clear political and scientific leadership on its production and regulation will be important for Australian growers, investors, medical researchers and the wider community over the next few years. The realization of multiple product streams, perhaps including CBD, will be key to the crop's future. Hemp seed (grain) for human food is currently the mainstay income from the crop, particularly in Tasmania, with a small number of grower/processors successful in the production of hurd (shiv) for the building industry. Fibre production and refinement remains the least developed of industrial hemp's product streams in Australia despite clear local and international markets for hemp fibre products.

The organizing committee of Robert Bell (Robert Bell Projects & AIHA), Georgina Wilkinson (iHempWA & AIHA), Charles Kovess (AIHA), Menghe Miao (CSIRO), Mac Fergusson (RMIT), Johnny Ni (AusBiotech) and myself would like to thank all the delegates, speakers, reviewers, exhibitors, sponsors and importantly their families, for their support in making the Conference very successful.

See you in Tasmania in March 2022 for the third Australian Industrial Hemp Conference.

Take care and stay safe,

Stuart Gordon

Session 1 – Conference Opening: New Agriculture


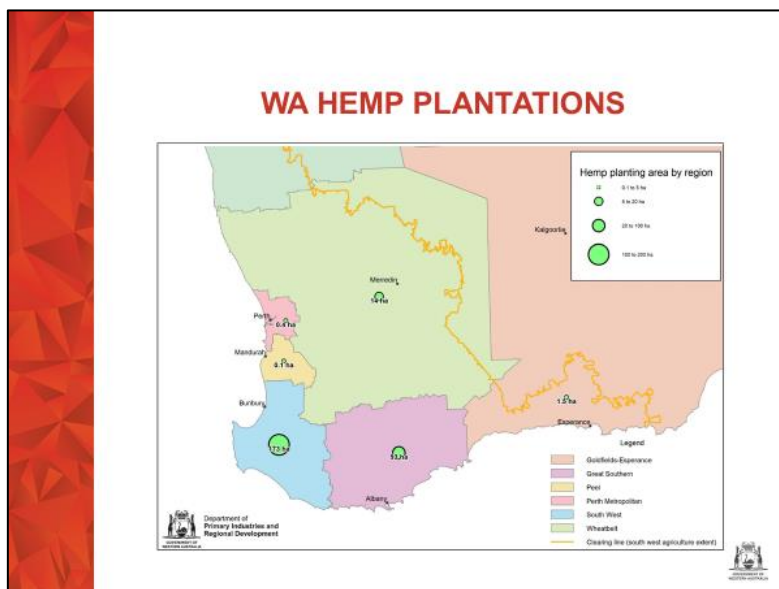
GROWING WA’S HEMP INDUSTRY

Hon. Alannah MacTiernan MLC

Minister for Regional Development, Agriculture and Food: Ports
 Minister Assisting the Minister for State Development, Jobs and Trade
 Western Australia

WA HEMP INDUSTRY

	2017/18	2018/19	2019/20
Licensees	42 🌿	67 🌿🌿	87 🌿🌿🌿
Hectares	68 🌿	494 🌿🌿🌿	282 🌿🌿
Varieties	5 🌿	16 🌿🌿	22 🌿🌿🌿

STATE GOVERNMENT SUPPORT

- Amended legislation on maximum THC concentration for industrial hemp in 2018
- Held two ministerial roundtables on industry priorities
- 3.2 FTEs working on support, regulation and extension
- Frank Wise Research Institute trials of Yuma 1
- \$400,000 in grants awarded over the past 15 months



INDUSTRIAL HEMP GRANTS SCHEME

- \$50,000 to HempGro – Best Seed for Best Region
- \$37,627 to the Manypeaks Southern Coastal Hemp Seed Cropping Trial
- \$99,000 to Ridgeview Building Company – Hemp Processing Plant
- \$76,000 to St Francis Pharmaceuticals – industry standards for hemp food product
- \$40,000 go to Raintree Pearls & Perfumes – develop WA export capacity



RIDGEVIEW HEMP PROCESSING PLANT

- Hemp processing plant now operational
- Grown in Esperance and processed in Margaret River
- Material is on display during the conference



Strategic partners David Campbell and Garry Rogers.



NORTHERN HEMP OPPORTUNITIES

- \$47,000 RED grant to assess the potential of industrial hemp in the Ord River Irrigation Area (ORIA).
- Funding builds on Kununurra hemp trials



FURTHER GRANTS AND SUPPORT

- Mirreco given access to DPIRD facilities to manufacture value-added products.
- \$50,000 RED grant for Vasse Valley hemp to develop WA's first large-scale commercial hemp seed processing facility.



FREEING CBD FROM NARCOTIC CONTROL

Recommendations:

- Follow UK and US lead by excluding hemp from the provisions of Article 28 of the UN's *Single Convention on Narcotics Drugs, 1961*
- Will require Federal legislation
- Being actively discussed at official level
- Need lobbying by industry





HEMP AS SHEEP FEED

- State Government to lead research into potential for hemp as feed for sheep
- The experiments in Katanning and NSW to investigate:
 - Hemp feed value
 - THC turnover
 - Meat quality



HEMP – IT'S A GROWING INDUSTRY WE LOVE IT



Session 1 – Conference Opening: New Agriculture

CREATING THE AGRIFOOD AND FIBRE INDUSTRIES OF THE FUTURE

Dr Michael Robertson (and Colleagues)

Science Director
CSIRO Agriculture and Food
Wembley, WA

E: Michael.Robertson@csiro.au T: +61 (0)417 721 510

ABSTRACT

The agriculture and food sectors have experienced unprecedented change in the last 30 years, and the future will continue bringing with it challenges and opportunities. This paper offers examples of how research and development is responding to these changes, with a focus on crop-based industries. Future trends influencing crop industries include; a hungrier world (population growth and a rising middle class), choosing customers (demanding safe, healthy, sustainable, ethical food and fibre), transformative technologies (particularly in digital that will enable new traceability systems), and a bumpier ride (due to the influences of globalisation, environmental changes, and resulting risk). Examples are provided to show how research and technology is responding to such challenges and opportunities. Examples outlined in this talk include:

- Value-adding to commodity crops. The creation of new varieties of canola that possess enriched levels of omega-3 fatty acids will create new opportunities for feedstocks into aquaculture and new food products for humans.
- Healthy grains. Cereal grains bred to contain high levels of resistant starch that can deliver health benefits in terms of cardiovascular disease and bowel function. The creation of the plant-based burger by V2Foods for a fast food chain is another example of science and technology responding to consumers demanding healthy food options.
- Digital innovation: The development and commercialization of a crop canopy temperature sensor that can detect when irrigation is needed is an example of how transformative technologies are responding to the pressing demands of industry - in this case the scarcity of water for irrigation in the cotton industry. Water availability will constrain the ability of the industry to expand into northern and southern Australia away from the heartland of northern NSW and southern Queensland. These systems will enable more efficient water management.
- Novel textile fibres: Synthetic fibres provide attractive usability properties for consumers. However, rising awareness of pollution by synthetic and non-recyclable textiles has stimulated researchers to develop synthetic-like traits for cotton fibres, thus minimizing the pollution and waste problem from clothes based on synthetics. This is a response to choosy customers, an environmental imperative and modern genetic technologies.

Successful crop industries of the future, such as hemp in Australia, will need to respond to these challenges and opportunities. Research and technology will continue to innovate and provide solutions and will be an essential part of the establishment of emerging industries.



Mega trends affected crop industries

- **Hungrier world**
 - Population growth and a rising middle class are increasing global demand for high-value foods
- **Choosy customers**
 - Empowered consumers are demanding safe, healthy, sustainable and ethical food & fibre
- **Transformative technologies**
 - Technological advances in AI, biological provenance, big data and traceability systems are changing the way food and fibre products are traded
- **Bumpier ride**
 - Globalisation, climate and environmental changes are reshaping the risk profile of agriculture



Examples in this talk

- Value-adding to commodity crops
 - Omega 3
- The rise of the health-conscious and ethical consumer
 - High amylose wheat
 - V2 burger
- Climate disruption
 - Climate change / water limitations
- Reducing environmental footprint & responding to consumer needs
 - Novel textiles

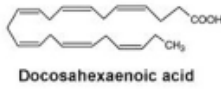
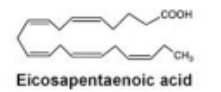


Value-adding to commodity crops

Surinder Singh and colleagues

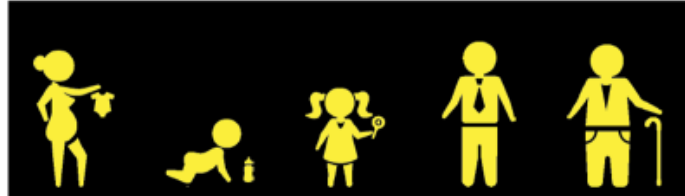


Why do OMEGA-3s matter?



EPA (20:5) and DHA (22:6) are essential ω 3 LC-PUFA found in every cell membrane in the body

Widely recognised for ability to improve many aspects of human health throughout life



Foetal growth & development

Brain growth. Visual development.

Brain growth

Cognition & mood

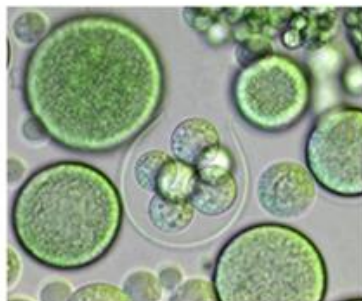
Alzheimers. Cellular health.



Global Omega-3 Status Map shows low levels for most of the world



Our solution



Microalgae
(EPA and DHA primary producers)



Canola



- DHA canola oil shown to be equivalent to fish oil in salmon aquaculture
- 1ha of 10% DHA canola = 1kg fish
- Market: Aquaculture & Direct human consumption, Pharma
- Global omega-3 market expected to reach US\$3 billion by 2023



The health-conscious and ethical consumer

Crispin Howett, Deb Krause and colleagues



Epidemic of Diseases of Affluence



65% Overweight
29% Obese

Type-2 Diabetes

Impacts 1.7 Million
Australians

Total economic cost
\$9 Billion

58% of cases
preventable

Colorectal Cancer

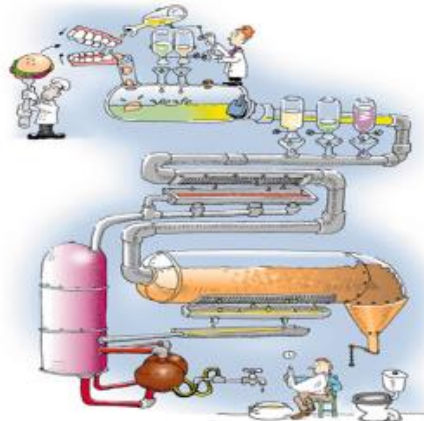
Annually kills
4,350 Australians

>3 x number who
die in car crashes

70% of cases
preventable



Benefits of Resistant Starch

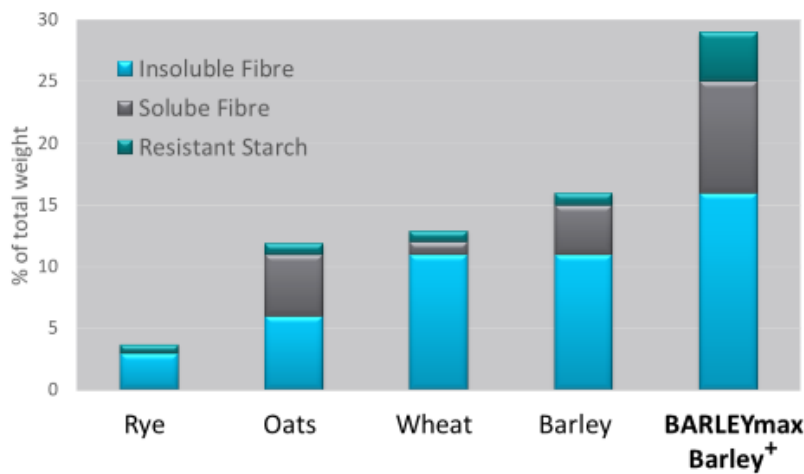


Resists digestion in stomach
Low GI for diabetics

Increased large bowel fermentation
Promotes bowel health



More fibre than any other cereal grain



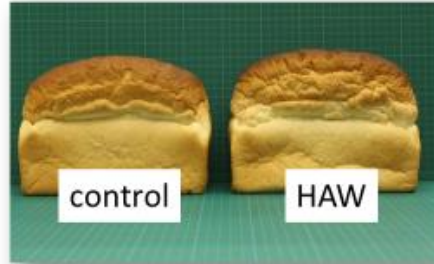
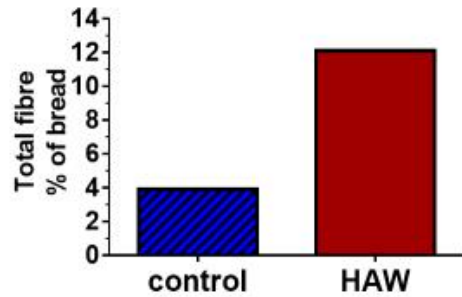
BARLEYmax or Barley+ Products





High amylose wheat

TDF + RS in white bread



Modifying grain for health outcomes



High amylose grains



Gluten-free barley



High β -glucan wheat



Thick aleurone cereals



Vegetarian Market is Growing

- Australia 3rd fastest growth
 - About 2.1 million Australians
- Global vegan market growing rapidly
 - \$136 million in 2018
 - \$215 million in 2020



livekindly.co



Impossible Burger

- V 1.0 coconut fat, wheat protein, potato protein
- V 2.0 gluten free soy protein not wheat
- Contains heme protein
 - Produced by fermentation
- Similar nutritional profile to meat



<https://www.impossible.com>



The Australian version

REBEL WHOPPER®

Rebel Whopper® features a patty made from plants, flame-grilled to give the irresistible smoky, BBQ flavour just like our classic Whopper®. Loaded with crisp fresh lettuce, ripe hand-cut tomatoes, onion, pickles, mayo and tomato sauce on a toasted sesame seed bun.

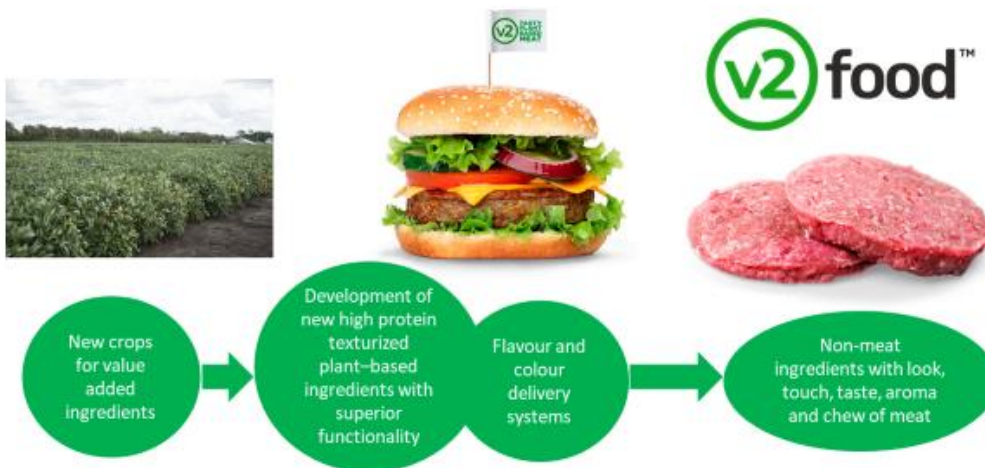
ENERGY	PROTEIN	FAT	SAT FAT	CHOLES	SODIUM	COLECAL
2760 kJ	26.1 g	38.0 g	13.4 g	32.2 g	8.4 g	1150 mg
66%	53%	74%	42%	17%	8%	50%

Further Allergen & Nutritional Information

PRE-ORDER IN APP

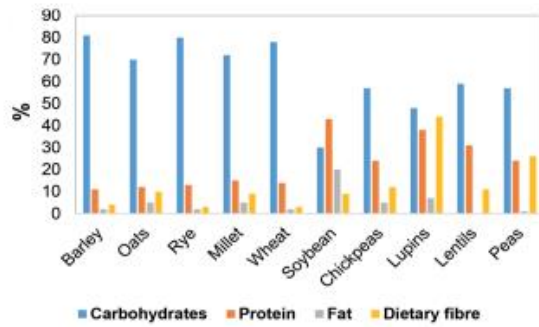


Opportunities for value added grains





New Grain Legume Opportunities



Maphosa & Jideani (2017)



- New high protein crops
- Low off flavour profiles, i.e. no beany flavour
- Non-GM
- Sustainably grown Australian produce

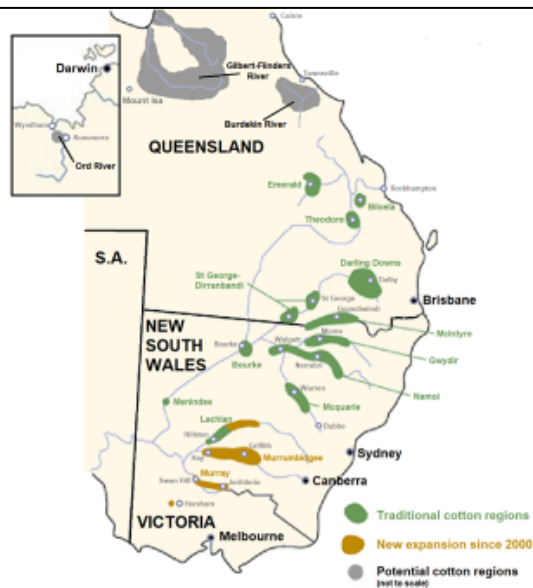
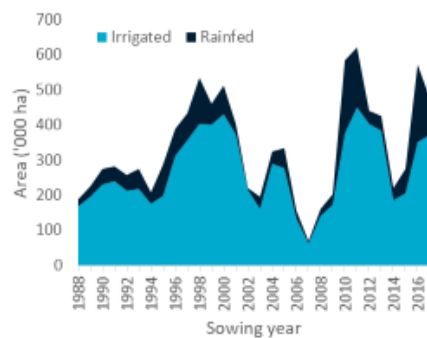


Insuring against disruption

Rose Brodrick and colleagues



Australian cotton production





Insuring against a previous potential disruption



Rose video



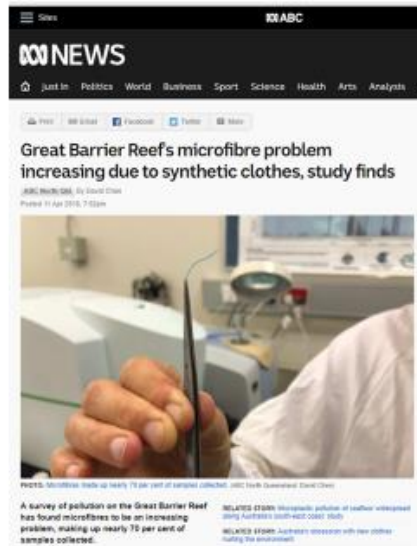
Reducing environmental footprint

Filomena Pettolino and colleagues



Combining the best of natural and artificial fibres

Property	Cotton	Polyester
Water absorbency	✓	✗
Breathability	✓	✗
Thermal conductivity (cool summer/warm winter)	✓	✗
Pilling	✓	✗
Elasticity	✗	✓
Weight/Density	✗	✓
Strength/Tenacity	✗	✓
Resilience (crease resistance)	✗	✓



Synthetic fibres and environmental impact



Novel synthetic plant fibres





Agrifood threats and opportunities

- Value-adding to commodity crops
- The rise of the health-conscious and ethical consumer
- Climate disruption
- Reducing environmental footprint & responding to consumer needs

Session 1 – Conference Opening: New Agriculture

EMERGING INDUSTRIES: INDUSTRIAL HEMP

Mr Tom McCue

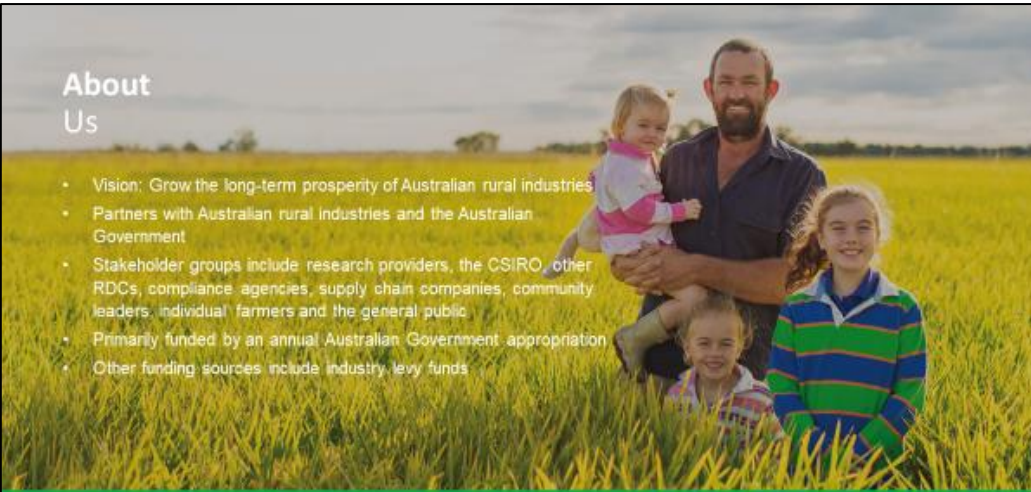
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Emerging Industries
Industrial Hemp

Australian Industrial Hemp Conference
26 February 2020



About
Us

- Vision: Grow the long-term prosperity of Australian rural industries
- Partners with Australian rural industries and the Australian Government
- Stakeholder groups include: research providers, the CSIRO, other RDCs, compliance agencies, supply chain companies, community leaders, individual farmers and the general public
- Primarily funded by an annual Australian Government appropriation
- Other funding sources include industry levy funds



Our Vision

To grow the long-term prosperity of Australian rural industries

1

People and Leadership

Goal
To support the people driving the future prosperity of Australian rural industries and regional communities by providing them with learning opportunities and experiences.

Priorities
Attracting capable people into careers in agriculture.
Building the capability of future rural leaders.

2

National Challenges and Opportunities

Goal
To identify and nurture research and innovation opportunities that are synergistic across rural sectors.

Priorities
Informing debate on issues of importance to rural industries.
Adopting new technologies for use across rural industries.
Working collaboratively on issues common across rural sectors.

3

Growing Profitability

Goal
To enhance the profitability and sustainability of our linked rural industries, regional communities and the broader Australian economy based on profitable farms.


Priorities
Engaging industry participants in determining R&E priorities.
Investing in innovation that supports linked industries to be more profitable.
Delivering outcomes to maximise industry uptake and adoption.

4

Emerging Industries


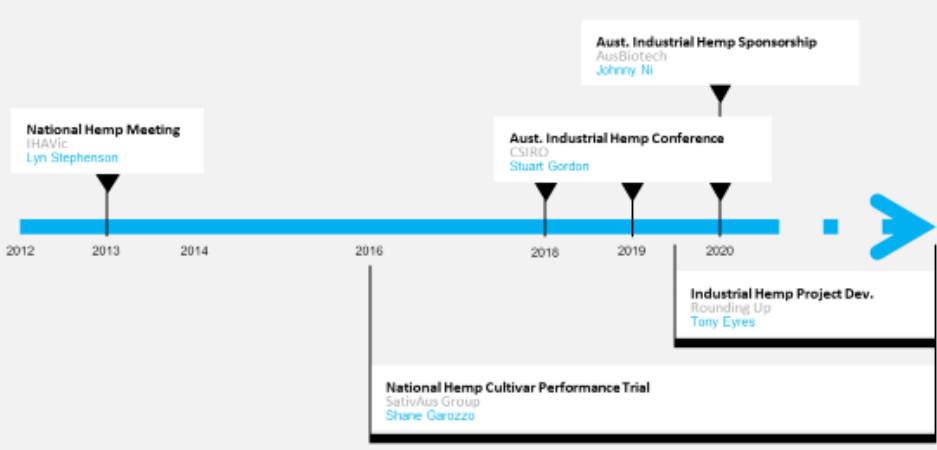
Goal
To support new and emerging rural industries.

Priorities
Supporting the early stage establishment of high potential rural industries.



AgriFutures projects Industrial Hemp

Project ID	Project Name	Start Date	Finish Date	Principal Investigator	Research Organisation
PRJ-008505	National Hemp Meeting	30/06/2012	2/08/2012	Stephenson, Lyn	Industrial Hemp Association of Victoria
PRJ-010776	The Australian International Industrial Hemp Conference	17/11/2017	4/04/2018	Gordon, Stuart	CSIRO
PRJ-011896	National Hemp Cultivar Performance Trial	30/07/2016	30/05/2024	Garozzo, Shane	SativAus Group Pty Ltd
PRJ-012018	Australian Industrial Hemp Conference 2020 - Proceedings - CSIRO	12/08/2019	27/03/2020	Gordon, Stuart	CSIRO
PRJ-012054	Australian Industrial Hemp Conference Sponsorship 2020 - AusBiotech	19/08/2019	27/03/2020	Ni, Johnny	AusBiotech Ltd
PRJ-012064	Industrial Hemp Project Development Consultant	30/08/2019	14/08/2020	Eyes, Tony	Stits Pty Ltd trading as Rounding Up

National Hemp Meeting
IHAVic
Lyn Stephenson

National Hemp Cultivar Performance Trial
SativAus Group
Shane Garozzo


Aust. Industrial Hemp Conference
CSIRO
Stuart Gordon

Aust. Industrial Hemp Sponsorship
AusBiotech
Johnny Ni

Industrial Hemp Project Dev.
Rounding Up
Tony Eyes

2012 2013 2014 2016 2018 2019 2020

AgriFutures projects Industrial Hemp



Australian Industrial Hemp Conference 2020



Department of
Primary Industries and
Regional Development



Structured to encourage networking, collaborations and a better understanding of the industry and its potential in Australia

<http://www.australianindustrialhempconference.com.au>

Australian Industrial Hemp Conference
FREMANTLE WESTERN AUSTRALIA
25 - 26 FEBRUARY 2020
WWW.AUSTRALIANINDUSTRIALHEMPCONFERENCE.COM.AU

food clothing paper oil nutrition housing



AgriFutures Emerging Industries Strategy

Identifying and supporting the emergence of agricultural industries that can reach or exceed a \$10M per annum threshold in the next five years.



Photo: EcoFibre



New industries can take a long time

If the NFF target of a \$100 billion agriculture sector by 2030 is to be realised, then the growth of new industries will need to be much more rapid.

- Ginger – 65 years to reach \$30 million
- Truffles – 25 years reach \$20 million
- Hemp - ???



AgriFutures Emerging Industries Strategy

- Understanding consumer trends and opportunities
- Building skills and confidence of agri entrepreneurs
- Connecting with investors
- Providing R&D support



Photo: ABC news



Market Research (2016) Corolis

- Sector Turnover Estimate \$1.0 million
- Potential \$10-\$25 million by 2025
- Challenges and Opportunities
 - Finding new markets for products as new to Australian industry
 - Requirements for specialist machinery and processing
 - Scale required at farm and processing facility level
 - Needs further research around oil instability (oxidises quickly)
 - Australia late to the market compared with competition



Photo: Hemp Foods Australia



New and Emerging Industries Corolis Key Findings



Proteins: Hemp for Stockfeed?

Dog food made from insects to go on sale in UK for first time

Globally pets consume 20% of meat and fish, a figure insect pet food could help to reduce



Industrial Hemp Variety Trial (IHVT)

- Contractor role for up to 12 months
- Identify, scope, and cost a range of trial options, gauge industry support for each of these options and negotiate co-investment from private and public R&D investors in Australia, including state governments
- Numerous criteria to focus on
- Consultation with industry and AgriFutures Australia
- Report and Business Plan



(Photo: Lyn Stephenson)



Hemp Industry: Issues critical for IHVT success

- Robust IHVT program, open and transparent
- Delivers industry needs
- Viable funding models
- Longevity
- Robust data capture, management and dissemination
- Extension methods



(Photo: DPRD)



Emerging Industries Open Call

Third open call currently open

Industries supported to date:

- Plantago
- Camels
- Coffee
- Goats
- Sea Urchin
- Quinoa
- Native Foods
- Seaweed
- Hemp
- Sesame and Essential Oils



Details on investment	A. Building early stage clusters	B. Building industry capability	C. Expanding industry potential
Maximum AgriFutures Funding support (A\$)	\$50,000	\$200,000 per annum	\$200,000 per annum
GVP of industry	Actual industry GVP <\$2 million per annum	Actual industry GVP >\$2 to \$10 million per annum	Actual industry GVP >\$10 million per annum
Maximum Funding duration	1 year only	Up to 2 years	1 year only
AgriFutures™ Emerging Industries investment support	<ul style="list-style-type: none"> • Forums, networking events and industry conference sponsorship • Subject matter expert travel support • Economic analysis/strategic planning • R&D gaps – technical, entrepreneurial approaches • Industry scaling R&D • Horizon scanning to identify industry opportunities • R&D investment to sustain investor & customer confidence and growth • R&D for industry value adding (domestic, international) 		
Cash co-investment	Desirable	Mandatory (Minimum 25% co-contribution)	Mandatory (Minimum 50% co-contribution)
Commercial partnerships	Mandatory	Mandatory	Mandatory

The Maturity Model



Key elements of the 2019-20 open call process

- Dividing investment opportunities and AgriFutures Australia support by maturity stage
- Co-investment
- Emerging Industries Canvas
- Additional Criteria
- Intellectual Property
- Investment Types



FAQ and myth busters

Who can apply?

- ✓ Industry representative organisations
- ✓ Leading businesses
- ✓ Researchers
- ✓ Must demonstrate whole of industry benefit



Support for startups

- evokeAG 2020
- Historically game-changing technological leaps included:
 - the grain stripper,
 - the stump jump plough,
 - mechanical wool shearers,
 - the Hendra Virus vaccine; and
 - no-bill cropping.
- The Future: Startup Alley
- Hemp?

Perth start-up Hemp Railway International develops world-first ballastless sleeper

Jenna Kanner | The West Australian
Wednesday, 27 December 2017 1:21PM



(Photo: West Australian)



Future Young Leaders

- Supporting new leaders in Emerging Industries
- Hemp?



Contact

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Senior Manager, Emerging Industries
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Subscribe to receive AgriFutures Emerging Industries Program updates:
<https://www.agrifutures.com.au/rural-industries/emerging-industries/?subscribe=1>



Session 2 – Industrial Hemp for Human Health

CANNABIS: A PLANT OF MANY APPLICATIONS AND COMPLICATIONS

Antony (Tony) Bacic, Veronica Borrett, Monika S. Doblin, Mathew G. Lewsey and Jim Whelan

ARC Research Hub for Medicinal Agriculture,
La Trobe Institute for Agriculture and Food (LIAF),
AgriBio Building, La Trobe University,
Bundoora, VIC

E: t.bacic@latrobe.edu.au T: +61 3 9032 7424

ABSTRACT

A large proportion of the world's medicines have their origin in plant-derived natural products which continue to dominate lead compound discovery. Furthermore, the commercial cultivation of plants is critical to the pharmaceutical industry as an affordable source of active pharmaceutical ingredients for several established therapeutics such as opioids and emerging treatments such as medicinal cannabis and peptides. Internationally, consumers, clinicians, governments, regulators, and the pharmaceutical industry are vitally interested in ensuring that commercial products are safe, efficacious and affordable. Despite this, more research on the numerous plant varieties, large-scale cultivation practices and extraction techniques used to identify active compounds for the formulation of therapeutics is required. Nowhere is this more relevant than in the emerging cannabis industry.

Since Neolithic times, humans have cultivated cannabis (*Cannabis sativa*) for stem fibres, seed oil (both derived from hemp varieties), and psychoactive cannabinoids making it one of the most versatile and earliest known domesticated plants. Industrial hemp has been an economically important crop in China since ancient times and continues to be grown world-wide for a myriad of uses. With respect to drug-type cannabis plants, various organs including the seeds, flowers, leaves, and their psychoactive preparations have been used medicinally as an analgesic and hypnotic, but evidence of their efficacy remains largely anecdotal.

In Australia, the search for novel therapeutic agents that are safely and sustainably produced has led Governments (State and Federal) and industry to recognise the importance of ensuring the provenance of crops, that they are adapted to their growing areas and reliably produce high yields of the desired pharmaceuticals, and that these can be efficiently extracted and separated from other compounds that may adversely affect their efficacy. Equally important is that reliability of supply, high quality and a reasonable price, to ensure a secure path to market. The growth of the medicinal cannabis market has been staggering, with global production predicted to grow from \$11B in 2017 to \$100B by 2035, i.e. an annual growth rate of between 17-22% (Prohibition Partners)! We have a time-limited opportunity to leverage our combined research expertise in agriculture, biology, synthetic chemistry and high-tech capabilities with our Industry Partners' technical, regulatory, market, supply chain and extraction capabilities to consolidate Australia as the world-leader in Medicinal Agriculture.

The ARC Research Hub for Medicinal Agriculture was established as a cross-disciplinary research and training program in collaboration with industry to address agronomy and cultivation, germplasm generation, novel extraction technologies and chemistries, through to the discovery and functional characterisation of novel lead compounds. We anticipate that the resulting knowledge will be

applicable across related industries and will build the specialised workforce needed to underpin Australia’s developing medicinal agriculture industry.



MA Scale of Initiative (2019-2024; 5 yrs)



Start date	22 July 2019
Total	+\$24M
Cash	
La Trobe University	+\$10M
ARC	\$4.995M
Industry Partners (8)	+\$3.2M
In-kind	+\$5.8M

Image courtesy of Cann Group

MA Vision & Purpose

AIM: to transform the production of high quality plant-derived therapeutics into an integrated, national industry that spans primary producers and manufacturers.



Image courtesy of Cann Group

Markets		
	Global	Australian
2017	\$11B	\$17M
2023	\$37B	\$1B
2035	\$100B	

Annual Growth- 17-22% p.a.
(Prohibition Partners)

- Develop an export ready, commercially competitive MedAg industry
- Use evidence-based research to safeguard purity and quality, and to better understand the mode of action, of cannabinoids.
- Develop an industry ready workforce (intellectual capital): TAFE/under-graduate/post-graduate

"Trusted & Independent Advisor"

MA Research Themes



Dr M Doblin

Theme 1: Improving the Profitability and Sustainability for Primary Producers

Leaders: Doblin, Lewsey, Gendall

Program 1: Enhanced agronomy for production (cannabinoids)



Prof M Anderson

Program 2: Improving indoor cultivation practices (cannabinoids)

Program 3: Improving medicinal plant varieties (cannabinoids)



Prof J Whelan

Technology Platforms
(omics/phenomics/transformation/chemistry/engineering)

Theme 2: Adding value for Pharmaceutical Manufacturers and End-Users.

Leaders: Beddoe, Whelan, Anderson, Mumford (UoM)

Program 1: Develop novel extraction and synthesis technologies

Program 2: Bioprospecting of novel plant-derived proteins/peptides/compounds

Program 3: Novel non-invasive high throughput analyses, measurements and monitoring technologies



Prof A Gendall

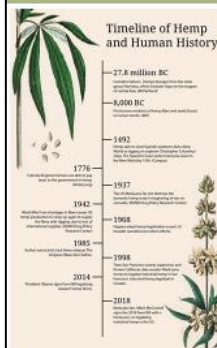


Dr M Lewsey



Prof T Beddoe

MA Humans have used Cannabis for millennia!

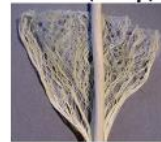


Russo et al., 2008

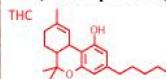
Food and oil (hemp)



Fibre (hemp)



Drug and Medicine ("marijuana")



(modified from Jonathon Page, Aurora)



Cannabis Types: Indica vs Sativa (& Ruderalis!)

- 1000's of cannabis strains (cultivars?)/chemotypes exist
- Most have been developed for recreational use!
- Patients & growers differentiate 2 general types



Hops

Hemp type
($< \sim 0.3\%$ THC)



Cannabis Sativa



Cannabis Indica

Drug type
($> 0.3\%$ THC)



(Image courtesy of Cann Group)



Market categories of Cannabis

- **MEDICINAL CANNABIS**
 - **Medical cannabis**
 - prescribed;
 - plant-based/-derived
 - **Pharmaceutical cannabis** (eg Sativex/Epidyolex/Dronabinol)
 - formulated or processed
 - plant-derived or synthetic
 - Clinical trials/licensed
- **RECREATIONAL CANNABIS**
 - High THC (psychoactive/intoxicating)
 - Illegal in most countries
- **INDUSTRIAL HEMP** ($< \sim 0.3\%$ THC)
 - Seed
 - Oils & fibre
 - nutraceuticals
 - etc



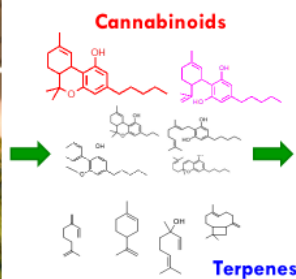
(Image courtesy of Cann Group)



Cannabis produces a complex mixture of bioactive secondary metabolites



(Image courtesy of Cann Group)

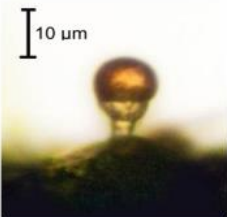
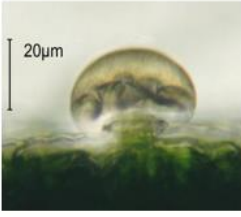
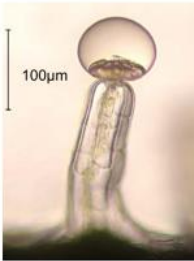


- psychoactive
- analgesic
- anti-nausea..
- neuroprotective
- etc



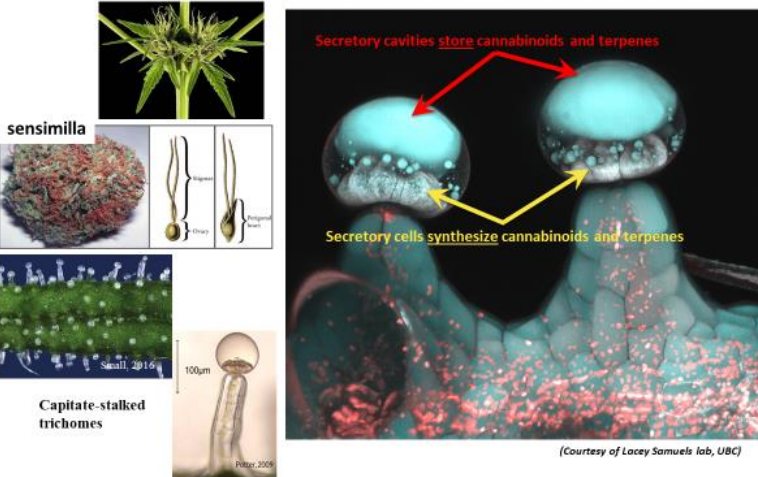
- **Entourage vs molecule-specific effect!**
- **Clinical- based evidence of efficacy vs anecdotal!**

Cannabis Glandular Trichomes (GTs)

		
Bulbous	Capitate-sessile	Capitate-stalked
<ul style="list-style-type: none"> <30 µm high Widespread on all aerial surfaces 	<ul style="list-style-type: none"> <30 µm high Widespread on all aerial surfaces 	<ul style="list-style-type: none"> >200 µm high Restricted to flowers

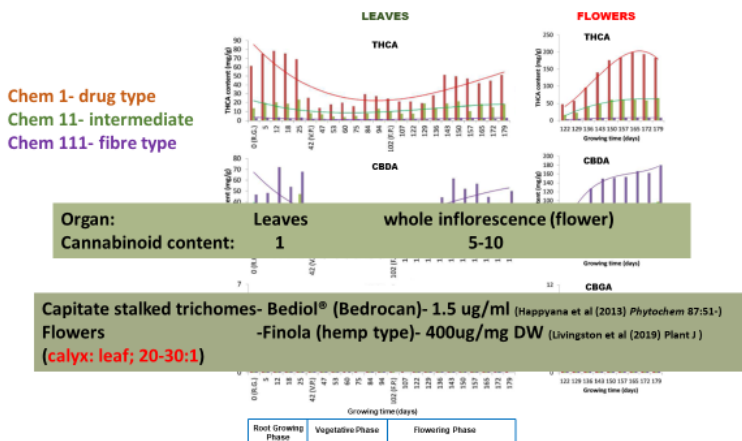
Potter DJ (2009) *The Propagation, Characterisation and Optimisation of Cannabis Sativa L. as a Phytopharmaceutical*. King's College London
 Huchelmann et al (2017) *Plant Physiol* 175:6-

Capitate stalked trichomes are the primary source of synthesis- flowers!

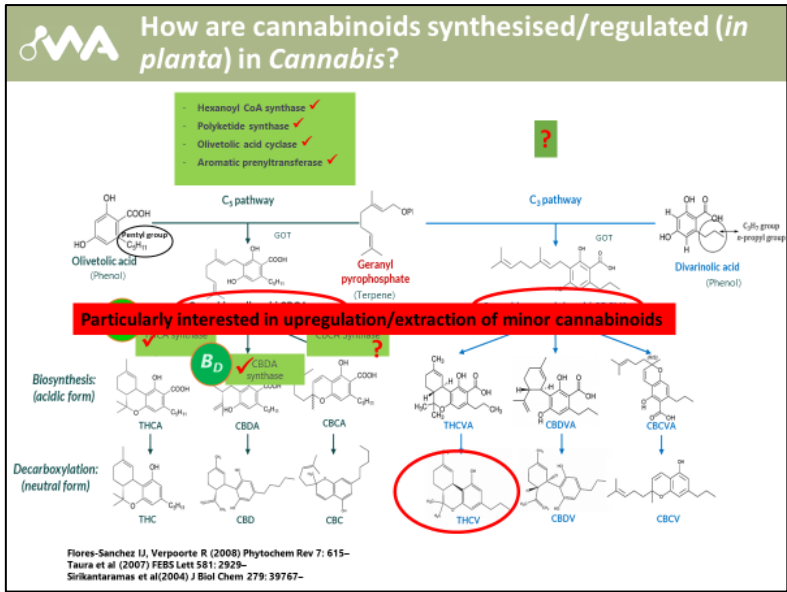


(Courtesy of Lacey Samuels lab, UBC)

Cannabis sativa cannabinoid content of leaves & flowers



(Aizpurua-Olaizola et al (2016). *Journal of Natural Products*, 79(2), 324-)

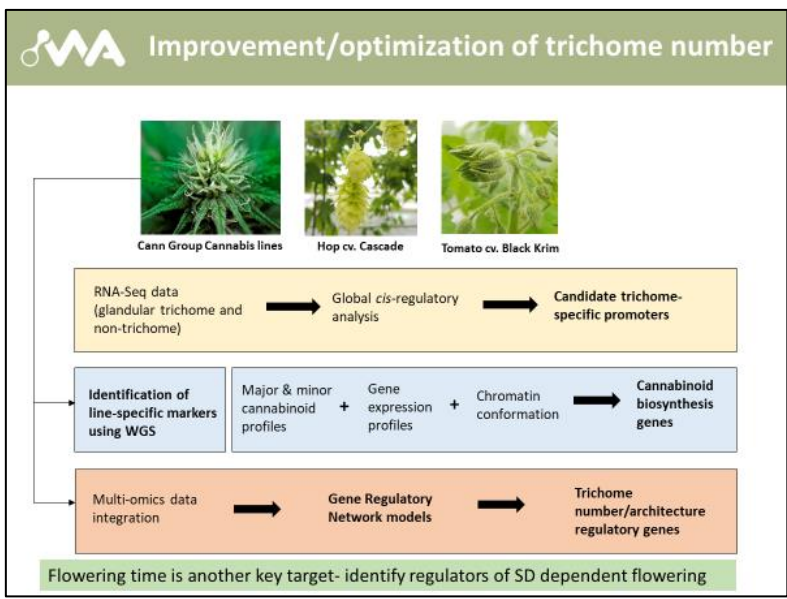


The *Cannabis* Genome

- High-quality genome assemblies and annotations important for downstream analyses
- 8 genome assemblies publicly available on NCBI for *C. sativa*; only 2 (cs10 and Jamaican Lion DASH) annotated
- A single genotype does not fully represent the entire genetic diversity present in a species due to SNPs, CNVs, gene PAVs, etc...
- Comparative genomics analyses important for identifying differences between genotypes/strains; this warrants the need for proper genome annotations
- Setting up an annotation pipeline to annotate the genomes of Purple Kush and Finola using publicly available data (RNA-Seq, cDNA transcript sequences, ESTs, Cannabaceae family protein sequences)

Defense/immunity protein	Storage protein	Membrane traffic protein	Transporter
Enzyme modulator	Structural protein	Nucleic acid binding	Viral protein

van Bakel et al. (2011). The draft genome and transcriptome of *Cannabis sativa*. *Genome Biology*, 12(October), 1–17. <https://doi.org/10.1186/gb-2011-12-10-r102>



WA Growth models for medicinal cannabis are evolving!

The scale of cultivation is being transformed!



WA Beyond genomes: "G x E x M"!

Ancestry-painted Chromosomes Marijuana

- Europe
- Denmark (marijuana-like)
- Swedish Lands (hemp-like)
- Eurasian Steppes
- China
- Uzbekistan
- Kazakhstan
- South Asia
- Nepal
- North India
- North Pakistan
- South Pakistan
- Southeast Asia
- Vietnam
- Cambodia
- Malaysia
- Melanesia
- Africa
- Morocco
- West Africa
- Central Africa
- Ethiopia

Environment: Light intensity & quality, CO₂, Nutrients, Growth conditioners, Phytohormones

Plasticity: Gene expression, Alternative splicing, Enzyme activity, Epigenetic variation

cannabisindustryjournal.com/news_article/the-first-map-of-the-cannabis-genome/
medicinalgenomics.com/jamaican-lon-cannabis-genome/ *Courtesy Dr Ricarda Jost & Prof Jim Whelan*

WA Two case studies from the literature

AgNews 11/01/20 (news.agropages.com)

Harvest Miracel announces cannabis research at Lethbridge University proves ionic copper can increase cannabis yields up to 25%

Coffman and Gentner (1975) Agronomy J. 67:

- Cannabis sativa* L. (Afghan origin) grown on 11 different soils soil & leaf tissue analysis
- quant. of 15 elements + CCC/CBD/THC/CBN

Key findings:

- nutrient stress (reduced plant height) enhanced Δ^9 -THC
- soil PO₄³⁻ was negatively correlated with [CBD]
- soil Zn was positively correlated with [CCC]

Nutrient impact on vegetative Cannabis growth:

N - K - Ca - Mg

- soil N influences sex ratio of wild plants
- soil P and K can increase yield

Courtesy Dr Ricarda Jost & Prof Jim Whelan

Sequence and annotation of 42 cannabis genomes reveals extensive copy number variation in cannabinoid synthesis and pathogen resistance genes

Kevin J. McKernan, Yoonsoo Hillbert, Liem T. Kane, ... bioRxiv

gene copy number variation (CNV) → phenotype of strains with biggest CNV

chemo type grouping → powdery mildew resistance grouping

- extensive CNV across strains, leading to variance in chemo-type (e.g. high/low THC) and phenotype (e.g. powdery mildew resistance)
- examples of unknowns:
 - how does CNV affect combined expression and gene regulation
 - how does CNV affect isoform-specific expression
 - what is the extend of sequence variation across copies, how does this affect 1) and 2) and enzyme activities



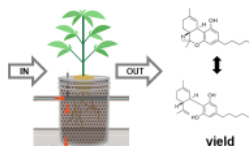
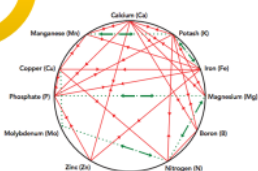
Active Crop Management

Analysis pipeline



- Re-iterative process for progressive yield improvement
- Holistic view of G x E x M interactions
- Incorporates information on genotype, plant nutrient status, transcriptomics & phenomics
- Informs changes in growth conditions
- Assessment through cannabinoid profiling & yield

nutrient composition



Courtesy Dr Ricarda Jost & Prof Jim Whelan

ngreentechnologies.com / leafly.com



ARC RESEARCH HUB FOR MEDICINAL AGRICULTURE

Thank you



Australian Government
Australian Research Council



LA TROBE
UNIVERSITY

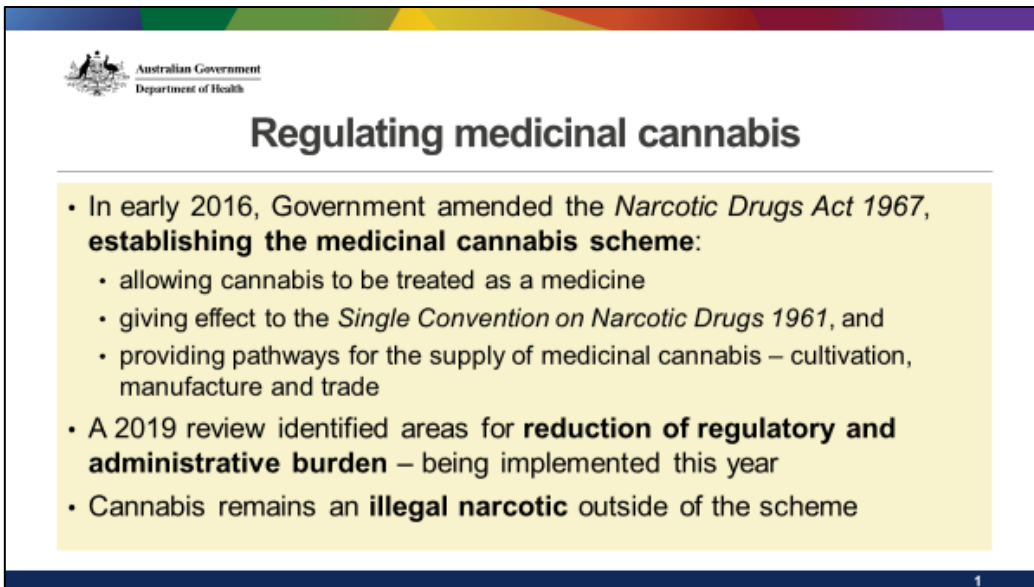
Session 2 – Industrial Hemp for Human Health

REGULATING MEDICINAL CANNABIS CULTIVATION AND MANUFACTURE IN AUSTRALIA: IT'S NOT HEMP

Adjunct Prof. John Skerritt¹

Deputy Secretary for Health Products Regulation²
Australian Department of Health
Woden, ACT

E: john.skerritt@health.gov.au T: (02) 6289 4200



The slide features a header with the Australian Government Department of Health logo and the title "Regulating medicinal cannabis". The main content is a list of bullet points on a yellow background, detailing government actions in 2016 and 2019, and the current status of cannabis as an illegal narcotic. A small number "1" is in the bottom right corner.

Australian Government
Department of Health

Regulating medicinal cannabis

- In early 2016, Government amended the *Narcotic Drugs Act 1967*, **establishing the medicinal cannabis scheme**:
 - allowing cannabis to be treated as a medicine
 - giving effect to the *Single Convention on Narcotic Drugs 1961*, and
 - providing pathways for the supply of medicinal cannabis – cultivation, manufacture and trade
- A 2019 review identified areas for **reduction of regulatory and administrative burden** – being implemented this year
- Cannabis remains an **illegal narcotic** outside of the scheme

1



The slide features a header with the Australian Government Department of Health logo and the title "The Australian government's intent". The main content is a list of bullet points on a yellow background, outlining the government's goals for patient access, quality medicine, clinical trials, and oversight. A small number "2" is in the bottom right corner.

Australian Government
Department of Health

The Australian government's intent

- Provide **patient access to Australian-grown and manufactured medicinal cannabis** outside the standard registered medicines route
- Provision of a **quality medicine through doctors prescription**
- **Encourage clinical trials** for future medicines registration
- The **Commonwealth Department of Health** has oversight of
 - Cultivation, production and manufacture, including for R&D (Office of Drug Control)
 - Product GMP, product scheduling, patient access and clinical trials notifications through the Therapeutic Goods Administration (TGA)
- **States and Territories also** have key roles for controlled substances

2

¹ John Skerritt addressed the Conference remotely via WebEx

² The Health Products Regulation Group comprises the Therapeutic Goods Administration and the Office of Drug Control

Hemp and cannabis – it’s the same species !!

- **Different strains** have been selected for fibre and seeds (hemp) and bud cannabinoid composition (medicinal cannabis)
- **Different licences** restrict what the grower and processor is allowed to do when growing industrial hemp versus medicinal cannabis
 - required under an international treaty, the **UN Single Convention on Narcotic Drugs**
 - so currently illegal to produce medicinal cannabis products including CBD oil from hemp
 - medicinal cannabis also cannot be used to make food or fibre products
- However hemp growers can supply **low THC hemp seeds** to medicinal cannabis growers, for use in the regulated medicinal cannabis industry

3

The **UN Single Convention** requires controls on the cultivation of the “cannabis” plant

- Possession, use, manufacture and cultivation of drugs in Schedule I (including cannabis, cannabis resin, extracts and tinctures) is **limited exclusively to medical and scientific purposes**
- Cultivation and production of cannabis be regulated by a **single government “agency”** (in Australia, the Office of Drug Control)
- The purpose of these controls is to **account for production** and **minimise diversion** of cannabis for criminal or recreational purposes
- **Failure to comply** could cripple Australia’s significant licit opiate and emerging medicinal cannabis exports

4

Why was the law set up this way ?

- **Australia is obligated to implement the controls** of the Single Convention
 - Art. 28 states only the cultivation of cannabis for fibre and seed are exempt from the drug control framework (confirmed by the International Narcotics Control Board)
 - Low levels of THC do not remove controls around cannabis under the convention
- In implementing the recommendations of the 2019 Review of the Narcotic Drugs Act, the Government is considering **whether greater flexibility is possible** - while remaining compliant with the Single Convention
 - The Department has been asked to examine options under the Narcotic Drugs Act for cultivators who wish to obtain CBD and other substances (e.g. terpenes) from **hemp** – legal advice is currently being obtained

5

Hemp seed foods for human consumption

- From 12 November 2017, changes to the Australia New Zealand Food Standards Code allow sale of **low-THC hemp seed foods** for human consumption
- **Several states and territories amended their Acts/Regulations** to permit the growing of industrial cannabis seeds for food for human consumption
- Certain hemp seed products and hemp fibre have also been **exempted from import restrictions** provided they meet specified CBD and THC limits



6

Licence	Hemp	Medicinal Cannabis
Regulators	State-dependent	<ul style="list-style-type: none"> •Office of Drug Control •State Poisons Licence •Therapeutic Goods Administration (if manufacturing products)
Starting Materials	Low-THC strains (<1%)	Any strain with any combination of cannabinoids
Products	Hemp fibre from the stem, hemp seeds, hemp seed oil	Harvested flowers, resins or extracts of whole flowers
Permitted uses	Non-therapeutic purposes (fibre, cosmetics, food, etc.)	Therapeutic purposes (medicine)

Adapted from www.pharmout.net/cultivation-of-medicinal-cannabis-vs-hemp/

7

There have been some incorrect statements from companies and the media

It is not currently legal to:

- **Export hemp** flowers and buds (for CBD extraction)
 - unless cultivated under a medicinal cannabis licence and permit
 - and a valid export licence and permit is needed
- Market CBD oils extracted from hemp for **animal use**
 - extraction of CBD from hemp buds would not be authorised used their state hemp licences
 - CBD for therapeutic use is an S4 "prescription animal remedy" so it requires a registered veterinarian to prescribe and supply



8

Medicinal cannabis is a prescription medicine in Australia

- **“Scheduling”** determines whether substances are for complementary, OTC or prescription only medicines based on the Scheduling Policy Framework
- **Decisions** based on advice from a Ministerial expert advisory committee following public consultation, implemented by states and territories
- The **active substances** have significant side effects, require a doctors intervention
 - THC (S8) – psychoactivity, drug interactions, impact on development
 - CBD (cannabidiol S4) – drug interactions, adverse effects at doses required e.g. for pediatric epilepsy
- So CBD-containing “dietary supplements”, foods and cosmetics are **NOT LEGAL** in Australia

9

Many other plant medicines are also prescription - only

Morphine



Atropine

Artemisinin



Quinine

10

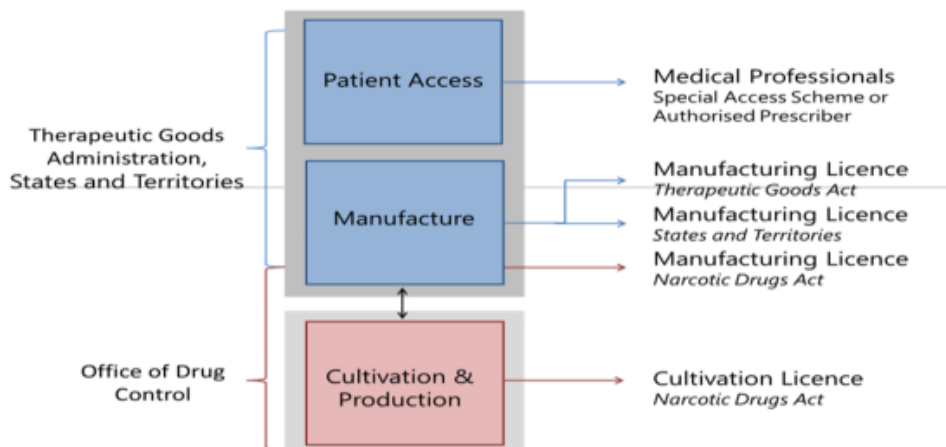
Because (other than Sativex) no medicinal cannabis products are registered medicines.....

- Medicinal cannabis products are available through **“unapproved products” pathways** for both imported and locally grown product
- **Authorised prescriber** permission available for groups of patients
- **SAS A - notification pathway** for patients who are seriously ill with a condition from which death is reasonably likely to occur within a matter of months, or from which premature death is reasonably likely to occur in the absence of early treatment
- **SAS B - application pathway** for patients that do not fit SAS A and where the product is not included on the list for SAS C notification

11

Special Access Scheme B Approvals as of 31 Jan 2020

- Almost 20,000 patients total for about 34,000 notifications/ authorisations/ prescriptions - SAS A+B, Authorised Prescriber, Sativex)
 - Approx. 30 % for cannabidiol, rest for THC/ CBD in various ratios
 - **Range of dosage forms**– raw bud, oils, tinctures, extracts, pharmaceuticals
- While a **wide range of indications have been approved**, there is no “list” of approvable indications
- All applications **considered on a case by case basis**
- **SAS online system** enables prescribers in all states to submit applications to access medicinal cannabis (except Tasmania)
- **Processing time** for almost all SAS-B applications under 2 days



What does the Office of Drug Control do?

- Regulating **cultivation and manufacture** of medicinal cannabis
 - Through licences and permits
 - Fit and proper persons requirements
 - Security and inspections
- Controlling the **import and export** of narcotics
 - Sponsored import of “bulk” medicinal cannabis products
 - Patient by patient imports for the Special Access Scheme
 - Export of manufactured (but not bulk “raw”) medicinal cannabis products permitted

Licence types

- The *Narcotic Drugs Act 1967* allows issue of three types of licences:
 - **Medicinal cannabis licence** – cultivation and/or production of medicinal cannabis for supply to the holder of a manufacture licence
 - Supported by permits for individual production runs
 - **Cannabis research licence** – cultivation and/or production of medicinal cannabis for research purposes
 - **Manufacture licence** – for the creation of medicines from the bulk raw cannabis material supplied under the above licences
- May be aggregated into a single licence type in 2020
- ODC also manages **import and export licences**

16

Cultivation licences - January 2020

- ODC has granted **102 cannabis licences** (94 currently in effect)
 - 32 licences for cultivation of cannabis for medicinal use
 - 20 for cultivation for research
 - 42 for manufacture of medicinal cannabis products
- Licence holders with permits now collectively authorised to annually **produce over 35,000kg of medicinal cannabis** (dry flower)

16

Australia must satisfy international obligations under the UN *Single Convention on Narcotic Drugs*

Under the Single Convention

- cultivation can only occur under government licence
- permits allow the Government to restrict how much is cultivated (and manufactured), thus preventing accumulation of narcotic material
- Licences and permits to import and export cannabis between countries

To obtain a licence

- you/your business associates, must meet the **fit and proper person** test
- **security arrangements** must be in line with the type of medicinal cannabis produced and risk of criminal diversion
- supply **pathways to patients** must be clearly established

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Therapeutic Goods Order 93

- Sets **minimum requirements for the quality and requirements on the manufacturing process** for medicinal cannabis products including assay limits for THC and CBD (90-110 %)
- **Applies to:**
 - medicinal cannabis products imported /exported from or supplied in Australia
 - cannabis plants used in the manufacture of medicinal cannabis products
 - other ingredients used in the manufacture of products, such as excipients
 - steps carried out in the manufacture of medicinal cannabis products
- **Sponsors/manufacturers must ensure** that the cannabis plants used to manufacture products meet requirements for mycotoxins, foreign matter, heavy metals, pesticide residues, total ash



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Good Manufacturing Practice (GMP)

- **Domestically manufactured cannabis APIs** are subject to GMP and TGO93
- **For manufactured products** planned for SAS/ Authorised Prescriber patient access pathways, GMP requirements apply including
 - process validation
 - sampling and stability testing
 - testing requirements
- **TGA guidance documents** may assist



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Need more information ?

TGA's website www.tga.gov.au has:

- TGO 93 as well as guidance documents
- Information on manufacture of medicinal cannabis for supply under SAS/ AP
- www.tga.gov.au/questions-answers-code-good-manufacturing-practice-medicinal-products

ODC website www.odc.gov.au has:

- Information on cultivation and manufacture licences and permits
- Information on import and export



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Session 2 – Industrial Hemp for Human Health

HEALTH BENEFITS OF CBD: CURRENT EVIDENCE AND FUTURE DIRECTIONS

Dr Amie Hayley

Centre for Human Psychopharmacology
Swinburne University of Technology
Hawthorn, VIC

and

Institute for Breathing and Sleep
Austin Hospital
Melbourne, VIC

ABSTRACT

Background: Cannabidiol (CBD) is a naturally occurring, non-psychotomimetic compound derived from the *Cannabis sativa* plant. Preliminary preclinical findings suggest that CBD may exhibit antiepileptic, antioxidant, anti-inflammatory, anxiolytic, antidepressant and/or antipsychotic properties. Clinical studies also support the use of CBD as a safe, well-tolerated and efficacious agent for mitigating symptoms associated with multiple sclerosis, as well as certain forms of paediatric epilepsy and seizure disorders. However, the longer-term pharmacological profile remains less described, and the potential toxicological and/or negative interactive effects are largely unknown. Despite these limitations, public enthusiasm for its therapeutic application have nonetheless contributed to a global CBD market now worth over AUD\$4.5billion.

Aims: The aims of this presentation are threefold:

1. Critically appraise available preclinical and clinical evidence pertaining to the demonstrated and/or potential health benefits of CBD,
2. Examine the rapid popularisation of CBD as a health aid and how this has impacted the trajectory of research in this area and
3. Discuss the future of CBD research and the need to prioritise high-quality multidisciplinary and translational research.

Discussion: Cannabinoid therapeutics is a rapidly expanding field of research. Despite its emergent profile, the clinical application of CBD remains somewhat controversial. This presentation will summarise current evidence pertaining to the substantiated and/or claimed health benefits of CBD, report on public and scientific trends related to its use and will provide an overview of recommended future research directions.

Part 1.

Cannabidiol (CBD)

Current Therapeutic and Research Evidence



CBD BASIC TERMS AND DEFINITIONS

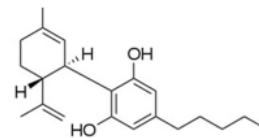
CANNABINOID- A class of chemical compounds that act on the cannabinoid receptors; the active constituent of cannabis

- There are 100+ cannabinoids that have been isolated from the cannabis plant

TETRAHYDROCANNABINOL (THC)- The psychoactive cannabinoid; responsible for providing the 'high'

CANNABIDIOL (CBD)- Non-psychoactive cannabinoid

- Can offset psychoactive effects of THC



THE NEED FOR STANDARDISED SCIENCE

Anecdotal ≠ scientific evidence

- Builds larger picture

Regulatory issues

- Variation in compounds, concentration, preparation (international)
- Standards (food/medicine?)

Identifying target therapeutic components

- Many potential targets

Time and resources

- Supporting research (realistically)

Fledgling industry (Australia)

- Reflects previous restrictions



GOALS OF CBD CLINICAL TRIAL RESEARCH

1. Discover new molecular targets and disease pathways
2. Develop/refine preclinical models of human disease
3. Establish and develop a clinical evidence base in humans
4. Increase the availability of cannabinoid treatments for patients



GOALS OF CBD CLINICAL TRIAL RESEARCH

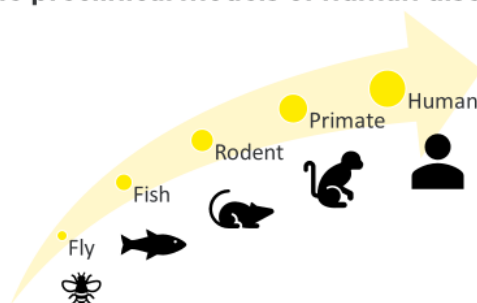
1. Discover new molecular targets and disease pathways

- a) Different compounds
 - i. CBD (more abundant), CBDN, CBE, CBL, CBT (less abundant)
- b) Target receptors
- c) Functionality
i.e. agonist / antagonist / inhibitor



GOALS OF CBD CLINICAL TRIAL RESEARCH

2. Develop/refine preclinical models of human disease



GOALS OF CBD CLINICAL TRIAL RESEARCH

3. Establish and develop a clinical evidence base in humans

- a) Case Control studies
- b) Observational/naturalistic trials
- c) Randomised clinical trials (Phase I and II)



GOALS OF CBD CLINICAL TRIAL RESEARCH

4. Increase the availability of cannabinoid treatments for patients

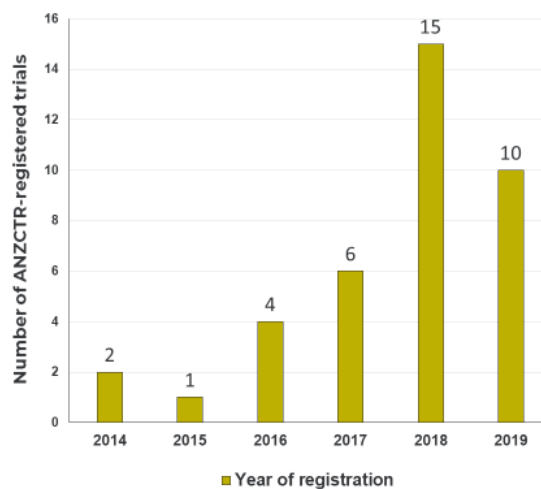
- a) Provide the evidence base to inform clinical decisions
- b) Support patient/clinician engagement
 - ❖ Encouraging different types of research (cohort etc)



Clinical trials on CBD/THC for medicinal purposes*

Australia and New Zealand
Clinical Trials Registry
(ANZCTR)

*As of February 2020



Total 38 trials since 2014

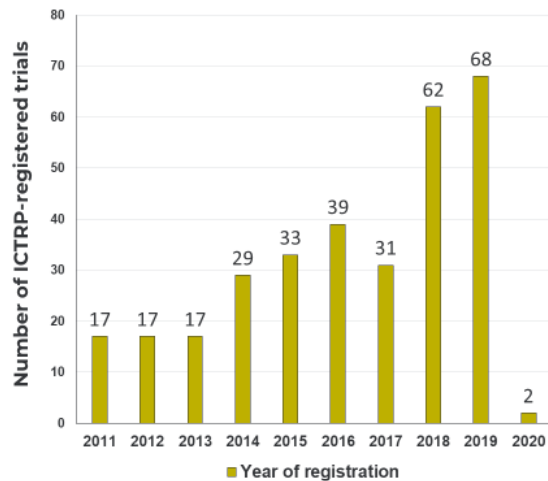


Clinical trials on CBD/THC for medicinal purposes*

World Health Organization (WHO)

International Clinical Trials Registry Platform (ICTRP)

*As of February 2020



Total 231 trials since 2011



CBD MEDICATIONS LICENSED INTERNATIONALLY

Product	Cannabinoid	Route	Indication
THC-dominant			
Dronabinol (<i>Marinol</i> ®)	Synthetic THC	Oral tablet	Anorexia in AIDS, cancer; CINV
Nabilone (<i>Cessamet</i> ®)	Synthetic THC	Oral tablet	CINV
CBD-dominant			
<i>Epidolex</i> ®	Plant extracted CBD	Oral (spray)	Nil yet
Cannabis plant matter	Various % THC, CBD available	Vaporised	Numerous
Balanced			
Nabiximols (<i>Sativex</i> ®)	Extracted THC:CBD (1:1)	Buccal	MS spasticity

CINV = Chemotherapy-induced nausea and vomiting



CBD MEDICATIONS LICENSED INTERNATIONALLY

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Balanced			
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CINV = Chemotherapy-induced nausea and vomiting



STUDY QUALITY AND GRADING OF EVIDENCE

Based on the GRADE* Quality of Evidence

Evidence Level & Features	
HIGH	Very confident the true effect lies close to that of the estimate of the effect. <ul style="list-style-type: none"> • Double-blind, placebo-controlled RCT
MEDIUM	Moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different <ul style="list-style-type: none"> • Open label trial
LOW	Limited confidence: The true effect may be substantially different from the estimate of the effect. <ul style="list-style-type: none"> • Case studies
VERY LOW	Very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect <ul style="list-style-type: none"> • Observational study

GRADE: Grading of Recommendations, Assessment, Development and Evaluations



CLINICAL RESEARCH: MODERATE LEVEL EVIDENCE

Epilepsy

Moderate- high quality evidence that CBD be used as adjunctive therapy to existing Anti- Epileptic Drugs (AEDs) in children or young people aged up to 25 years.

- Primary aim of decreasing seizure frequency and improving overall quality of life.
 - Re-evaluate after 12 weeks for AE's, SAE's

Evidence is **unavailable for first line or sole use** of medicinal cannabis in epilepsy, or for adults aged over 25 years.

The pharmacokinetic (PK) and pharmacodynamic (PD) interactions of cannabinoids with other AEDs are not yet fully elicited.



CLINICAL RESEARCH: MODERATE LEVEL EVIDENCE

Multiple Sclerosis (MS)

Low to moderate quality evidence to suggest pharmaceutical-grade THC (dronabinol or THC extract) is effective for treating symptoms of MS-related pain.

- Based on 11 systematic reviews, which included 32 individual **HIGH QUALITY** studies

Balanced THC:CBD (Nabiximols, Sativex) **may be effective** for treating symptoms of pain and spasticity in MS, in certain patient populations.

Findings are **mixed** for secondary symptoms (i.e. bladder function, sleep, patient quality of life, ataxia/tremor and disability/disease progression).

No studies included active alternatives (non-cannabinoid medicines) as comparators, which is an important limitation.



CLINICAL RESEARCH: MODERATE LEVEL EVIDENCE

Chronic Non-Cancer Pain (CNCP)

1. **MS-related neuropathic pain**- >30% reduction in pain (**low confidence**)
2. **Non-MS related neuropathic pain**- ~50% reduction in pain (**moderate confidence**)
3. **Arthritis/fibromyalgia**- insufficient information to make recommendation

Nabiximol may have a **modest effect** in some CNCP conditions over a limited time period.

However, there is a substantial **risk of bias** in the trials reviewed, tolerance is not addressed and the risk of harm with long term use of medicinal cannabis is poorly documented.

Lack of consistency for some individual cannabinoids probably reflects the **small number of trials, varied methodological quality, and their small sample sizes**.



CLINICAL RESEARCH: OTHER CONDITIONS

Condition	# studies	Findings
Weight gain in HIV/AIDS	1 RCT	THC > placebo
Depression	3 RCTs	Placebo > THC/CBD
Anxiety	1 RCT	CBD > placebo
Sleep/insomnia	12 RCTs	THC/CBD, THC > Placebo
Psychosis	1 RCT	CBD = amisulpiride
Tourette Syndrome	1 RCT	THC > placebo
Glaucoma	1 RCT	THC=CBD=placebo



CURRENT THERAPEUTIC STATUS OF CBD

1. **Low addiction potential**
2. **Low recreational abuse potential**
3. **Well-tolerated**
4. **Moderate evidence for select conditions**
5. **Medicinal cannabis is not considered a first-line therapy for any indication***

*Clinical Guidance for the Use of Medicinal Cannabis Products, TGA**



Part 2. Cannabidiol (CBD)

Future directions



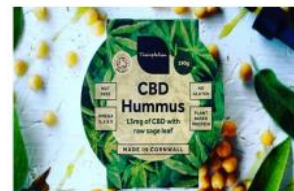
CBD IN POPULAR CULTURE

The problem...

- ❖ Matching expectations with evidence
 - Lag between experimental research into clinical practice
- ❖ Information sources and tackling misinformation
 - The role of the internet, friends, or family members, rather than from healthcare professionals/scientists
 - User pays system
- ❖ Standardisation
 - Doses, administration routes etc.



CBD IN POPULAR CULTURE



Melbourne gets its first cannabis dispensary - and it may be the first of many

"We're not just about medicinal cannabis. We're about wellness in general, health and wellbeing. People could come to us if they've got the flu," he said.

- ❖ Advertising methods (street-level)
 - ❖ Health claims
 - ❖ Terminology
- ? Legal or clinical issue



CBD IN POPULAR CULTURE

The solution...

- ❖ Increase scientific transparency
 - Removing 'invisible paywall' of scientific research
 - Engage end-users (patients/clinicians)
- ❖ Innovate science communication / literacy
 - Social media, traditional media
 - Support critical thinking skills
- ❖ Develop clinical/scientific consensus
 - Collaboration



FUTURE RESEARCH

1. Dose-ranging clinical trials
2. Long-term prospective human trials
3. Functional outcomes
4. GMP/GCP certification
5. Stronger R&D incentives
6. Dedicated research facilities



MEDICINAL CANNABIS RESEARCH GROUPS

1. Medicinal Cannabis Research Australia
2. Centre for Medicinal Cannabis Research and Innovation
3. The Australian Centre for Cannabinoid Clinical and Research Excellence
4. Lambert Initiative for Cannabinoid Therapeutics
5. Medicinal Cannabis Research Collaboration (Swinburne)



THE MCRC AT SWINBURNE UNIVERSITY

End-to-end phase 2/3 medicinal cannabis clinical research trials

Current:

1. Inflammation
2. Insomnia
3. Driving performance
4. Traumatic Brain injury
5. Gingivitis
6. Cannabis Use Disorder

Future:

1. IBS
2. Methamphetamine Use Disorder



CONCLUSION AND THANK YOU



Session 2 – Industrial Hemp for Human Health

CANADA'S APPROACH TO THE REGULATION OF INDUSTRIAL HEMP AND CANNABIS FOR MEDICAL PURPOSES

Michael McGuire

Director

Licensing and Medical Access Directorate
Controlled Substances and Cannabis Branch
Health Canada

ABSTRACT

Canada has been a global leader in the regulation of industrial hemp for more than 20 years and has had rules in place related to the use of cannabis for medical purposes for almost the same amount of time. Both regimes were impacted by Canada's decision to legalize and strictly regulate the use of cannabis for non-medical purposes nation-wide in October 2018, but in different ways.

This presentation will provide an overview of how both are regulated in Canada today, how the hemp and cannabis supply chains work, and the challenges that lie ahead.

Introduction: Why does Canada's experience matter?



- Canada has had legal industrial hemp and cannabis for medical purposes regimes in place **for roughly two decades** – we have much to offer in terms of experience and lessons learned
- In 2018, Canada made significant changes to its industrial hemp regulatory regime, and at the same time **became the second country in the world to fully legalize and regulate cannabis for non-medical purposes** – the hemp and cannabis industries in Canada are now more linked than ever before

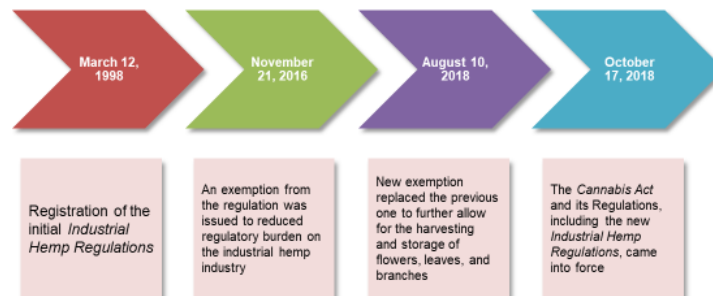
HEALTH CANADA >

Regulation of Industrial Hemp in Canada



HEALTH CANADA >

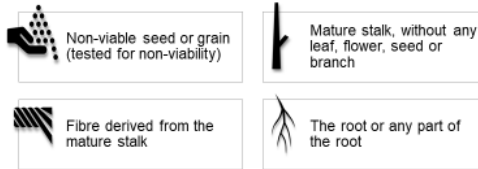
Timeline of industrial hemp regulation in Canada



HEALTH CANADA >

The Cannabis Act and Industrial Hemp Regulations

- In Canada's *Industrial Hemp Regulations*, "Industrial Hemp" is defined as a **cannabis plant** — or any part of that plant — in which the concentration of THC is 0.3% (weight by weight) or less in the flowering heads and leave. Any cannabis plant with THC concentrations above that amount is considered *cannabis* and governed under the *Cannabis Regulations* and subject to stricter controls.
- It is **prohibited** to possess and conduct activities with industrial hemp without an industrial hemp or cannabis licence, **unless** they are related to plant parts excluded from the control of the *Cannabis Act*:



(Schedule 2 of the Cannabis Act)

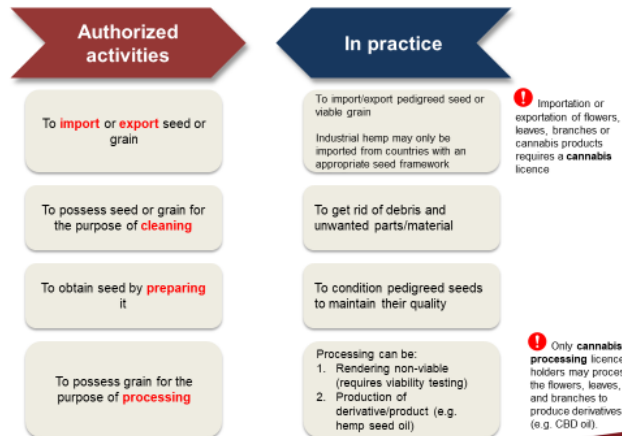
HEALTH CANADA >

Licensable activities under Canada's Industrial Hemp Regulations



HEALTH CANADA >

Licensable activities under Canada's Industrial Hemp Regulations



HEALTH CANADA >

List of Approved Cultivars (LOAC)



A holder of a licence that authorizes cultivation, other than as a plant breeder, must sow only seed of pedigreed status that is of an approved cultivar as set out by the **List of Approved Cultivars**.

The LOAC:

1. Is amended on a regular basis
2. Is published on the Health Canada website
3. Only includes varieties that consistently demonstrate THC levels of 0.3% or less

Only the varieties that are grown for **pedigreed seed** or **plant breeding** purposes are required to have THC test results submitted to Health Canada regularly.

HEALTH CANADA >

Other Hemp Regulatory or Policy Requirements

- ✓ Industrial hemp must be stored in conditions that maintain its quality
- ✓ Licences are valid for up to 5 years but cultivation site locations must be reported annually
- ✓ Only recognized plant breeders may be licensed to propagate new varieties not on the LOAC
- ✓ Some cannabis licence holders who purchase industrial hemp may impose additional requirements, such as pesticide testing
- ✓ Applications are submitted through a national online application portal



HEALTH CANADA >

Active Industrial Hemp Licences in Canada

(Data as of September 30, 2019)



HEALTH CANADA > 10

Cannabis for medical purposes in Canada



HEALTH CANADA >

Background

- Canada has had a regulatory regime providing Canadians with access to cannabis for medical purposes since 2001. Over the years, the regulatory framework for the program has evolved largely in response to court decisions.
- Over the last two decades, courts in Canada have repeatedly ruled that Canadians have a constitutional right to reasonable access to a medicine – in this case, cannabis – under the *Canadian Charter of Rights and Freedoms*. Most of the government's regulations were developed in response to those court decisions, until 2018.
- When cannabis was legalized across Canada for non-medical purposes in 2018, the government made a deliberate decision to maintain a distinct regime to continue to provide reasonable access to cannabis for medical purposes to Canadians who have the support of their health care practitioner.

HEALTH CANADA >

Current medical regime

- Today, Canadians authorized by their health care practitioner can access cannabis for medical purposes by:
 - purchasing cannabis directly from a federally-licensed seller;
 - registering with Health Canada to grow a limited amount for their own medical purposes; or
 - registering with Health Canada to designate someone to grow it for them.
- In all cases above, a patient must first get a **medical document** (similar to a prescription) from an authorized health care practitioner. Medical documents are valid up to maximum of one year and then must be renewed.
- Patients may also choose to purchase their cannabis supply from a provincial/territorial authorized retail outlet or online sales platform, like any other adult, without the need for a medical document.

HEALTH CANADA >

Obtaining cannabis from a federally licensed seller

- Individuals may access cannabis for medical purposes by registering with a federally licensed seller of their choice.
 - Orders are placed using a secure website or by phone and shipped directly to the registered patient
 - Patients can order the following classes of cannabis: fresh, dried, concentrates (ex. oils), topicals, edibles, plants or seeds
- Holders of a medical sales licence produce cannabis and cannabis products according to the same strict rules and regulations as companies which produce cannabis for non-medical purposes.
 - Must meet Good Production Practices (GPP)
 - Companies must adhere to both physical and personnel security requirements

As of September 30, 2019, there were **369,614** medical client registrations with federally licensed sellers.

HEALTH CANADA >

Obtaining cannabis through personal or designated production

- Individuals with a medical document from a health care practitioner may apply to Health Canada for a registration to:
 - grow a limited amount for their own medical purposes; or
 - designate someone to grow it for them.
- Registered individuals may grow cannabis at their own ordinary place of residence, or at another site if they have the land owner's permission. Only four registered individuals may be present at any given site.
- The number of plants that a registered individual can grow is tied to the daily amount authorized by the health care practitioner (i.e. grams per day).

As of September 30, 2019, there were **29,193** individuals registered with Health Canada for personal or designated production.

HEALTH CANADA >

Hemp and CBD Products



HEALTH CANADA >

Hemp and CBD Products

- With regulatory changes made in 2018, the industrial hemp and cannabis industries in Canada now have an opportunity for more supply chain integration.
- While many industrial hemp farmers in Canada continue to cultivate hemp for food, clothing and other material, a growing number are choosing to sell their chaff to cannabis licence holders, who then can process it into cannabis products like CBD oils, creams, etc., and then sell those products to the medical and non-medical market.
 - ❗ Industrial hemp licence holders cannot make or sell CBD products themselves, unless they also hold a cannabis licence.
- Between October 2018 and September 2019, cannabis licence holders reported purchasing/receiving **82,417 kg** of dried cannabis from hemp licence holders.

HEALTH CANADA >

Looking ahead

- The Government of Canada continues to support the industrial hemp industry in Canada by maintaining a regulatory framework that is fair and balanced in terms of requirements and controls.
- We are monitoring international developments in the area of CBD and industrial hemp as they continue to evolve.
- Health Canada is updating its policy for having varieties added to the List of Approved Cultivars. This update should result in a more flexible approach to getting high CBD varieties added to the LOAC.

HEALTH CANADA >

Session 3 – Growing industrial hemp: International perspectives

HEMP INDUSTRY IN CANADA: CURRENT STATUS AND OUTLOOK INTO THE FUTURE

Jan J. Slaski

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Vegreville, Alberta, Canada

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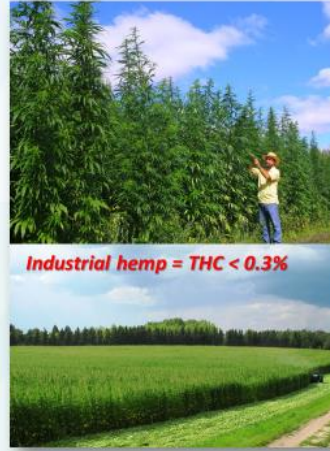
ABSTRACT

During the past two decades, since the legalization of hemp as an agricultural crop, growth of the Canadian hemp industry was primarily driven by a booming demand for grain for health food products and, to some extent, for cosmetics. In 2018, value of the Canadian hemp industry was \$285 million including \$96 million in revenue from export sales and \$42 million in revenue from domestic sales.

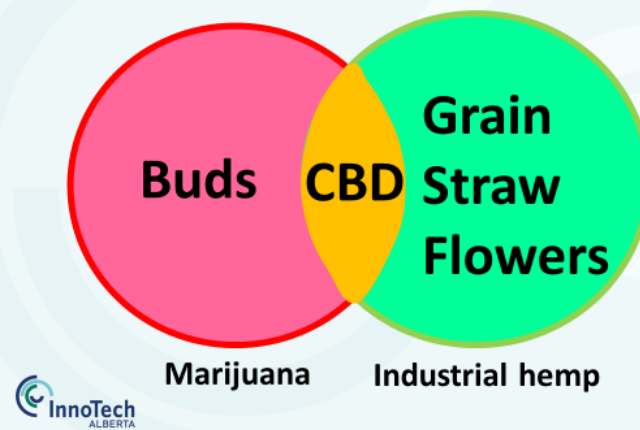
In October 2018 the Cannabis Act was introduced in Canada. This legislation legalized the recreational use of marijuana, but even more importantly, it permitted utilization of whole industrial hemp plants including flowers, leaves and chaff. Therefore, the new regulations empowered fresh tangible opportunities for this genuinely multipurpose crop. As a result, according to the projections of the Canadian Hemp Trade Alliance, value of the hemp industry in the country will surpass \$1 Billion by 2023.

This talk will review the four pillars supporting current and future development of the Canadian hemp industry value chain that include hemp for food, fibre, feed and fractions (cannabinoids, i.e. CBD). The hemp industry in Canada is poised to continue to grow. Unsaturated domestic markets for food and cosmetic products and the development of new and improved products and formulations is expected to drive need for the seeds. In addition, off-type seeds, screenings and seed hulls that are currently not permitted as livestock feed will be soon allowed for inclusion in feeding rations since the registration process with Canadian regulators has already commenced. In 2019 the first commercial-scale fibre processing facilities have been launched in Alberta. Thousands of acres of fibre-type varieties were contracted by the processors to secure high-quality feedstock for their operations. Acreages of purposely grown hemp for fibre will rise as new decortication plants are scheduled to be built in the upcoming years. Ample availability of bast and hurd will lead to further development of environmentally friendly fibre-based products such as construction materials, bio-composites, textiles, etc. Finally, the fractions (non-narcotic cannabinoids) - the fourth pillar of the Canadian hemp industry - came to play in 2018 and continued to gain commercial traction in 2019 as multiple processors established facilities across the country. It is worth to notice that to date Canadian growers tend not to rely on the fractions as a sole source of income (as is currently observed in some other jurisdictions) but rather pursue a more economically sustainable approach involving all revenue streams offered by this multi-purpose crop.

Setting the stage – low and high THC cannabis



Cannabis subspecies: what do they have in common?



Two major usage types (*the third in the works*)



Grain type

- Short stature
- High seed yield
- Low vegetative biomass

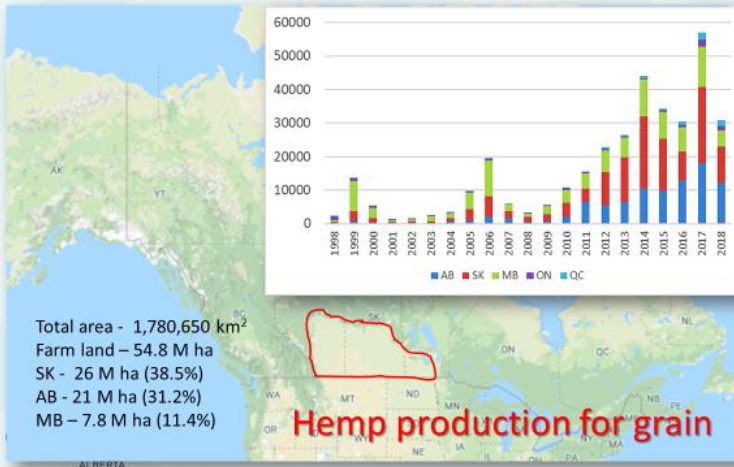
Fibre (dual) type

- Tall or very tall plants
- Very high stem yield
- Lower seed yields

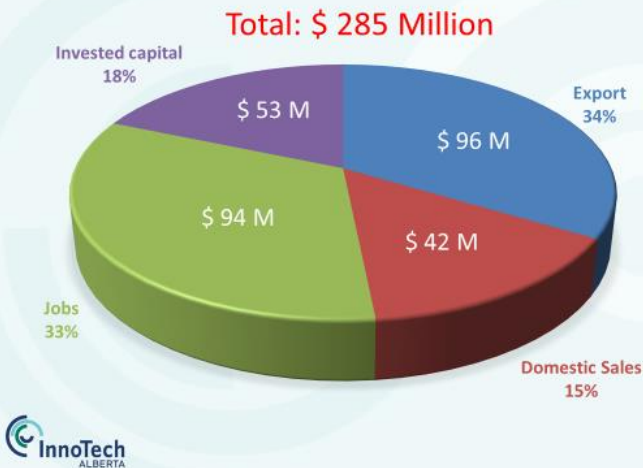


CBD type - high levels of non-narcotic cannabinoids and terpenes

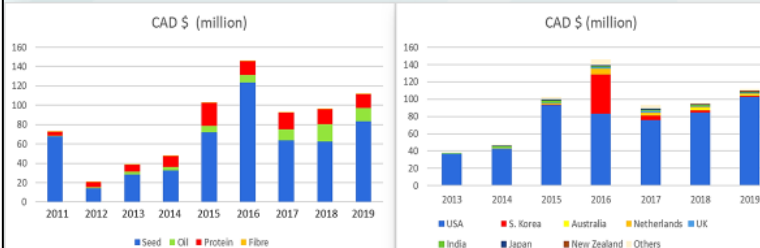
Hemp production on the Canadian Prairies



Size of the Canadian hemp industry in 2018



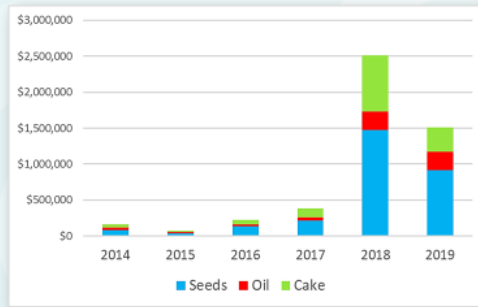
Export of the Canadian hemp products



- USA is a major importer of the Canadian hemp
- Export to South Korea spiked in 2016
- Canadian hemp was exported to 33 countries in 2019
- Export to Australia ranked #3 in 2019



Canadian export to Australia



Volume (kg)

	2014	2015	2016	2017	2018	2019
Seeds	7122	4062	12358	21538	201122	126240
Oil	5528	1797	3312	3500	41614	24040
Cake	240898	95662	376803	689272	4204144	1819286



Canadian hemp industry SWOT analysis

STRENGTHS

- Current global leadership position in hemp food production
- Knowledge and experience of stakeholders since 1998
- Industry driven, industry focused, entrepreneurial energy
- Recognition of hemp as a multipurpose crop

WEAKNESSES

- Still a small, emerging industry with limited resources for the many jobs to undertake
- Lack of stable funding for industry development



Canadian hemp industry SWOT analysis (2)

OPPORTUNITIES

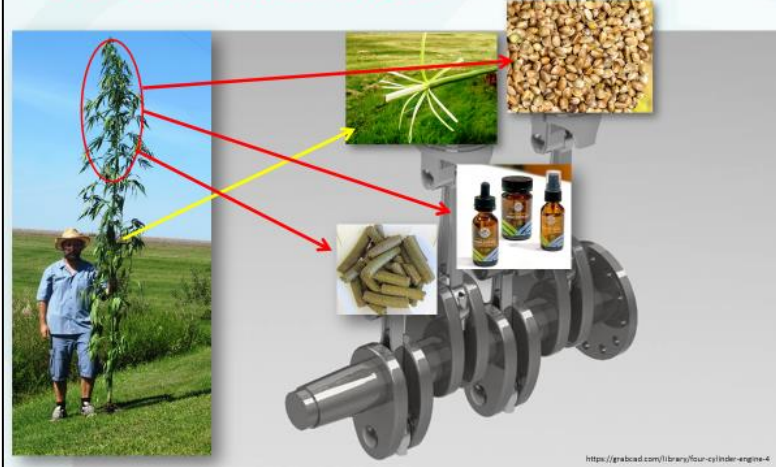
- Consumer and government push for hemp based sustainable products
- Multiple revenue streams derived from one crop
- Investor interest stimulated by regulatory changes

THREATS

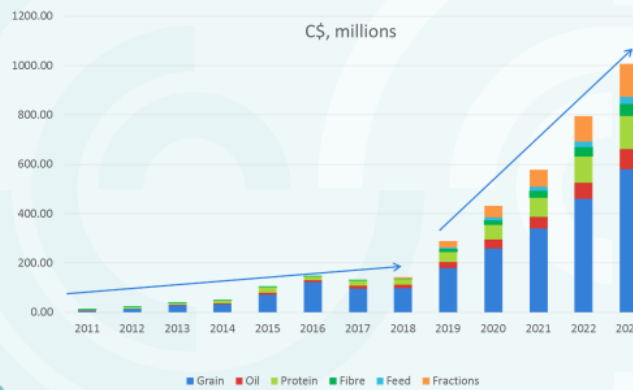
- Still a small, emerging industry – lack of awareness with consumers
- Foreign competition – EU, China looking at food market, US cultivation in the future...“window of opportunity” for leadership could close quickly



Canadian focus: Hemp industry powered by a four cylinder engine



Growing a \$1B hemp industry by 2023



...by seizing the value of the whole hemp plant

Tremendous economic contribution

Annual KPIs	2018 Baseline	2023 Projected
Sales (C\$, m)	138	1,008
Jobs (FTE)	1,311	9,576
Payroll (C\$, m)	94	689
Annual Invested Capital (C\$, m)	53	389
Seeded Acres	80,000	450,000
R&D Investment C\$, m	7	40



Canadian Hemp Trade Alliance (CHTA): fuel accelerating industry development

- A national organization that enables all four market opportunities through research, education and trade promotion
- Established in 2003, the Alliance represents those involved in Canada's hemp industry
- Nearly 450 members include farmers, processors, manufacturers, researchers, entrepreneurs and marketers



Top priority areas of CHTA



- Create stable funding platform for industry development by establishing a check-off system
- Promote/support research in priority areas (in cooperation with major granting agencies)
 - National variety trials
 - Heavy metal accumulation
 - Whole plant post-harvest
- Establish standards for the industry (development of standards with ASTM) for food, feed, fibre and fractions
- Influence cannabis policy and regulation to liberalize hemp-derived cannabinoid (CBD) extraction and sale
- Establish long-term international strategy
 - a new international hemp federation to influence policies and regulations affecting hemp globally



Concluding remarks: The future is bright

- Hemp industry in Canada is poised to grow because of new tangible opportunities
 - Food – unsaturated domestic market, new products
 - Fibre – first commercial scale processing facilities, contracted fibre acres
 - Fractions – hemp is major CBD source, ingenuity of industry contributors, did not put all eggs in the CBD basket
 - Feed – registration process has commenced
- Robust agronomy package - Industrial hemp eGuide <http://www.hemptrade.ca/eguide>
- Raising awareness/education (workshops, trade shows and conferences)



Session 3 – Growing industrial hemp: International perspectives

CHINA HUMANS AND HEMP – A NEW AGE OF HEALTH

Prof. Sun Yufeng³

Chief Expert
Institute of Bast Fiber Crops
Daqing Branch of the Heilongjiang Academy of Sciences
Daqing, Heilongjiang, China

Contents



-  *Introduction of hemp*
-  *Present situation and prospect of application of Hemp
China*
-  *Breeding situation in Heilongjiang Province of China*
-  *Main research directions on hemp of DBHAS*



01 Introduction of hemp

³ Prof. Sun Yufeng and his delegation's visit to the 2nd AIHC was cancelled due to the outbreak of the Coronavirus. His presentation was given by Mr Alex Meng, an associate from Melbourne VIC.

Cannabis sativa L.

The European Union calls cannabis varieties with tetrahydrocannabinol (THC) content less than 0.3% industrial cannabis, which refers to non-toxic or low-toxic cannabis types (THC content < 0.3%) that can be commercialized and have no extracted drug value. As industrial raw materials for development and utilization. China refers to industrial hemp as hemp.



关于汉麻

HEMP

Hemp originated in China, "the source of national textile, clothing ancestors for thousands of years".

During the Western Han Dynasty, hemp and silk products entered the Middle East, the Mediterranean and Europe along the "Silk Road", and then went to the world.

China- "medicine and food"
Europe and America- "Functional Food"

As the main food of local residents, hemp seed, the hometown of longevity in Bama, Guangxi Province in China.

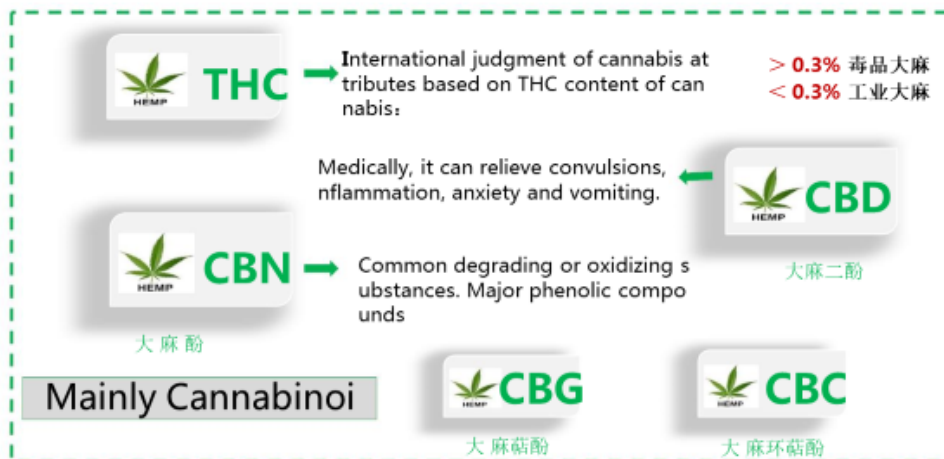
Modern medicine
The Medicinal Value of Hemp- Ancient Prescriptions of Chinese Medicine

热点

700余种化学成分

大麻素 非大麻素

Cannabinoids





02

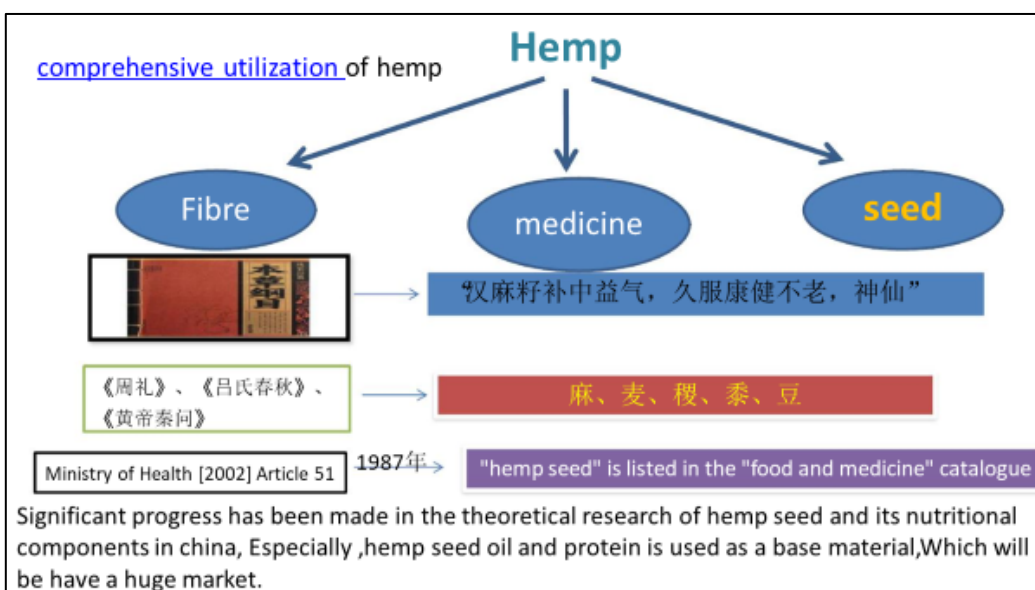
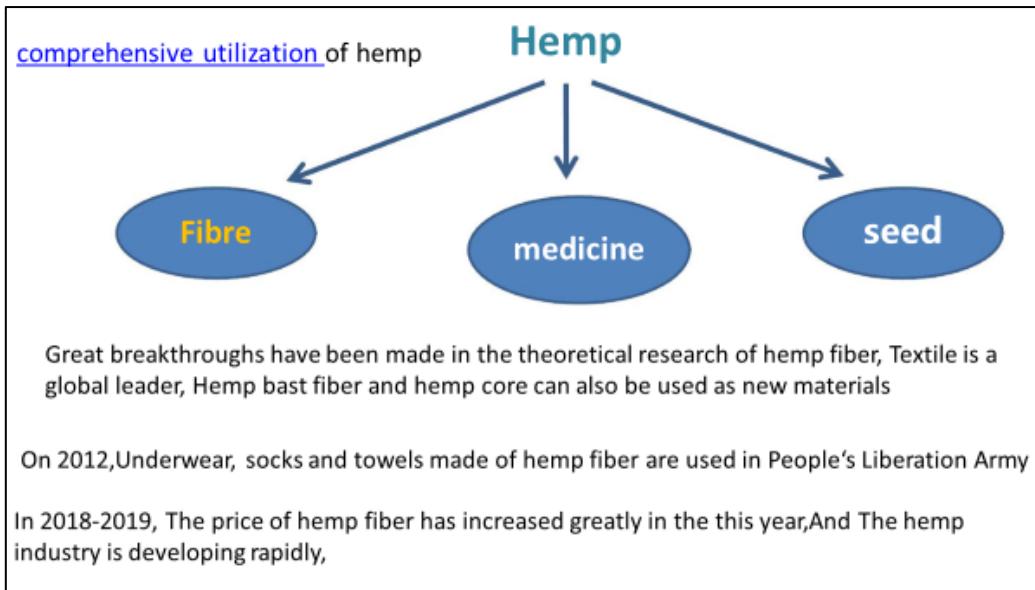
Present situation and prospect of application of China hemp

Comprehensive Utilization Value of Hemp



At present, the utilization of hemp fiber and hemp seed is the main part in China ,Mainly in the textile and food industries such as cooking oil ,Other emerging applications, such as health care and food additives,Which still needs to expand, Flower Leaf and CBD extraction was mainly for export,At the policy level, Flower Leaf extract of Hemp is only allowed to be added to cosmetics ,that Not Allowed to add to Food and drink. Food-drug homology of Hemp It was allowed to use it in cosmetics and foods.



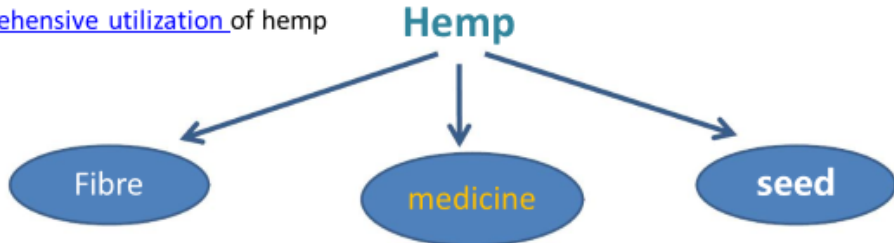


seed

Hemp seed contains 25% - 35% oil, about 80% unsaturated fatty acids, and the proportion of $\omega - 6$ and $\omega - 3$ is close to 3 / 1, which is the gold proportion for normal metabolism of human body. The protein content is between 20% and 25%. The protein content of seed kernel is more than 40%. It contains 8 kinds of amino acids necessary for human body. The hemp kernel protein account is 2 / 3. It is similar to human body protein and belongs to "high quality complete protein", also known as super food.



comprehensive utilization of hemp



List of names of used cosmetic ingredients is announced by the State Administration of Food and drug in 2015, Contains "cannabis leaf extract. "

Most Chinese companies are still in the early stages of the hemp layout, Focus on Planting and extraction、 fiber links of hemp, Application of hemp leaf extract in cosmetics be opened up in china.

By January 2019, 41 countries around the world had declared medical marijuana legal, and more than 50 countries had declared CBD legal.



Expected 2024 ,Market size of CBD will increase to 1.8 billion yuan in chian
The compound growth rate during the period was 21.96%.

2018-2024 年大麻二酚市场规模预测



Bio-active ingredient—cannabinoids

Important applications of china hemp are in the field of cosmetics.



According to the data of WHO, there are more than 50 million epileptics in the world, 80% of them can not get regular treatment.

In the future, 3000-4000 new diseases can be developed by CBD



In the future, Research value and new utilization direction of medicinal materials will be confirmed in International academic research and practical application, It is highly likely that China will further promote the legalization of hemp,And Increase in the number of provinces promoting the legalization of hemp. To support the development of Hemp related industries.



03

Breeding situation in Heilongjiang Province of China

Main Planting Area of Hemp In China

At present, more than 30 countries around the world are planting and comprehensively exploiting hemp in large areas. The annual planting area is about 60-700,000 mu, and the annual fiber production accounts for 38% of the world, ranking second in the world, mainly in Heilongjiang and Yunnan provinces. The planting area of Heilongjiang Province is about 400,000 mu, accounting for about 70% of the country's planted area. Due to geographical advantages, the quality of hemp fiber in Heilongjiang Province is the best. An average annual planting area is about 20000 hectares in Heilongjiang Province.



At present, only Heilongjiang and Yunnan have liberalized hemp cultivation in China, of which Yunnan Province has implemented it in the form of government decrees, and Heilongjiang Province has only promulgated the "New Drug Control Regulations of Heilongjiang Province" through legislation, And Government support.

云南省人民政府办公厅文件

云政办发〔2010〕10号
云南省人民政府办公厅关于印发
云南省生物资源产业化管理条例
的通知
《云南省生物资源产业化管理条例》自发布之日起施行。

黑龙江省人民政府办公厅文件

黑政办发〔2010〕10号
黑龙江省人民政府办公厅关于印发
黑龙江省生物资源产业化管理条例
的通知
《黑龙江省生物资源产业化管理条例》自发布之日起施行。

① 2010年1月1日

中国云南省工业大麻合法化正式开始实施。
《云南省工业大麻种植加工许可办法》—政府令形式

② 2017年5月1日

中国黑龙江实施新的禁毒条例，明确将工业大麻与毒品大麻区分开，
允许工业大麻种植、销售、加工。
《黑龙江省禁毒条例》—立法形式

Main Planting Area of Hemp In Heilongjiang Province

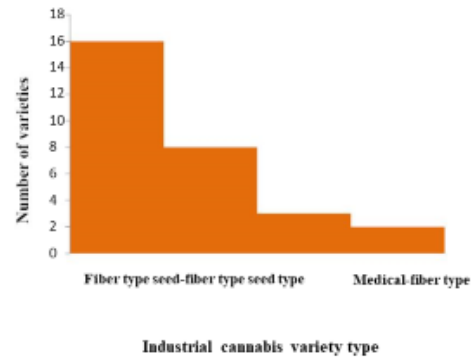


It is mainly distributed in, Daqing, Harbin, Qiqihar Mudanjiang, Suihua, Heihe, Qitaihe and other areas in Heilongjiang Province. The accumulated temperature zone is dominated by the first to fourth accumulated temperature zones.



Main Variety breeding of Hemp In China

In 2001-2018, a total of 29 varieties were cultivated in China, including 16 fiber-type varieties, 8 seed-fiber-type varieties, 3 seed-type varieties, and 2 fiber-and-drug-type varieties.



Mainly Research Institutions of Heilongjiang

3 major research institutions

Variety and supporting series technology, comprehensive utilization development, etc.

Another 10 companies have cultivated varieties

Heilongjiang Academy of Sciences Daqing Branch

Heilongjiang Academy of Agricultural Sciences — Heilongjiang Academy of Agricultural Sciences Institute of Economic Crops

Heilongjiang Provincial Academy of Agricultural Sciences Daqing Branch



Cultivation of Industrial Hemp Varieties From 2001 to 2018 in Heilongjiang Province

Name	Type	Suitable Place	Institute	Time
大麻1号	Fiber	哈尔滨、齐齐哈尔、牡丹江、大庆、黑河	DBHAS	2015
龙麻1号	seed	哈尔滨、齐齐哈尔、牡丹江、大庆、黑河	DBHAS	2017
龙麻2号	Fiber	哈尔滨、齐齐哈尔、牡丹江、大庆、黑河	DBHAS	2017
汉麻1号	Fiber	哈尔滨、齐齐哈尔、牡丹江、大庆、黑河	DBHAS	2017
汉麻2号	Fiber	哈尔滨、齐齐哈尔、牡丹江、大庆、黑河	DBHAS	2017
汉麻3号	seed-fiber	哈尔滨、齐齐哈尔、牡丹江、大庆、黑河	DBHAS	2017
汉麻4号	seed-fiber	哈尔滨、齐齐哈尔、牡丹江、大庆、黑河	DBHAS	2018
汉麻5号	Fiber	哈尔滨、齐齐哈尔、牡丹江、大庆、黑河	DBHAS、 Daqing Tianmu Industrial Hemp Development Co Ltd	2018
格列西亚	seed-fiber	哈尔滨、齐齐哈尔、牡丹江、大庆、黑河	DBHAS	2017
庆大麻1号	Fiber	黑龙江省	DBHAAS	2016
庆大麻2号	Fiber	黑龙江省	DBHAAS、 Daqing Tianzhi Grass Biological New 2017 Material Technolo	2017
线麻1号	Fiber	哈尔滨、绥化、齐齐哈尔、牡丹江、黑河	Mudanjiang Heilong Agricultural Science and Technolog	2018
牡麻1号	Fiber	哈尔滨、绥化、齐齐哈尔、牡丹江、黑河	y Development Co Ltd. (MIAS)	2018

Variety cultivation trend

The fiber type is the main type, and the seed type, the seed fiber type, and the high CBD type are important development directions in the future.



In 2019, Heilongjiang Province participated in the production test variety including all the above types, of which the proportion of medical varieties increased.

Variety cultivation test

The test setup of no less than 6 test points per year is to ensure the data collection of the four test sites, and to evaluate the comprehensive traits such as the high yield, stability and regional environmental adaptability of the varieties.



Varietal test point
Expert evaluation



Large-scale planting of indoor and outdoor and various planting methods of different types of varieties has been gradually realized.



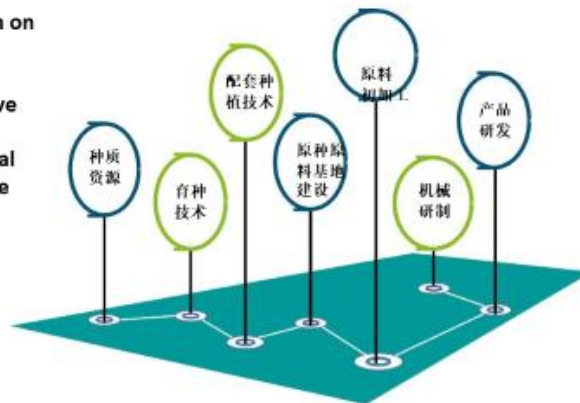
Mechanized harvest greatly reduces the cost of planting



04

Main research directions on hemp of DBHAS

• After more than 40 years of accumulation on the research, we have a domestic leading level in flax and industrial hemp breeding and cultivation techniques. By now, we have more than thousands of flax and hemp germplasm, 19 flax varieties and 13 industrial hemp varieties. Some of them have been the mainly varieties for production.

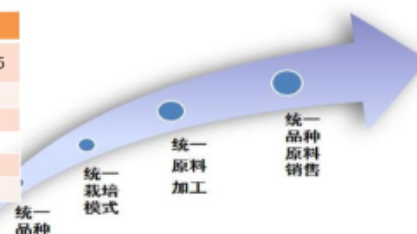


• The research directions mainly focus on the collection and introduction of germplasm resources, cultivation and breeding technology of new varieties, supporting planting technology, construction of raw material base, preliminary processing of raw materials, mechanical development, product technology development and other key directions.

Hemp variety		List of Hanma varieties (2015-2019)			
		序号	品种名称	类型	育成时间
Fiber type Raw stem yield: 7415-10936 kg/hm ² Fiber production: 平均2100 kg/hm ² THC minimum content: 0.0017%	Seed yield 1200-1500 kg/hm ²	1	Huo Ma 1	Fiber type	2015年
	Seed (Seed fiber) type	2	Long Ma 1	Seed type	2017年
Seed yield: 850-1500kg Fat content: 31.4-32.0% Protein content: 24.5-26.7%	Fiber production 7400-8400 kg/hm ²	3	Long Ma 2	Fiber type	2017年
		4	Han Ma 1	Fiber type	2017年
		5	Han Ma 2	Fiber type	2017年
		6	Han Ma 3	Seed fiber type	2017年
		7	Ge Lie Xi Ya	Fiber type	2017年
		8	Han Ma 4	Seed fiber type	2018年
		9	Han Ma 5	Fiber type	2018年
		10	Han Ma 6	Fiber type	2019年
		11	Han Ma 7	High CBD type	2019年

Industrialization and application of varieties

序号	标准名称(Name of Standard)	标准代号	实施时间
1	纤维工业用大麻良种繁育技术操作规程	DB23/T2063-2017	2016.03.16
2	汉麻与大豆间作栽培技术规程	DB23/T 2317-2019	2019.4.19
3	盐碱地纤维用汉麻栽培技术规程	DB23/T 2328-2019	2019.4.19
	大麻雨露二粗	DB23-T2330-2019	2019.4.19
5	大麻雨露干茎	DB23-T2331-2019	2019.4.19
6	大麻雨露纤维加工操作规程	DB23-T2332-2019	2019.4.19



In view of the problems affecting the orderly development of the industry caused by the uneven variety, planting technology and raw materials, we work on promoting a unified production mode to meet the demand of textile enterprises for the consistency of raw materials quality, and cooperates with the provincial Fiber Inspection Bureau to jointly promote the local standards for fiber primary processing in Heilongjiang Province and the standardization and management of fiber raw materials and primary processing.

Development of special machinery for hemp



We're undertaking the state key program: "The research and develop of cotton and hemp intelligent and efficient harvesting technology and equipment"

2020/2/26

Primary processing of raw materials

Bio-degumming technology can effectively assist and enhance the degumming effect, and ensure the output and quality of fiber raw materials.

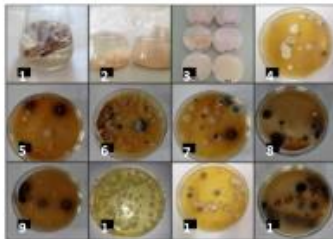


图1: 菌种富集培养及分离
1: 灭菌生理盐水冲洗大麻茎 2: 大麻茎粉培养基
3: 混合培养基接种平板 4*12: 不同菌落形态



图6 室内模拟脱胶实验



Application of hemp chips in the cultivation of Black fungus



Benefit accounting: the cultivation volume of *Auricularia auricula* in the whole province is calculated in accordance with 7 billion bags, and all hemp scraps are used to replace part of saw dust to cultivate *Auricularia auricula*.

It can save about 1.26 billion Yuan annually, which can greatly promote farmers' income, and play a positive role in straw utilization and ecological protection.

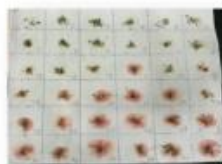


Development of hemp seed polypeptide and other functional food



Polypeptides have the functions of easy absorption, anti-oxidation, blood pressure reduction, blood lipid reduction, blood glucose reduction, immunity enhancement, anti-tumor, etc., which have been widely used in health food, medicine, cosmetics and other fields. The technology of preparing hemp seed polypeptide by complex enzymatic method is mature. The degree of protein hydrolysis was increased to 27.23%, the yield of polypeptide was 80.36%, and the polypeptide with molecular weight less than 5000da accounted for more than 90%. At present, there is no hemp polypeptide health food in China. Our hospital has developed a series of health food, such as hemp polypeptide oral liquid, hemp polypeptide buccal tablet and so on.

Semi quantitative and quantitative analysis of cannabinoids



THC半定量快速检测分析



定性定量检测分析：液相、液质等检测分析



Study on Extraction and purification of cannabinoids

Cannabidiol, CBD

- (一) 柱层析色谱技术, CBD含量>80%。
- (二) 离子交换树脂技术, CBD含量>85%。
- (三) 快速纯化系统技术, CBD含量>99%。
- (四) 超临界CO₂提取技术, CBD含量>40%

According to the data of WHO, there are more than 50 million epileptics in the world, 80% of them can not get regular treatment.



THANK YOU

E-mail: alexmeng888@gmail.com

Session 3 – Growing industrial hemp: International perspectives

AN UPDATE ON THE NZ IHEMP INDUSTRY AND THE ISSUES WE FACE IN 2020

Richard Barge

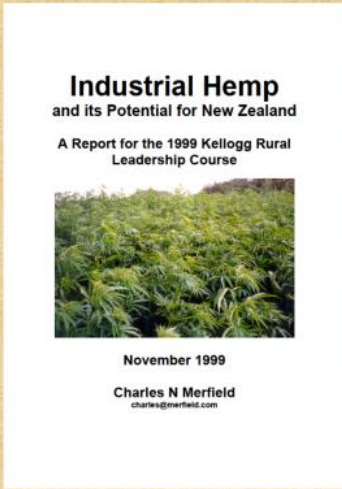
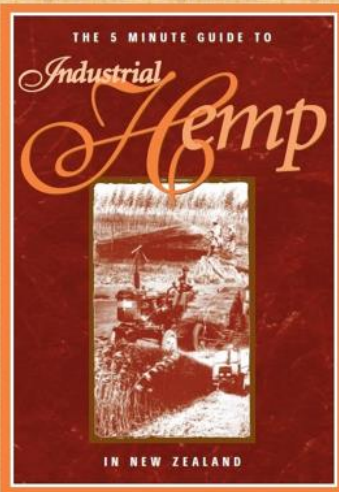
Chairman,
NZ Hemp Industries Association Inc.,
Howick, Auckland NZ

E: richard@hemptastic.co.nz T: +64 9 533 6690

contents



- ▶ NZHIA since 1997
- ▶ The NZ Industrial Hemp Regulations 2006
- ▶ Statistics and information
- ▶ Current situation - Snapshot New Zealand
- ▶ The Issues facing the emerging industry
- ▶ Hemp Summit & Expo 4-6 June 2020



Misuse of Drugs (Industrial Hemp) Regulations 2006

(SR 2006/163)

3 Object

The object of these regulations is to enable the cultivation and distribution of industrial hemp under a licensing regime that ensures that other forms of cannabis are not cultivated and distributed under the guise of industrial hemp.

cannabis means *Cannabis sativa*

hemp means cannabis plant, seed, or fruit

Misuse of Drugs (Industrial Hemp) Regulations 2006

(SR 2006/163)

industrial hemp means hemp in the form of—

- (a) plants with a THC content that is—
 - (i) generally below 0.35%; and
 - (ii) is not above 0.5%; or
- (b) seeds harvested from plants of that kind

hemp product means a product of a kind that is derived, in whole or in part, from industrial hemp

67 Permission

- (1) Every person is permitted to possess, use, and trade in—
 - (a) hemp products; and
 - (b) hulled hemp seeds; and
 - (c) stalks of industrial hemp, as long as those stalks are without leaves or fruit.
- (1A) Every person is permitted to import into and export from New Zealand—
 - (a) hemp products; and
 - (b) hulled hemp seeds; and
 - (c) stalks of industrial hemp, as long as those stalks are without leaves or fruit.
- (2) This regulation does not affect any other restrictions imposed by law.

Industrial Hemp Regulations - Approved Cultivars

Approved Cultivar	Date Approved
A1 Monopurp	26 February 2019
Anka	7 September 2006
Aotearoa 1	31 July 2008
CFX-1	19 November 2014
CFX-2	19 November 2014
CRS-1	19 November 2014
Fasamo	7 September 2006
Fedora 17	25 March 2010
Ferimon 12	15 October 2009
Finola	7 September 2006
Futura 75	19 November 2014
Katani	26 October 2018
Kompolti	7 September 2006
Sirius	26 February 2019
USO 31	7 September 2006



SINGLE CONVENTION ON NARCOTIC DRUGS, 1961,

as amended by
the 1972 Protocol Amending the Single Convention
on Narcotic Drugs, 1961



Article 28. Control of cannabis

1. If a Party permits the cultivation of the cannabis plant for the production of cannabis or cannabis resin, it shall apply thereto the system of controls as provided in article 23 respecting the control of the opium poppy.
2. This Convention shall not apply to the cultivation of the cannabis plant exclusively for industrial purposes (fibre and seed) or horticultural purposes.
3. The Parties shall adopt such measures as may be necessary to prevent the misuse of, and illicit traffic in, the leaves of the cannabis plant.

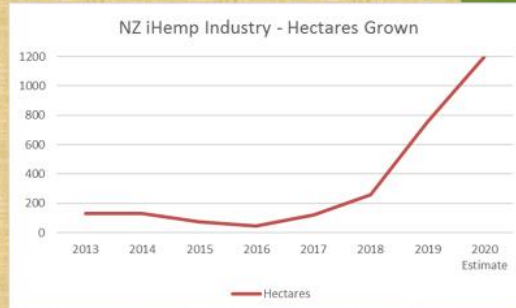
Number of licences and areas cultivated in New Zealand

	2016	2017	2018	2019
General Licences	21	35	49	130
Processing Licences	12	14	3	20
Research and Breeding	8	8	13	19
Total # of licences	41	57	65	169
Area cultivated - hectares	43	120	259	754
Area approved - hectares		154	332	2,627



Where and how much hemp is grown in Aotearoa/New Zealand

2019 - Approved hectares = 2,627, actually grown 754



Current Regulations

- Misuse of Drugs Act 1975
- Industrial Hemp Regulations 2006
- Hemp Seed Food - December 2018
- Medicinal Cannabis Regulations - December 2019

Aotearoa/New Zealand's strengths

- Kiwi Ingenuity - A well trained R&D ecosystem
- Favourable climate and latitudes
- Access to water and skilled farmers
- High quality standards and manufacturing
- Positive global image, trusted brand

Weakness

- Lack of awareness
- Lack of funding and scale
- Tendency to commoditise farming outputs

Opportunities

- Global branding to discerning customer in niche high value markets
- Innovation - products and tech
- Bio-regional development

Threats

- Regulatory Risk - creating uncertainty
- Pest and diseases
- Lack of infrastructure and markets

**Callaghan
Innovation**

New Zealand's
Innovation
Agency



The elephant in the room - our regulators intent
 Enabling the industry - we need access to the
 revenue streams from the whole plant



- FOOD 
- FIBER 
- HEALTH 
- Medicinal
- Wellness
- Natural Health Products
- Cosmetics

The Issues

- Removing iHemp from the Misuse of Drugs Act 1975
- Remove hemp from being treatment as a controlled drug
- Access to the animal food market - Hemp seed and flower
- Whole plant utilisation- circular economy
- Treatment of CBD - Natural Health Products Vs Medicines
- Maintaining high quality standards and product integrity
- Managing the issues around scaling
- Change to the Food Code, to allow leaf and flowering top (AUS/NZ)

The Way Ahead- NZ Hemp Sector Strategic Planning Project

September 4 2019

The NZHIA is launching a participative process to engage all investors to co-design a Strategic Plan 2019-30 which builds on the key strategic insights from iHemp Summit held last year which featured 29 leaders of the industry, including offshore speakers. This plan will focus on Hemp- across the spectrum from the health and nutrition whole foods and nutraceutical products and through to fibre-based building, composite and textile products.



Your all invited!

NEW ZEALAND
iHEMP 2020
SUMMIT & EXPO
Growing the Future
4 - 6 JUNE | ROTORUA

Come over and exhibit your products and services
2020 Summit & Expo 4-6 June Rotorua

Thank you and we look
forward to working with
you to build a great
industry

Richard Barge – richard@hemptastic.co.nz

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Session 3 – Growing industrial hemp: International perspectives

POTENTIAL OF INDUSTRIAL HEMP IN POLAND CHALLENGES AND OPPORTUNITIES

Prof. Malgorzata Zimniewska


Institute of Natural Fibres and Medicinal Plants
Poznan, Poland


E: malgorzata.zimniewska@iwnirz.pl

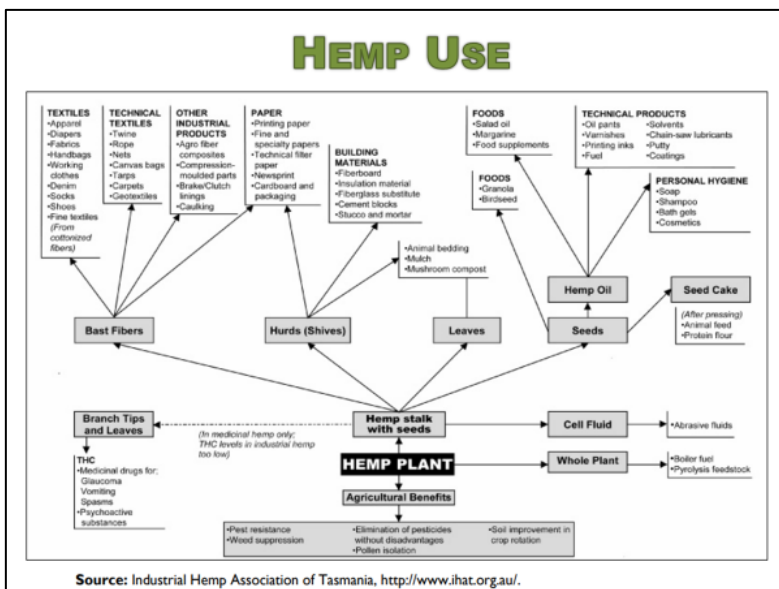
HEMP BIOMASS

- Waste of hemp cultivation for seeds purpose
- Waste of hemp cultivation for CBD purpose
- Hemp cultivation for soil reclamation and remediation
- Processing waste
- 1 ha of hemp cultivation gives biomass:
 - 15 t of Bialobrzekskie variety
 - 13,5 t of Tygra variety
 - 10 t of Henola variety

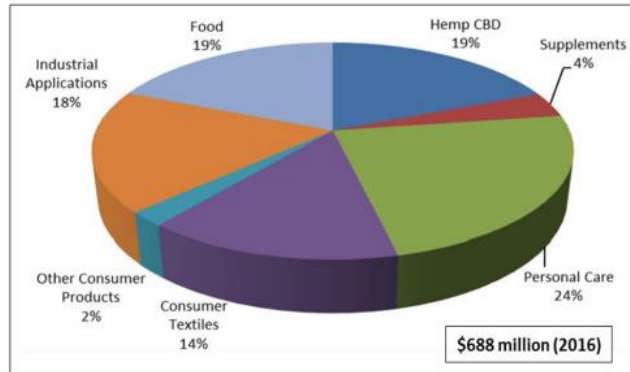
“The production of Hemp is **carbon negative**, which means it absorbs more carbon from the atmosphere during its growth than is emitted by the equipment used to harvest, process and transport it.”





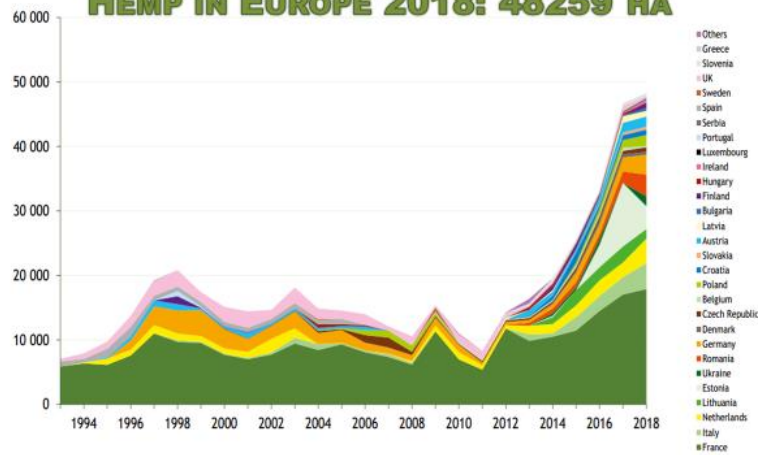


HEMP - BASED PRODUCT SALES BY CATEGORY, 2016



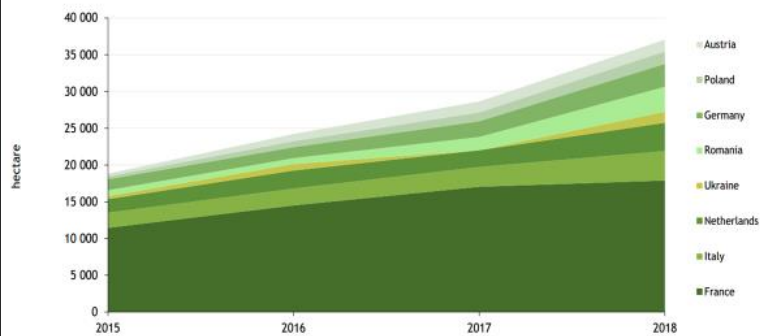
Source: HIA, "2015 Annual Retail Sales for Hemp Products Estimated at \$573 Million," May 9, 2016.

TOTAL CULTIVATION OF INDUSTRIAL HEMP IN EUROPE 2018: 48259 HA



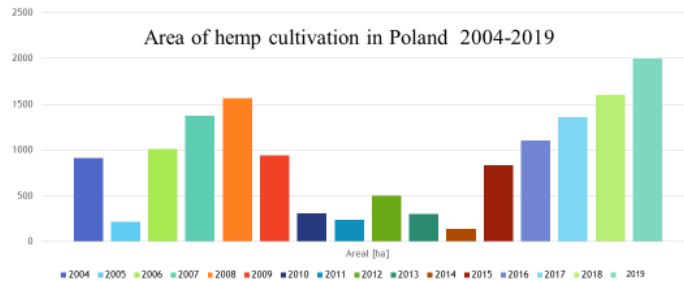
Source: Lorenza Romanese, EIHA, Warsaw, 05.02.2020

A POSITIVE GROWTH RATE FOR THE CULTIVATION AREA OF INDUSTRIAL HEMP



Source: Lorenza Romanese, EIHA, Warsaw, 05.02.2020

DYNAMIC INCREASING OF HEMP CULTIVATION IN POLAND SINCE 2014



2014

- Subventions from Ministry of Agriculture and Rural Development.
- Novelization of law in terms of the fight against drug addiction, (easier to get permission for hemp cultivation and buying)

CHARACTERISTICS OF HEMP HARVESTED IN POLAND 2009-2013

VARIETY	HARVEST [dt/ha]			CELLULOSE [%]	OILS ETHEREAL [%]	THC [%]
	STRAW	SEEDS	FIBER			
BIAŁOBRZESKIE	162,5	8,25	45,80	47,15	0,41	0,018
BENIKO	153,5	6,75	43,80	47,95	0,35	0,010
RAJAN	187,0	8,80	-	44,70	0,34	0,027
TYGRA	153,5	9,00	39,55	40,10	0,28	0,034
WOJKO	167,0	8,00	43,30	47,00	0,39	0,011
HENOLA	135	20-25	25,9	46,60	0,18	0,020

CHALLENGE: INCREASE OF COMPETITIVENESS OF HEMP CULTIVATION BY BIOLOGICAL PROGRESS AND TECHNOLOGICAL INNOVATION



Creating of perspective genotypes ensuring desired properties of plants, for example:

- Bioactivity of panicles (CBD content)
- Functional properties of fibers including bioactivity
- Increase of phenolic acids content
- Increase of cellulose content (bioethanol)



OPPORTUNITY: HEMP TEXTILE SECTOR DEVELOPMENT

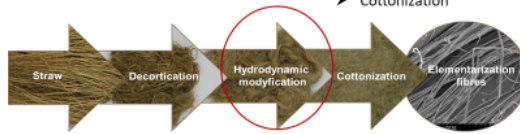
- Textile sector is one of the biggest producer of waste
- in Europe consumption of textiles is approximately 25 kg/person/year, but only 4 – 5 kg is collected to reuse or recycling purpose
- Eco-design - improve the circularity of products, extending lifetimes, repair, remanufacture, reuse, design for recycling, design from recycled material

HEMP TEXTILE IN CIRCULAR ECONOMY:

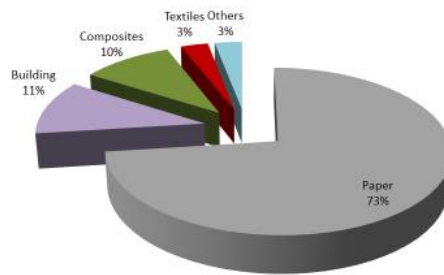
- long life - good mechanical properties,
- reuse,
- recycling
- remanufacturing

HEMP FIBERS:

- **Long hemp fibers** – the best quality
 - Dew retting
 - Wet spinning system
- **Cottonized hemp fibers**
 - Decortication
 - Degumming (enzymatic, US treatment)
 - Cottonization



HEMP FIBERS USE



Source: <http://www.mastersoflinen.com>

BASIC QUESTION:

**DEW RETTING
OR
DECORTICATION**



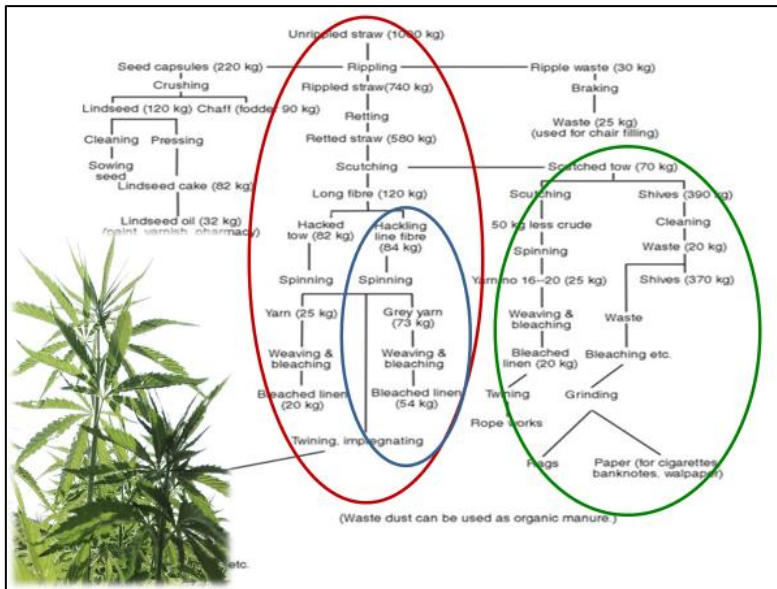
DEW RETTING

AIM: HIGH QUALITY OF LONG FIBERS

- Applied after mechanical pulling of stalks and deseeding
- Hemp stems - spread evenly in a field
- Retting duration: depending on:
 - climatic conditions
 - soil fungi and bacteria activity - microorganisms secrete enzymes that degrade: pectin substances, proteins, sugars, starch, fats and waxes, tannins and minerals

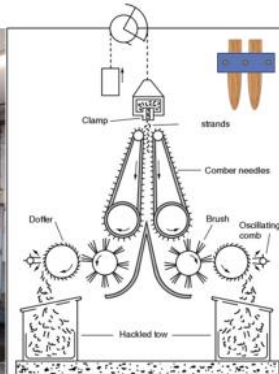


brahmsmount.com



HEMP-HACKLING MACHINE:

for separating the long fibers from scutched hemp stock. It operates together with a scutching and tow-cleaning machine at primary processing sites. The hemp-hackling machine has a gripping conveyer with two specially shaped belts, two scutching drums, a countershaft, and a transmission mechanism.



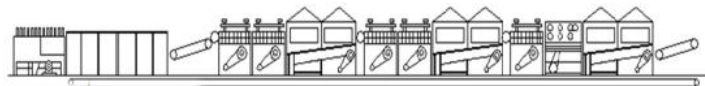
HEMP WET SPINNING



WET SPINNING - spinning frames function in the same way as spinning frames for other fibres, but for wet spinning the machine is equipped with a water trough through which the rove has to pass before reaching the drafting zone



DECORTICATION

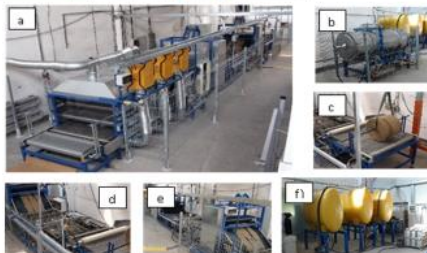


COTTONIZATION



Model Line for decorticated hemp fibers:

- bundle fibers
- degumming
- ellementarization
- Patent: PL 232829, 2019



Zimniewska M, Zbrowski A, Konczewicz W, Majcher A, Przybylski J, Matecki K, Wiśniewski M, Kicińska-Jakubowska A, Mańkowski J. Cottonisation of Decorticated Flax Fibres, FIBRES & TEXTILES in Eastern Europe 2017; 25, 3(123): 26-33. DOI: 10.5604/12303666.1237220

HEMP FIBERS CHEMICAL COMPOSITION

Degumming method	Variety	Content of:									
		Waxes and fats		Pectin		Lignin		Cellulose		Hemicellulose	
		%	SD	%	SD	%	SD	%	SD	%	SD
HEMP											
Water retting	Beniko	0.23	0.01	1.47	0.09	2.81	0.29	71.31	1.32	15.03	0.02
	Wojko	0.24	0.04	0.67	0.02	3.02	0.31	72.53	0.11	16.67	0.24
	Tygra	0.25	0.04	0.56	0.00	2.78	0.28	70.79	0.13	15.00	0.28
	Białobrz eskie	0.34	0.02	0.67	0.02	2.38	0.22	72.03	0.22	14.37	0.29
Decortication	Białobrz eskie	0.47	0.02	2.00	0.09	5.55	0.17	66.02	0.46	21.25	0.05
Dew retting		0.56	0.14	3.68	0.19	4.31	0.04	66.16	0.48	21.72	0.12
Water retting		0.34	0.02	0.67	0.02	2.38	0.22	72.03	0.22	14.37	0.29
Osmotic degumming		0.44	0.04	2.82	0.22	4.03	0.09	67.81	0.52	16.29	0.03

PHENOLIC ACIDS CONTENT IN HEMP FIBRES

Degumming method	Variety	Content of acids:							
		Syringic [mg/100g]		Sinapinic [mg/100g]		p-Coumaric [mg/100g]		Ferulic [mg/100g]	
		Result	SD	Result	SD	Result	SD	Result	SD
HEMP									
Water retting	Beniko	0.031	0.001	-*	-	0.722	0.019	-*	-
	Wojko	0.046	0.001	0.048	0.002	0.741	0.006	0.027	0.001
	Tygra	0.036	0.001	0.100	0.003	0.695	0.034	0.572	0.031
	Białobrz eskie	0.033	0.001	-*	-	0.024	0.006	-*	-
Decortication	Białobrz eskie	0.224	0.011	0.672	0.023	0.746	0.008	2.082	0.036
Dew retting		0.079	0.003	-*	-	0.717	0.008	0.039	0.004
Water retting		0.033	0.001	-*	-	0.024	0.006	-*	-
Osmotic degumming		0.094	0.003	-*	-	1.111	0.011	0.625	0.009

ANTIOXIDANT PROPERTIES HEMP FIBERS

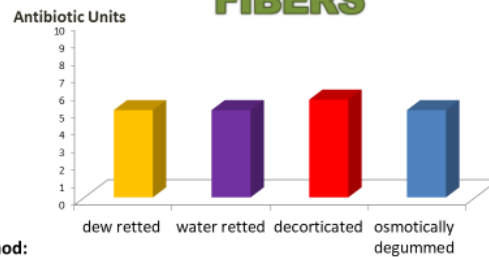
Degumming method	Variety	FRAP [umol/L]		Inhibition of DPPH	
		Result	SD	%	SD
HEMP					
Water retting	Beniko	140.34	4.75	11.30	0.92
	Wojko	156.75	2.31	10.04	0.49
	Tygra	165.76	1.62	32.55	0.32
	Białobrz eskie	76.62	1.33	3.09	0.18
Decortication	Białobrz eskie	230.22	1.55	18.03	0.63
Dew retting		124.09	1.93	5.31	0.25
Water retting		76.62	1.33	3.09	0.18
Osmotic degumming		93.71	0.69	3.94	0.19

HEMP - STATISTICAL ANALYSIS

Tested parameters	Values of the Pearson correlation coefficient			
	Content of ferulic acid	Content of p-coumaric acid	Content of syringic acid	Content of sinapinic acid
Hemp variety				
Lignin content	0.11	0.93	0.66	0.43
FRAP	0.54	0.96	0.46	0.72
DPPH	0.96	0.54	0.02	0.89
Method extraction of hemp				
Lignin content	0.81	0.67	0.91	0.76
FRAP	0.91	0.28	0.96	0.96
DPPH	0.94	0.21	0.97	0.99



ANTIBIOTIC ACTIVITY OF HEMP FIBERS



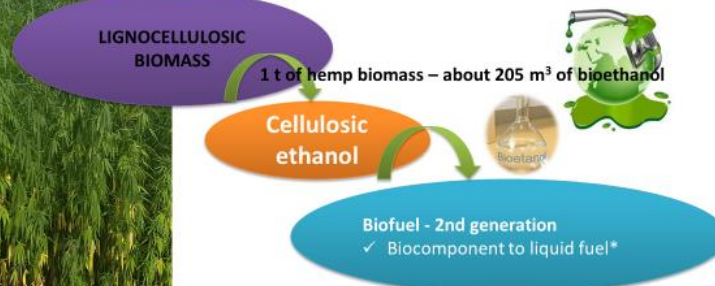
Test method:

- 20 samples of fibre
- Preparation of liquid extracts with use of bacterial base (CASO Broth, Merck) (121°C, 20 min.)
- 1 ml of fibre extract was added to standard strain of *S. aureus* - ATCC 6538
- Incubation for 18 h, temp. 37°C
- Determination of minimal concentration of fibre extracts which inhibit standard strain of *S. aureus* growing (MIC-Minimal Inhibitory Concentration)
- MIC (Minimal Inhibitory Concentration) range: 150-200 mg/ml, correspond to 5, 0 do 6,7 A.U.

BIOETHANOL – PRODUCT FROM HEMP BIOMASS

*EU Regulation:

in 2020 - share of biocomponents in liquid fuel 10% including 3% of biofuel higher generation



Source: J. Batog, J. Frankowski, A. Wawro, W. Geparda, Study on hemp use for bioethanol production, Statutory research, INFMP, 2018-2019

HEMP CULTIVATION FOR SOIL RECLAMATION AND REMEDiation

DOUBLE ENVIRONMENTAL IMPACT

- Hemp cultivation as a method of soil reclamation at industrial area, mainly post mine lands
- Improvement of productivity of the soil (roots system), absorption of heavy metals,
- In Poland – total area of degraded lands - 67 550 ha
- Annual soil reclamation - 2500 ha (65% for agriculture needs, 35% for forest purpose)
- Additional environmental benefit:

1 ha of hemp cultivation absorbs 2.5 t of CO₂ from atmosphere

Source: J. Mankowski, Life+, Reclamation of degraded lands, 2013-2018

CONCLUSION TEXTILE ASPECT

High potential of hemp fibres in terms of textile application:

- exhibit inherent antioxidant and antibiotic activity, diversity of which depends on the plant variety, method of fibre extraction and subsequent stages of the technological chain applied for the fibre processing
- This knowledge should be used in designing functional pro-healthy textiles able to support human skin protection against reactive oxygen species, microbes and UV radiation
- Hemp textiles – from renewable resources, recyclable, long-lasting, designed for recycling, able to reuse, repair, remanufacture

CONCLUSION

PROGRESS TOWARDS A CIRCULAR ECONOMY FROM A MATERIALS PERSPECTIVE

Material input

- HEMP– sustainable, renewable raw materials

Eco-design

- Bast fibers show high mechanical properties – products can be designed to last longer
- Hemp products can be designed for disassembly
- Bast fibers - recycled materials included in product design
- Hemp materials designed to be recycled, avoiding pollution from recycling loops

CONCLUSION

PROGRESS TOWARDS A CIRCULAR ECONOMY FROM A MATERIALS PERSPECTIVE

Production

- Hemp production less waste in production
- No environmentally hazardous substances in production

Consumption

- Hemp products can be used longer?
- Consumption of Hemp products generates less waste

Waste recycling

- Hemp waste are recycled or bio-degradable
- The Hemp products recycling system is optimised for environmental and economic sustainability



Session 4 – Hemp varieties for Australia

PLANS FOR A NATIONAL INDUSTRIAL HEMP CULTIVAR TRIAL

Tony Eyres and Andrew Bulkeley

Principals
Rounding Up
Botany, NSW

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ABSTRACT

AgriFutures Australia⁴ is supporting the development of national industrial hemp variety trials (IHVT), to address a core issue identified by Australian industry as essential to its growth ambitions. The primary objective of the IHVT is to determine the best performing grain varieties of industrial hemp for Australia. Whilst focusing on an initial three years, longevity of the trial scheme is key with a goal to design and establish a programme that can extend for a decade.

Agricultural advisory firm, Rounding Up was engaged by AgriFutures Australia to consult widely with the industry on priority areas, develop and cost a trial scheme, suggest a suitable management construct and attract capital to fund and oversee delivery nationally. Rounding Up worked in conjunction with a Project Steering Committee with representation from private research providers, corporate entities and industry bodies including the Australian Industrial Hemp Alliance (AHIA) and the Tasmanian Hemp Association.

Industry consultation by Rounding Up included convening 10 workshops around Australia, meeting 300 stakeholders and conducting over 600 phone calls while encouraging industry participants to complete an online survey.

This consultation helped to shape a core piece of project activity being the development of a framework and detailed set of protocols for IHVT. These protocols prescribe transparency and objectivity in the selection of varieties, site locations and compliance in delivery. They instil simplicity in design and execution without compromising the integrity of the trials and learnings to be achieved.

Draft trial framework and protocols were subject to further technical review, leveraging off 2020 Industrial Hemp Conference in Fremantle. Rounding Up's industry engagement identified suitable participants that brought considerable experience from across the value chain from growing, processing, agronomy, research design, extension through to end-users.

Detailed experimental processes (ie. site preparation, planting, harvesting, drying), accurate data collection and recording, audit oversight, laboratory methodology and timely reporting are all defined. The protocols include oversight by an expert biometrician to ensure statistical rigour in design and analysis of outputs.

Keywords: national; variety trials; grain yield; replicated; independent data

⁴ AgriFutures Australia is the trading name for Rural Industries Research & Development Corporation (RIRDC), a statutory authority of the Federal Government established by the Primary Industries Research and Development Act 1989

Our Goal

Identifying projects that support the emergence of agricultural industries that can reach or exceed a \$10M per annum threshold in the next 5 years ...

...in support the NFF target of a \$100 billion agriculture sector by 2030.

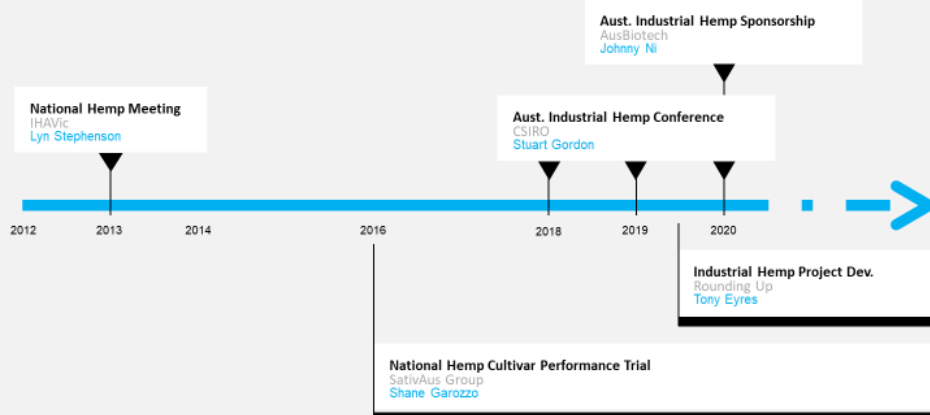


PRJ-012064 Industrial Hemp Project

AgriFutures Australia is funding a national project to support the Industrial Hemp industry to reach or exceed a \$10M gross value of production per annum in the next five years.

“To identify, scope and cost a range of trial options, gauge industry support for each of these options and negotiate co-investment from public, private and not-for-profit sources in Australia”.

AgriFutures projects
Industrial Hemp



AgriFutures projects
Industrial Hemp



Established in 2007

Commercially-centred agriculturalists

Corporate, government and not-for-profit experience, locally and globally

- Business strategy
- Capital markets
- Trade
- Research & Development
- Manufacturing
- Supply chain
- Business transformation



Rounding Up
Capital and partnerships for growth

Rounding Up
Delivering PRJ-012064 Industrial Hemp Project

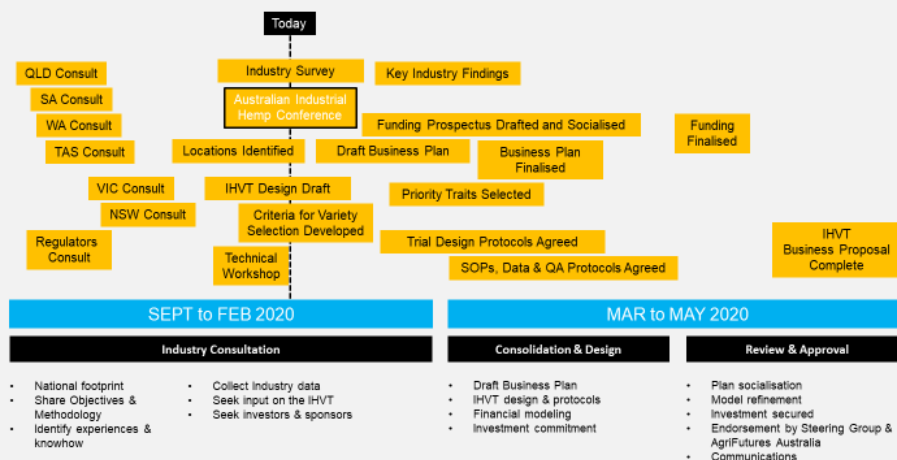


The Industrial Hemp Variety Trial Scheme (IHVT)

CONSULT
widely

Develop and
cost a
TRIAL
SCHEME

Secure
FUNDING



IHVT
Project Timeline



1. Consult 2. Design 3. Refine 4. Approve 5. Launch

- Experienced operators
- New players
- Potential adopters
- Adjacent industries

300 stakeholders
10 workshops
600 phone calls

IHVT
Project Methodology

Grower Licences = 250+
Crop Size = 1,200ha
Varieties = 28

Multiple Industry Bodies
HATAS, AIHA, HempVic,
HempWA, IHANSW, IHASA

Complex Regulation
FSANZ, ODC, TGA
& State/Territory Depts.

STRENGTHS		OPPORTUNITIES	
✓ High energy and engaged	✓ Government commitment	◇ Common industry strategy	◇ Common language
✓ Expanding participation (+120%)	✓ Large experience pool	◇ Simplified regulation	◇ Fit-for-purpose varieties
✓ Extensive research		◇ Normalise the industry	◇ Agronomic capabilities
			◇ Processing facilities

IHVT
Industry Observations

NATIONAL

VIABLE Funding Models

ROBUST in design & TRANSPARENT

Delivers INDUSTRY NEEDS

Effective EXTENSION

LONGEVITY

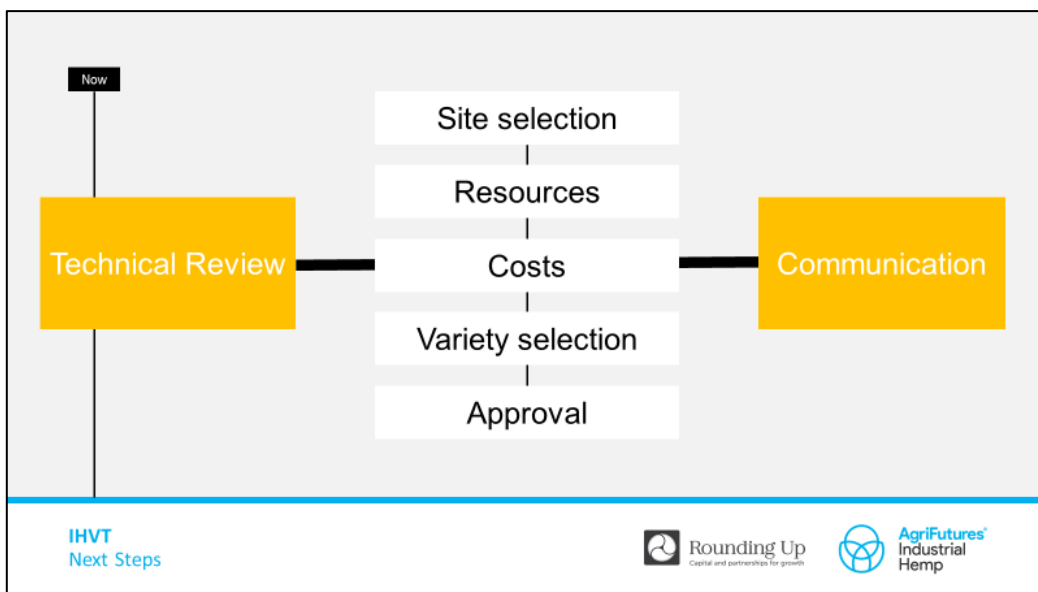
IHVT
Critical Success Factors

✓ 3-year scheme	✓ National footprint
✓ Replicated trials + Commercial growers	✓ Transparency
✓ Grain focus	✓ Information & learnings
✓ Up to 15 varieties	✓ Governance

IHVT
Draft Trial Design

Rounding Up
Capital and partnerships for growth

AgriFutures[®]
Industrial Hemp



Participation

Partners / Collaborators \$\$\$ People Ideas	Industry surveys In person	Contact details m: 0429 069 072 e: sativa@rounding-up.com
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IHVT
Targeted for Spring 2020 Planting

Rounding Up
Capital and partnerships for growth

AgriFutures[®]
Industrial Hemp

Session 4 – Hemp varieties for Australia

CAN YOU PLEASE ALL OF THE PEOPLE ALL OF THE TIME?

Jo Townshend

R&D Manager
Midlands Seeds Ltd.
Christchurch, NZ

E: jo.townshend@midlands.co.nz



 MIDLANDS

National Cultivar Evaluation Trials

Can You Please All Of The People All Of The Time?

Joanne Townshend, R&D Manager, Midlands Seed Ltd



 MIDLANDS

Where to Start

- Who are the trials designed to help?
- What are the keys to administration success?
- What should the entry rules for cultivars be?
- How should trial sites be established, managed and harvested?
- What should be assessed?
- Putting the hemp industry into perspective
- How are sites and trial operators selected?
- The KISS principle



Who are the trials designed to help?

- Growers
 - Location, climate, soil type, irrigation, daylength, disease & insect pressure
 - Processors
 - Cold pressed oils, dehulled hemp, ingredients such as flour & protein
 - Fibre
 - Medicinal
-



What are the keys to administration success?

- Set the rules of engagement – get all companies to agree on rules & protocols
 - Remember who you are doing this for
 - Will not be perfect straight away – they should grow and develop over time
 - Agree when data is acceptable or should not be included
 - Get a good Biometrician – this will be money well spent
 - Generate trial plans, analyse data, identify issues, generate tables for publication
 - Divide jobs up so not one company or person is doing too much work
 - Much of this ends up being voluntary time of fully employed people
 - Have a minimum of two meetings per year
 - Trial planning discussion & trial results and reporting
-



What should the entry rules for cultivars be?

- Minimum two years of Australian performance data available or one year + one year of overseas performance data inc. THC test results
 - These are not breeder trials
 - These are not agronomic management trials
 - There will be challenges around cultivar reactions to Australia's short days – this needs to be known
 - Fresh seed must be available in the year of trialing (ideally no carry over seed)
 - Commercial seed quantities must be available at the conclusion of the trial (eg. following year)
-



How should trial sites be established, managed and harvested?

- Trial protocols set by steering committee well in advance
 - Grain and Fibre trials established separately +/- THC & CBD
 - Trials to have robust statistical design (minimum four replicates)
 - Pre-plant soil test
 - Machine planted & harvested where at all possible
 - Sowing dates to be adhered to (maybe different for each region)
 - Plant population targets set and met (know seed quality pre-planting)
 - Minor individual management ie. +/- broadleaf herbicides
 - Bird control (??)
 - Seasonal measurements known by trial operator and data collected
 - Trial site management diary including all inputs
 - Data CV's set and met

What should be assessed?

• GRAIN

- ✓ Height, days to flowering, days to harvest, disease susceptibility, standability, harvestability
- ✓ MD yield corrected to 9%MC
- ✓ TSW
- ✓ 2-5kg test dehulling for yield
- ✓ 2-5kg test Press for Oil yield
 - ✓ FA profile
 - ✓ Protein content



What should be assessed?

• FIBRE

- ✓ Height, days to flowering, days to harvest, disease susceptibility
- ✓ Dry yield corrected to 0%MC
 - ✓ At Full Flower & Grain Maturity
- ✓ Long fibre yield?
- ✓ Hurd yield?
- ✓ Quality measurement?



Putting the hemp industry into perspective



- 2019 Australian Wheat 15.2M Tonnes, Barley 8.9M Tonnes (DAWE Feb 2020)
 - Legislative levy of 1.02% of farm gate sale price
- 2020 NZ Cereal harvest forecast to be 95,000Ha (AIMI July 2019)
 - Legislative levy of 0.9% of farm gate sale price
 - Average 9T/ha & \$400/T = $\$3600 * 0.9\% = \$32.40/\text{ha}$ levy
 - CPT Trials cost approx. \$8000/site inc Admin
 - Conduct 11 wheat + 3 Barley trial sites throughout NZ
 - Paid for by grower levy, grain companies & end-users
- 2018 licensed area in Canada was 31,500Ha (Health Canada Feb 2019)
 - National cultivar trials conducted by Canadian Hemp Trade Alliance
 - Working on implementing a grower levy – trials funded by growers & industry
 - Conducted 8 Grain + 9 Dual Purpose trials in 2018
- Australian Hemp – no levy, area unknown, but much less than above, big country!
 - Average 800kg/ha & $\$3.50/\text{kg} = \$2800 * 1\% = \$28.00/\text{ha}$
 - $\$8000/\$28 = 285\text{Ha}$ of production levy to pay for one trial if not other source of funding



How are sites and trial operators selected?

- Complete background analysis as to which areas are most likely to be suitable to grow hemp
- Start in areas where commercial production is done to gain experience & refine protocols
- If area is irrigated then conduct a trial under irrigation and vice versa
- Ideally sites situated within a commercial field (not a seed crop/research station)
- Many trial providers for national cereal, cotton and canola – leverage expertise
- Make sure providers have suitable equipment/machinery
- All sample testing to be done by one approved lab/facility per test



Remember
the KISS
principle



So will you please all the people all of the time?



Thank You



Session 4 – Hemp varieties for Australia

HARNESSING NOVEL DIVERSITY FROM CANNABIS LANDRACES TO BREED IMPROVED CULTIVARS

Omid Ansari, PhD

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ABSTRACT

Hemp (*Cannabis sativa*) breeding has the potential to provide significant improvements to hemp seed, fibre and medicinal production and for local economies. For over a decade, Ecofibre Limited (Ecofibre) has been researching and breeding high yielding hemp cultivars that are suited for production in 0-45°S and N latitudes.

In recent years, the breeding program has transitioned from the initial introduction and acclimatization of poorly adapted international germplasm to delivering increased yields from our commercial cultivars. In the process Ecofibre has become a leader in Cannabis breeding in Australia by applying modern breeding techniques and tools.

Our original commercial varieties in NSW and QLD traditionally yielded an average of 0.7-0.8 t of seed per hectare. Our newest Tasmanian grain variety, which is due for commercial release in late 2020, is capable of delivering an average of 1.5-2.1 t/ha.

In our pre-breeding program, we are selecting promising early stage lines from Ecofibre's genebank and conducting replicated yield and adaptability trials in-field across NSW, QLD and Tas. A number of these lines have yielded extremely well compared to established commercial varieties, sourced domestically and internationally. In particular, advanced breeding lines EC1900159, EC1900121 and EC1900144 have yielded in excess of 8 t/ha (replicated research plots – multi-year trials).

As we progress this genetic pipeline the next step is to improve the uniformity of height and maturity date of these lines, which will optimise machine harvestability and commercial yields. We will also optimise for seed oil content; the highest yielding line from our grain breeding program has an oil content of approximately 37% of seed weight, versus a typical average of 32%.

In my talk, I present a summary of our recent research findings, together with background on Ecofibre's experience in breeding and selection of advanced breeding lines for food applications.

Keywords: *Cannabis sativa*; hemp breeding; high seed yielding cultivars; quality attributes; adaptation

Session 4 – Hemp varieties for Australia

HEMP FARMS AUSTRALIA SEEDING A SUSTAINABLE FUTURE

Lauchlan Grout and Harrison Lee

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FREMANTLE HEMP CONFERENCE 2020

WHO

WHAT

WHY

HOW

- ✦ History of Hemp Farms Australia (HFA)
- ✦ Overview of presentation
- ✦ Localised seed is the future
- ✦ Best farming practices
- ✦ Importance of carbon sequestration
- ✦ Focusing on a sustainable future

SEED SUPPLY

- ✦ What is our local industry lacking?
- ✦ Focusing and improving on what works
- ✦ State-wide support on cultivar comparison trials
- ✦ Collaborating with local DPI to allow cross-state research collaboration



UPCOMING SEED CERTIFICATION

- ✦ National Seed Certification regulations
- ✦ What does this entail and how will it help?
 - ✦ Breeder seed
 - ✦ Registered seed
 - ✦ Planting seed (replacing Certified seed)



BEST FARMING PRACTICES

- ✦ What is the basis of 'best farming practices'
- ✦ How can hemp become a staple within modern BFP
- ✦ Importance of rotational cropping vs mono-cropping
- ✦ Tailored genetics for environment, cropping regimes and end use



CARBON SEQUESTRATION

- ✦ Hemp's ability to sequester large amounts of carbon
- ✦ Additional revenue stream for growers and land owners
- ✦ Essential for our soils long-term sustainability
- ✦ Off-setting negative farming practices

IN CONCLUSION.

- ✦ What HFA can provide to new growers
- ✦ Importance of Australian adapted cultivars
- ✦ Collaborating with research groups to improve industry knowledge
- ✦ Overall strong foundations to build a sustainable industry



Session 5 – Managing and Harvesting Your Hemp Crop

GROWING QUALITY HEMP HEMP FOR FOOD, FIBRE OR CBD

Jeff Kostuik

Director Operations Central Region
Hemp Genetics International
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Growing Hemp Successfully

- What is the market demanding?
- How can you supply quality hemp?
- Systematic approach is required to maximize quality;
 1. Proper Planning
 2. Agronomics,
 3. Harvest & Storage Practices.



Hemp Genetics International
Plant Genetics for the *Natural World*

Agronomy

- ▶ Field selection
- ▶ Crop Rotation
- ▶ Variety Selection
- ▶ Seeding
- ▶ Fertility
- ▶ Weed Control
- ▶ Harvest



Hemp Genetics International
Plant Genetics for the *Natural World*

Field Selection Criteria

- ▶ Crop Rotation history
- ▶ Herbicide history – No residual herbicides
- ▶ Fertility – N, P, K, and S levels
- ▶ Weeds – Problem weeds
- ▶ Trash Management



Hemp Genetics International
Plant Genetics for the *Natural World*

Soil Properties

- ▶ Moderate soil texture (loam, clay loam)
- ▶ Heavy clay should be avoided mainly due to excess moisture
- ▶ Sandy soils will work with adequate moisture
- ▶ Non-saline
- ▶ Good tilth
- ▶ Good surface and internal drainage



Hemp Genetics International
Plant Genetics for the *Natural World*

Variety Selection

- ▶ Hemp research data is somewhat scarce
- ▶ Try to get localized data
- ▶ The more site years the better the data
- ▶ Strip trials are not always enough...ask if its replicated and what the Coefficient of Variation (CV) and Least significant difference (LSD)



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Seeding

- ▶ Seed Shallow - ~ ½ inch
- ▶ 25-30 lbs/acre seeding rate for grain
- ▶ Higher seeding rate for Fibre
- ▶ Warm Soils – above 10 C degrees
- ▶ Equipment – Low fan speed for air seeders



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Fertility

- ▶ Hemp responds well to N, P, K and S when soil nutrients are low

Nutrient	Total Plant (Kg/ha)		Grain (Kg/ha)		Uptake Hemp/day
	Hemp	Canola	Hemp	Canola	
N	200	120	40	65	6.7
P	47	50	19	35	1.56
K	211	75	10	17	6
S	14	20	3	12	



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Grain Harvest Management

- ▶ Timing of Harvest
- ▶ 10 to 20% moisture
- ▶ Cracking
- ▶ Frost
- ▶ Dry to below 10% for safe storage



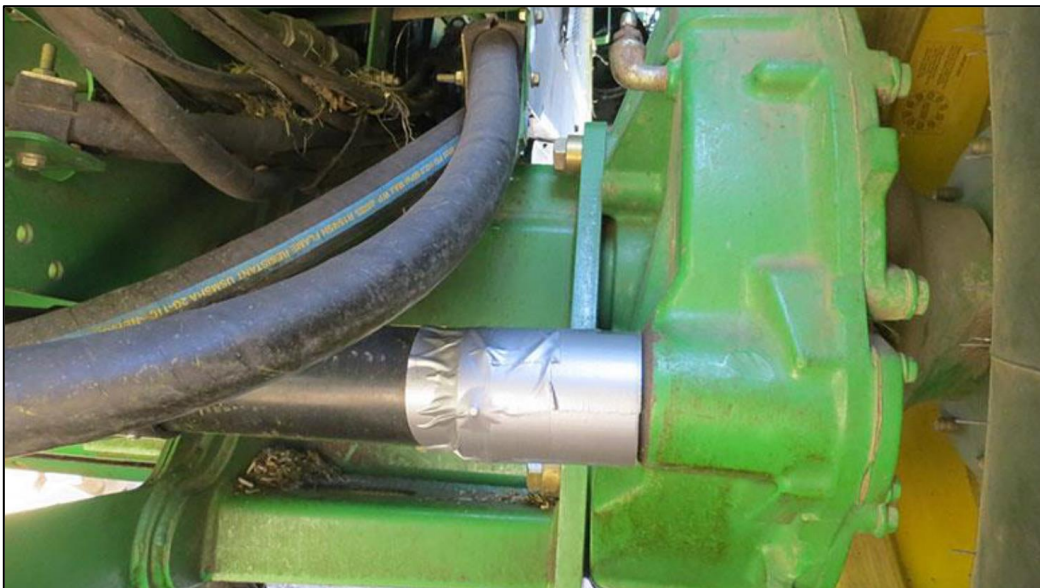
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Microbiological Limits

Peroxide Value	Less than 4 meq/kg
Standard Plate Count	<100,000 CFU/g
Total Coliforms	<1000 CFU/g
Fecal Coliforms	Negative=LOD<10CFU/g
E. coli	Negative=LOD<10CFU/g
Salmonella	Negative
Staphylococcus A	Negative
Mold & Yeast	<1000CFU/g
Gluten	Less than 20ppm
THC	Less than 10ppm
Pesticide Residue	Nil



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- ▶ University of Kentucky
- ▶ Cornell University
- ▶ Penn State
- ▶ North Carolina State
- ▶ University of Vermont
- ▶ North Dakota State
- ▶ Morrisville State
- ▶ Purdue
- ▶ Minnesota
- ▶ Washington State
- ▶ Lehigh Valley
- ▶ Colorado



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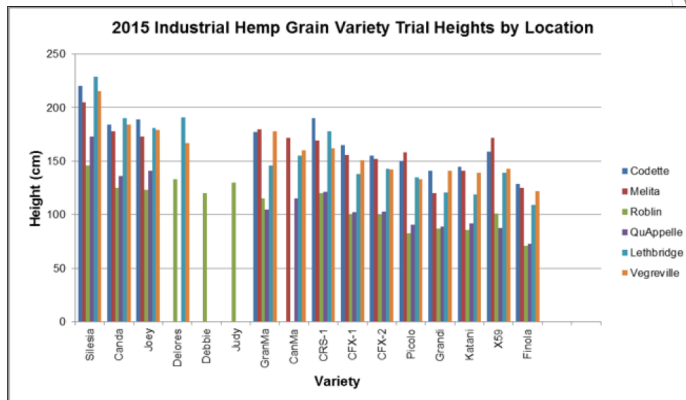
Variety Selection Criteria

- ▶ Yield
- ▶ Height
- ▶ Disease susceptibility
- ▶ Herbicide tolerance
- ▶ Maturity
- ▶ Shelling



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Plant Height Variety x Location



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Seeding rate

- ▶ Plant population
- ▶ Higher seeding rates may lower yield due to promoting long internodes and suppressed branching
- ▶ Hemp (single stalk annual) suppress later branching when grown in thick stands



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Daylight sensitive Seeded mid-June

This plant is 6 inches tall and has started the reproductive cycle after June 21st.



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Disease - Sclerotinia



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Botrytis – White mold



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Insects



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Wind prior to harvest

Can shell excessively if you get a wind event(s) prior to harvest



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Straight Combining

Goal : Smooth uniform feeding

Problems:

- ▶ Fibers wrapping on moving parts

Solutions:

- ▶ Correct Timing!!
- ▶ New Combines – no Modifications
- ▶ NEW knife and guards
- ▶ Draper headers best



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#1 priority is to dry the hemp to <9%

Dry Low + Slow to avoid toasting the hemp



Factors for bacterial & mold growth

Time

Temperature

Moisture



Higher moisture + Higher temperatures = Ideal conditions conducive for development of bacteria and molds



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Storage & Handling

- Long Term Storage - Cold and dry grain
- Minimize Damage - Operate augers at capacity and slowest possible speeds



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Storage & Handling

Prevent Contamination

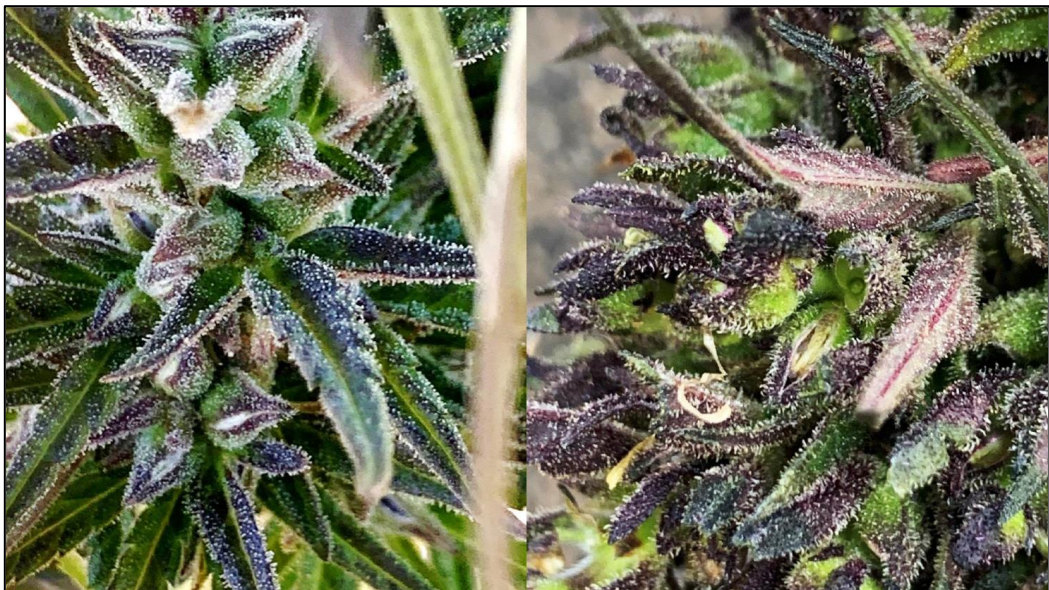
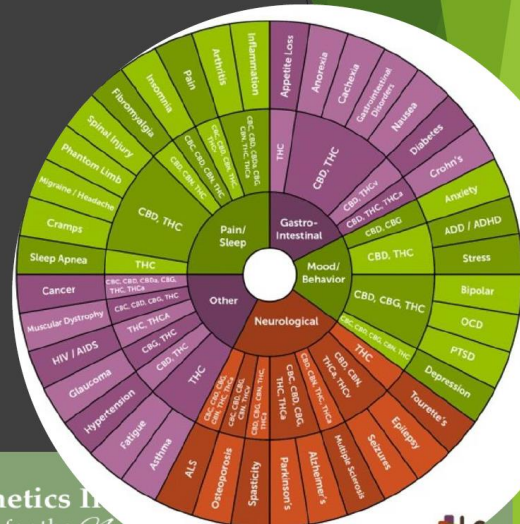
- Clean harvest and handling equipment
- Clean out the bins
- Eliminate opportunities for rodents, birds, and other pests

Prevent Spoilage & Monitor

- Invest in moisture cables



CBD - Cannibidiol



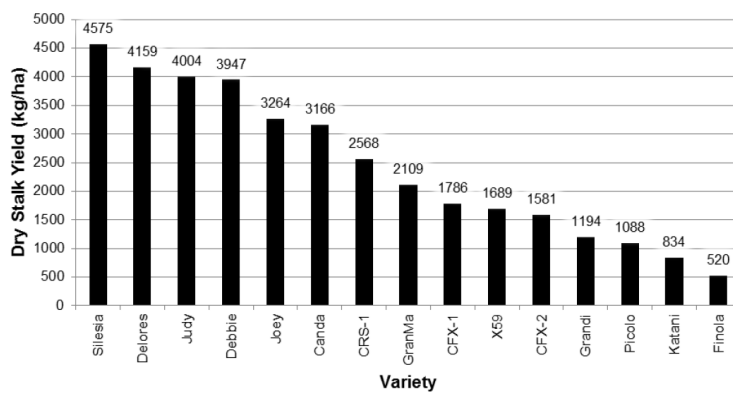
Fibre Research Manitoba

- ▶ Working with Fibre City to quantify quality traits regarding bio-fibre crops
- ▶ 1M2 samples taken from the variety trial
- ▶ Stalks are air dried (no retting)
- ▶ Leaves and stems are stripped
- ▶ Final dry stalk weight is taken



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2015 Industrial Hemp Fibre Variety Trial Dry Stalk Yield at Roblin, MB



15



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Fibre processing at
AITF, Vegreville



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for the *Natural World*

Session 5 – Managing and Harvesting Your Hemp Crop

MORE 'LESSONS LEARNED' IN THE FARMERS' FIELDS: HEMP AGRONOMY 2018-20

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ABSTRACT

In the two years since the Geelong Conference, Hemp Farming Systems has continued to work with a diversity of hemp seed and grain growers, mainly in southern Australia. We hope this will change as more and more farmers in the 'North' realize that it is possible to grow successful hemp seed and grain crops if they are sown in late winter and mid- to late summer (in the extensive area where frost is a constraint). This assumes that the summer is either too wet or too hot and dry to accommodate the seven or more months needed for biomass crops. However, where frost is not a problem and if there is ample water hemp should grow at any time of year – provided the seed of agronomically relevant, day-length insensitive genotypes is available.

Logically, it should be possible to fit a '*Helicoverpa/Heliothis* – free' window into this scheme of things. Unfortunately, an infestation in northern NSW in August 2019, leads us to think that winter active *H. punctigera* might be an issue in the future (perhaps a symptom of climate change). *H. punctigera* is less likely to be resistant to conventional insecticides, so that is a 'bonus'.

Broadleaf weed management is a critical issue for seed and grain crops, while the crop is establishing. The Australian Pesticides and Veterinary Medicines Authority (APVMA) permits the application of two pre emergence herbicides and one post-emergence herbicide for the management of broad leaf weeds. Each has had a damaging effect on hemp seedlings under specific circumstances involving the soil type, temperature and/or soil moisture. This is a critical area where further careful observation, monitoring and communication is required. There are some inconsistencies in the APVMA permits and have taken steps to remedy this.

The value of remote sensing imagery cannot be underrated when it comes to assessing the over-all condition of a crop, especially when it is 'well grown'. This technology has allowed us to determine in large fields (~40 ha) the extent and intensity of weed infestations, herbicide induced plant mortality, and the degree of success of irrigations.

Whilst we continue to learn more and more about more and more, there are many areas of constraint where we find that detailed knowledge is lacking; this is where we regret the absence of a nation-wide research program dedicated to the industrial hemp crop (but thanks to Agrifutures for getting the ball rolling). For instance, we work on the assumption that a 4 month seed/grain crop will require 4 ML per ha as rain or irrigation. How can this be reduced or is it in fact sufficient?

Keywords: environmental constraints; insect problems; weed management; remote sensing; filling knowledge gaps

INTRODUCTION

Hemp Farming Systems provides on-farm technical and other support to farmers who want to include industrial hemp in their farming systems. Hemp may be an ancient crop in terms of when it was first cultivated but Australian growers are still pioneers in many ways. There is so much to learn.

John Muir stressed the basic agronomic requirements of a range of hemp-based cropping systems in the paper at the February 2018 Conference in Geelong. And these must be correctly implemented if crops are to succeed:

- The variety (*aka* chemovar⁵) must be sown at the right time of year for that location to achieve the desired result, be it biomass, seed or grain. The driving phenomenon is that the flowering period of the most popular varieties is triggered by day length.
- Soil tests are needed to establish the pre-sowing fertilizer requirements of a given field.
- The seed bed needs to be fine and deep with no low (= wet) spots, and the fertilizer should be spread evenly, well before sowing.
- Weed management is critical, especially for seed/grain crops.
- Hemp has positive roles to play in farming systems, so that rotations should be planned to benefit hemp and the co-crops.

These are pretty basic points, and they can apply to any arable crop you can think of. But whilst the principles are the same, the details are different. Hemp has its own way of doing things. For instance, it is provably wrong to assume hemp seed will dry on the head as quickly as canola seed – it takes twice as long. Also, hemp is not wheat. It will go mouldy or even catch fire, if left in the back of a truck for four days before it is dried.

We have continued to work with farmers in eastern and southern Australia over the past two years, and this paper reports some of the additional things we have learned. At this point are pleased to acknowledge Hemp Farms Australia because they have given us the opportunity to engage with their farmer clients.

We are always thinking about the future expansion of industrial hemp across Australia – what are the realities, advantages of and constraints to growing hemp North of, say, 25°S. Hypotheses to be explored include; (i) hemp crops can be grown all through the year in northern Australia, and (ii) there are good reasons for doing this. For instance, grain farmers and processors may need a continuous supply of fresh produce, seed growers may wish to supply winter grown seed for early spring sowing or, late summer sowing where monsoonal rain in the summer may preclude sowing in Spring.

Caveats: *A further point is that we have also become increasingly frustrated by (i) what we do not know and (ii) the nationwide paucity of public sector crop research scientists who can help us to solve problems in a systematic and meaningful way.*

Climate

Frost

Most Australians live near the coast and do not realize how many frosty nights the rural heartland experiences, especially in southern Australia; frost can be the factor that limits hemp cultivation in these areas. This extends well beyond the SE corner into southern Queensland, and further West – see Figure 1.

⁵ A chemovar is a chemically distinct entity in a plant or microorganism, with differences in the composition of the secondary metabolites.

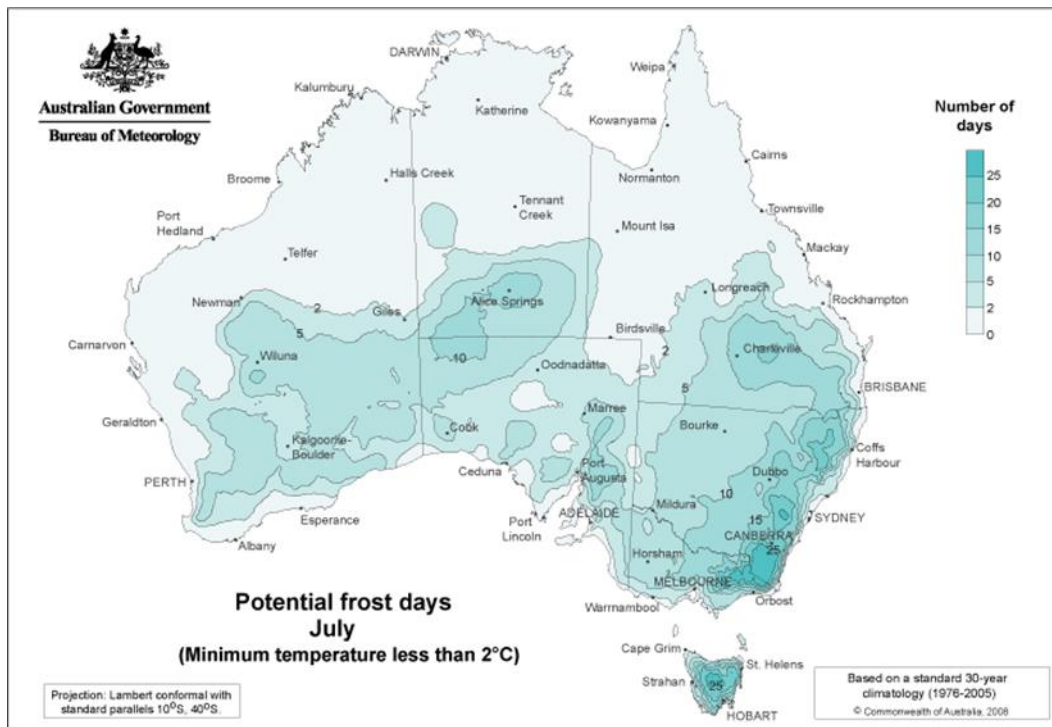


Figure 1 – Bureau of Meteorology: Potential frost days in July [1]

We know that leaves and flowers can be scorched by frost, to the extent that an early winter crop may not need desiccation. We have also seen crops virtually wiped out by frost in an area where the locals say frost is 'not too bad'.

Research in Canada indicates that seedlings are more frost tolerant than older plants [2]. This was confirmed by a small trial. Seedlings growing from a few seeds sown in July grew well even though the leaves and flowers of the main crop, which had been sown in May were badly scorched. This points to the possibility of sowing seed/grain crops at the end of winter: Late enough to avoid frost damage, and early enough to avoid inundation by heavy rain in January to March in the East, or the prolonged summer drought in Western Australia.



Figure 2 – Photo shows seed head that is totally dried out after severe frost

The degree of frost tolerance (defined as degrees below a specific air temperature) in the commonly grown cultivars (as seedlings and when seed is setting) is another of our many unknowns. This would make a good topic for a research organization that has the appropriate facilities.

Heat

At the other end of the scale, the high temperatures during the latter half of 2019 have made us think about their influence on the success of hemp as a crop in Australia. For instance, the germination rate of a consignment of seed that had to be stored due to unforeseen circumstances in a 'conventional' Queensland shed during November fell from 70 to 10%. Germination was also very uneven. It varied from close to perfect to zero, e.g., there were meter long strips with 30 perfect seedlings surrounded by bare patches. Close examination indicated that the precision of the seed set could not have been improved: the un-germinated seeds were still in place. The effect of the Thiram seed coating was questioned, but the whole batch of seed had been treated evenly. We suspect that seeds in the bags on the outside of the stack became too warm, whereas those in the inner bags were better insulated from the hot air in the shed.

A clue to the cause came from Canada [3]. A detailed study of seed survival at a range of storage conditions; temperature (20, 25, 30, 35 and 40°C), relative humidity (60, 70, 80 and 90% RH) and time (up to 24 weeks), indicated germination dropped off markedly in seeds held at 25°C or more.

The temperature in the QLD shed had not been checked but with outside temperatures in the 35-40°C range it must have exceeded 25°C for lengthy periods each day. We surmised that the small batches of seed that germinated came from the inside of the stack where they were thermally insulated by all the seeds around them.

Measurements of soil temperature were also checked. They peaked in the 60-70°C range (midday) on the soil surface and were not much cooler at a depth of 25-30 mm where the seed had been placed. This did not explain the uneven plant stand but it did give an indication of the tolerance of young hemp seedlings to high.

Wind

Hemp Growers in southern Victoria had to re-sow part of their crop because the combination of temperatures in the high 30s and a strong wind created a sand-storm. The seedlings were literally sand blasted.

New varieties: day-length insensitivity and bisexuality

Another primary focus particularly for the seed and grain sector is the evaluation of varieties that are insensitive to day-length and, if possible, monoecious. The former characteristic means that they will produce seed 'anywhere, at any time' without the need for the day length trigger. 'Monoecious' means that male and female flowers develop on the same plant, so that all plants produce seed, not just about half. Regular (not freak) yields of 3 MT/ha harvested seed have been reported from monoecious varieties growing in eastern Europe and Colorado.

A question to be answered: can monoecious seed/grain crops be sown at a lower than normal density (perhaps 20 kg/ha) to induce bushier plants, carrying more seed per plant?

Variety testing needs to be done by experts and we hope that the Agrifutures project that is getting underway will focus on helping us to garner new knowledge, such as this.

Helicoverpa (Heliothis) spp.

We learned that human logic does not always apply to noctuid moths. We found no *Helicoverpa* caterpillars in a hemp seed crop harvested in August 2017 in northern NSW. We concluded that this was because cotton and other crops on which *Helicoverpa* proliferates had been harvested at least one life cycle previously or had only just been sown as winter crops.

Was this a light bulb moment? The logic and relevance, following the principles of sustainable pest management, were that this was a case of pest avoidance: 'late sown seed/grain crops avoid *Helicoverpa* attack'.

However, two years later, and only 280 km to the West, another seed crop had a larval population that required a pesticide application in August. Again, other host crops in this cotton growing area had been out of the ground for over a month. The whole area was subject to drought (and frost). Most of the neighbouring fields had been cultivated well enough to bust pupae. We assumed that the culprit was *H. armigera*, but it was probably *H. punctigera* because this species does not pupate over winter [4]. We have some confirmation but need to check in 2020.

Climate change seems to be impacting on many other givens – why not the phenology of insects? Perhaps this is a clue to the conundrum. It is also worth noting that we found *Helicoverpa* caterpillars boring the stem at the top of the plant, so that the tips broke off at their exit hole about 10 cm from the growing point. An implication is that this behaviour will make insecticides less effective (as the caterpillar is inside the stem), or it could be a facet of *H. punctigera* behaviour.

This coincided with the discovery of the larvae of a cerambycid beetle (not identified) with the same habit. We can also report that the red shouldered leaf beetle will attack hemp crops in the Bundaberg area.

On the subject of pests, we must also mention that we have seen plants destroyed by feral pigs. We have also seen pictures of leaf damage caused by caterpillars that look very much like the armyworm, *Spodoptera litura*. This has to be checked – because the caterpillars could also be *S. frugiperda*, the fall army worm, a pest of significance that has invaded Africa, India and the rest of Asia over the last three years.

Post-emergence herbicides

Pendimethalin (aka Stomp) has been approved by the AVPMA for one application to hemp fields pre-sowing or pre-emergence. This process will kill some grass and broad leaf weed seedlings as they emerge. The current minimum recommended rate depends on the concentration in the products of specific manufacturers. It varies from about 0.6 to 1.2 - 2.0 L product/ha.

Hemp fields are getting larger. The advantages are obvious, but it means that soil texture can vary considerably within one crop. Modifications in sowing depth and irrigation schedules can be made, but not every farmer would think about the rate of herbicide application. We have encountered a problem with pendimethalin in two fields where there were patches of sandy soil sitting on clay or a heavier loam. One had been treated with pendimethalin at 2 L/ha as recommended by the APVMA, the other, mistakenly, at 3 L/ha. The hemp plants in the sandy patches were stunted or dead. The plants that survived had a swelling at the top of the root, to the extent that they looked like white radishes (see Figure 3). This was put down to a response to the herbicide. We have suggested the AVPMA permit should be modified to accommodate this new information, mentioning that the *application rate should be reduced to perhaps 1 L/ha in light/sandy soil*. This is a special warning for farmers growing hemp in sandy soil near the coast or on river terraces.



Figure 3 - The photos show poor or no plant growth on a sandy patch and the swollen roots of the plants growing there.

Pesticide approvals

The APVMA regulates which pesticides can be applied to all crops in Australia and states the safety issues that apply. This information is part of the packaging of pesticide products. Hemp crops are considered to be 'minor' and are not mentioned in these label instructions, but the APVMA has given special authority to farmers to apply certain pesticides. These authorities are distributed across six permits that partially repeat other entries and sometimes mix up different classes of pesticide. Hemp Farming Systems is working with AIHA and AVPMA to; (a) rationalize this situation and (b) extend the list of permitted materials, especially in the organic sector. We are ready to move towards finalizing this issue and welcome any further advice.

Irrigation

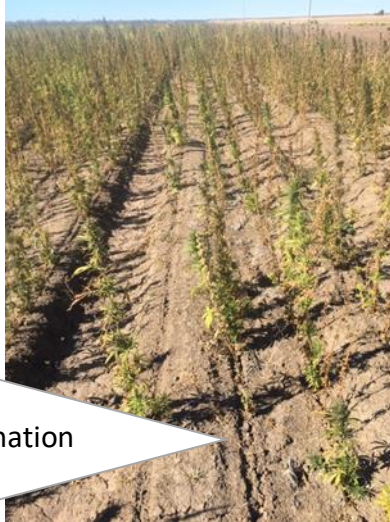
A rule of thumb is that an irrigated hemp seed/grain crop will need about 4 ML of water. Experience in the 2019 winter and summer indicates that this may not always be enough. Farmers need to be aware – especially when climate change seems to make everyone think twice about sowing crops.

Seed rates and germination tests

It might be considered a no brainer, but it is necessary to heed the results of germination tests and adjust sowing rates according to tests carried just before sowing. There is also varietal variation in the size of seeds. This means that varieties with small seeds can be sown at a lower rate (kg/ha) than larger seeds.

Smearing

When the seeder is pulled across wet clay soil that has just been irrigated, it smears the surface and creates a hard crust (see Figure 4). This impervious layer is situated just where the seedlings want to break-free from the soil five or six days later. Alternatively, the furrow into which the seed has been placed is not covered and the seed is left exposed. In either case, many of the seedlings do not survive. The simple advice is to let the surface of clay soils dry a little before sowing.



The smearing effect – note poor germination

Figure 4 – Photo showing the consequences of a ‘smearing’ effect

Drones and multispectral imagery

Hemp fields are getting larger – that is the name of the game. We at HFS like to know what is happening right across a field. Drone and multispectral imaging technology enables one to see, for instance, where weeds are taking over, that frost has dried out a patch near a wind break and will have to be harvested soon, or that a bid to irrigate failed. A time series can be accumulated by visits, drone in hand or via satellite imagery.

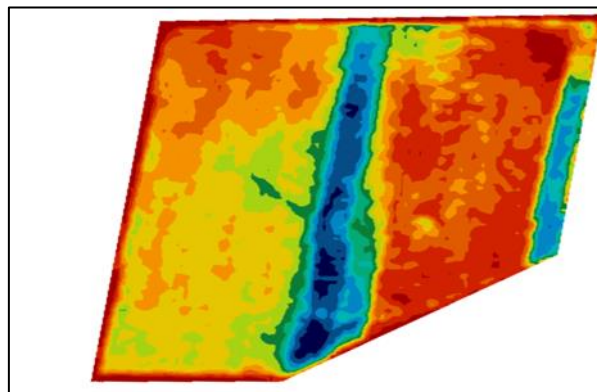


Figure 5 – Multispectral pseudo-imaging of an irrigated crop

False or pseudo-colour imagery has been around for perhaps 20 years, but just a couple of years ago the multispectral imaging was invented. This extends the versatility of the technique by capturing light in the blue, green, red, near-infrared and red-edge electromagnetic bands. The latter is particularly valuable for detecting change in chlorophyll quality (and therefore healthy plant growth) over time. As important, the detectors are designed to make them small drone friendly. The red sectors in Figure 5 show areas in a 70 ha field where irrigation did not properly (satisfactorily) reach the crop. The blue patches indicate different weed densities.

Conclusions

This is an overview of what we have learned in the last couple of years. We have covered a wide range of topics but there are always lingering thoughts and doubts in our minds. What are we not seeing? For instance, are diseases having an undetected impact? Like everyone working in agriculture we ask: what is the weather going to do? How do we help our clients become climate smart? For instance, is it possible to integrate effective windbreaks (trees) with the space needed for

irrigations systems to operate to prevent blasting from wind driven sand and to add the biotic diversity needed to support the natural enemies of the insect pests?

Every time we become familiar with a hemp field we learn something new. One thing that is not new is the realization that that there are so many things we and others want to know – but there are so few people in this well-resourced, lucky country to carry out the research needed to answer some fairly basic questions.

Our industry is too small to support the investment in research via levies. We need support from research scientists. Sadly some State Governments seem to be petrified by the H word. Thank goodness for Western Australia and South Australia.

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Session 5 – Managing and Harvesting Your Hemp Crop

INTEGRATED INSECT MANAGEMENT IN AUSTRALIAN INDUSTRIAL HEMP CROPS

Philip Armitage

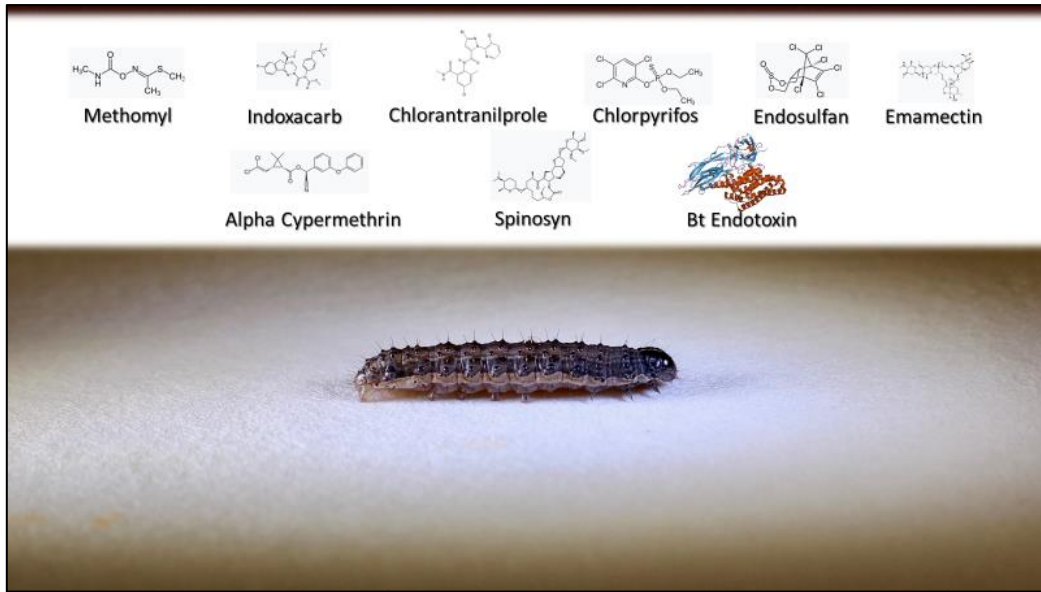
General Manager

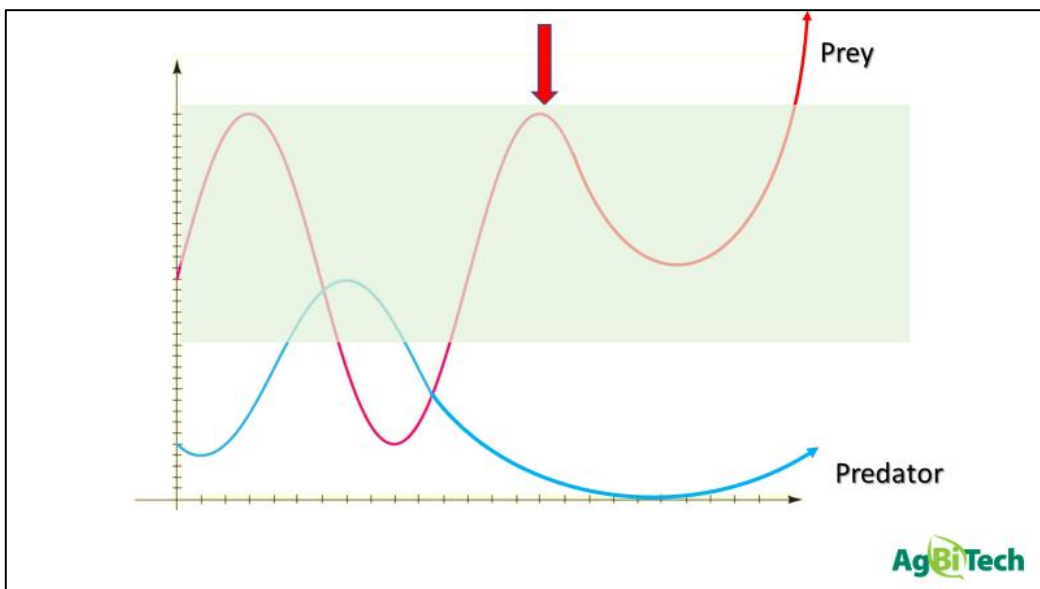
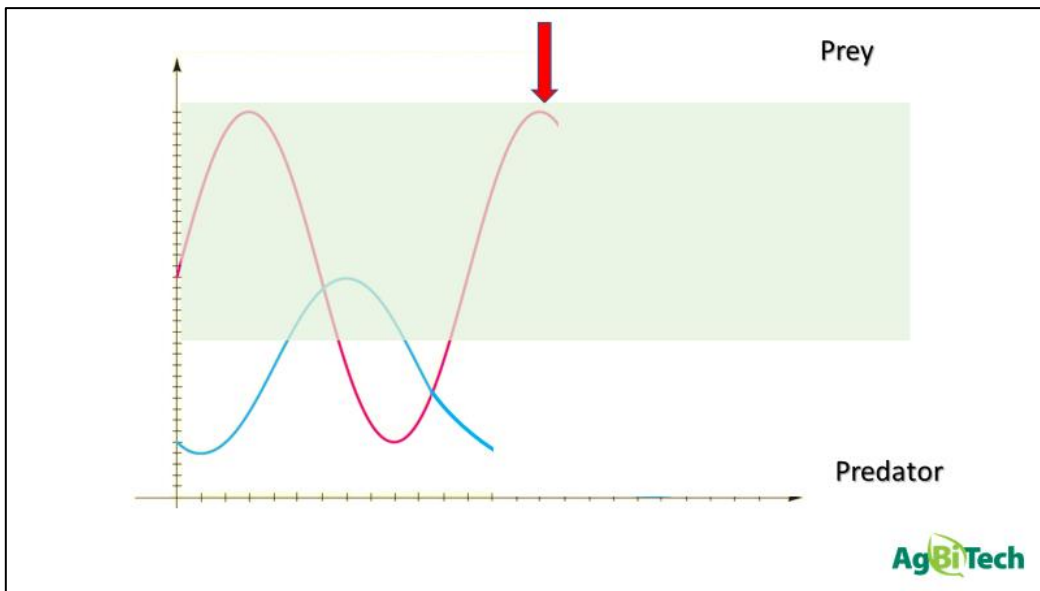
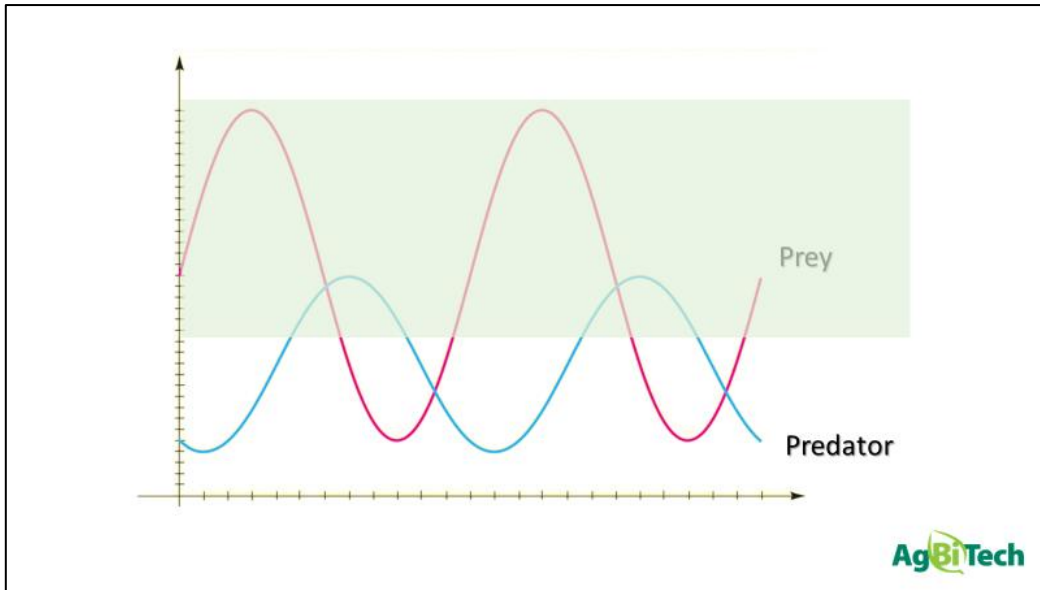
AgBiTech

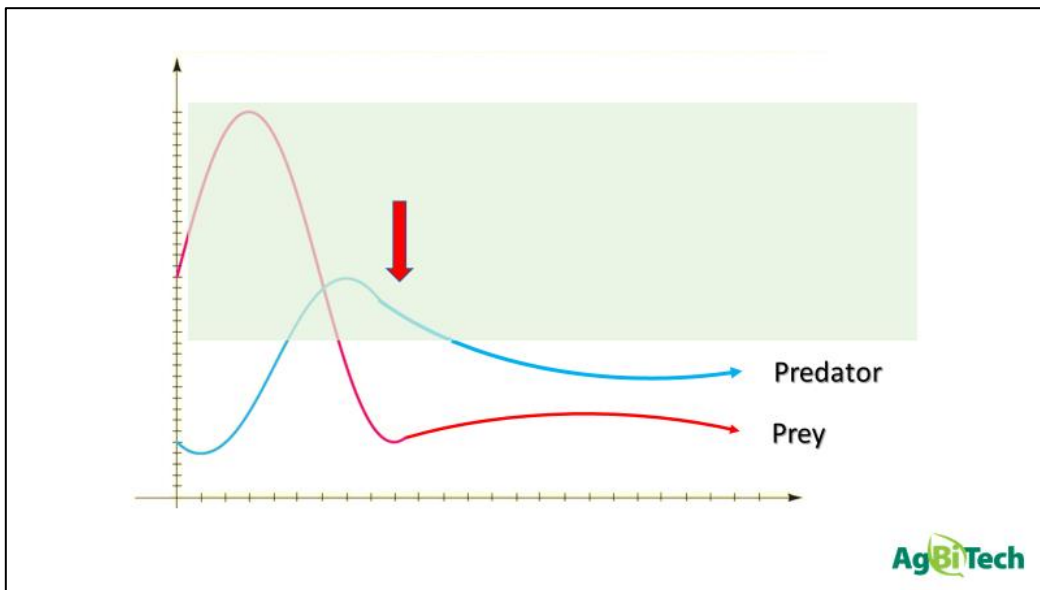
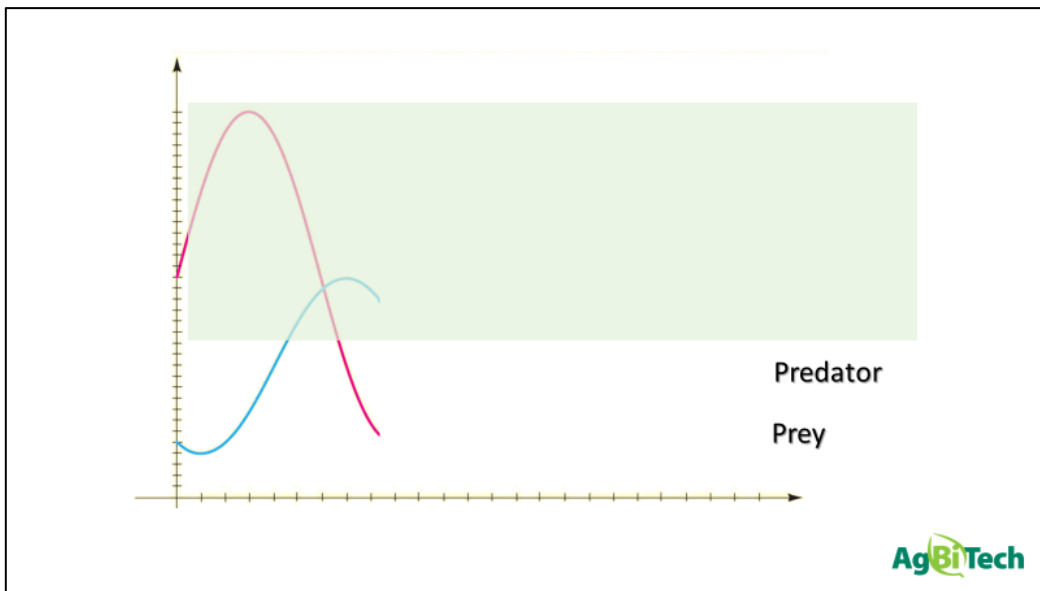
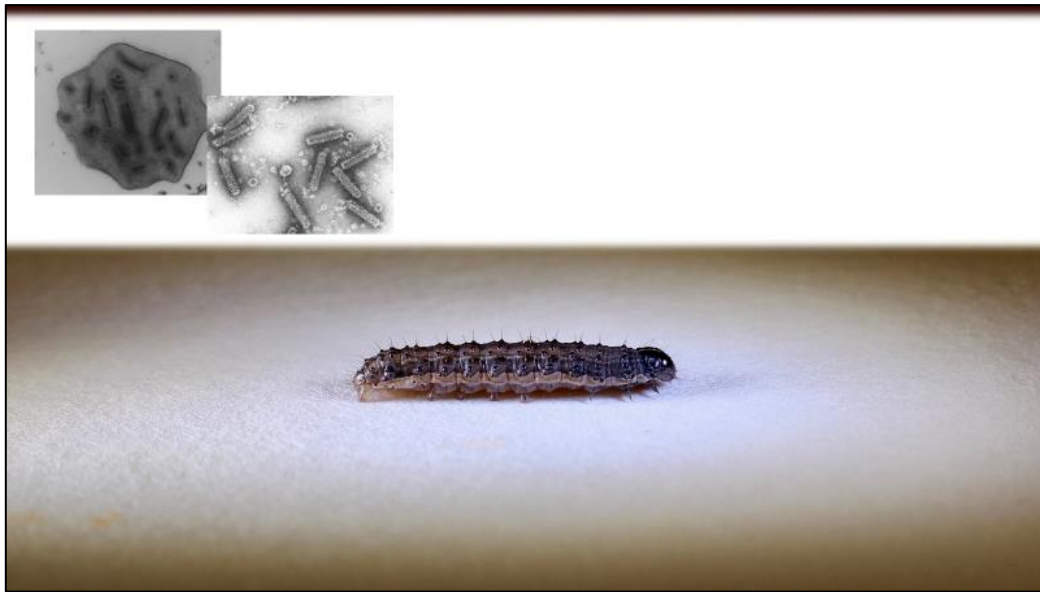
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Tasmanian Ecology
Helicoverpa armigera
Helicoverpa punctigera

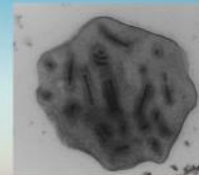
Physiology of Hemp

Economic Damage

Pesticide registrations
Export residues

Baculovirus – Nucleopolyhedrovirus - NPV

Hyper species specific
Selectivity, Withholding period
Cost, Epizootic effects

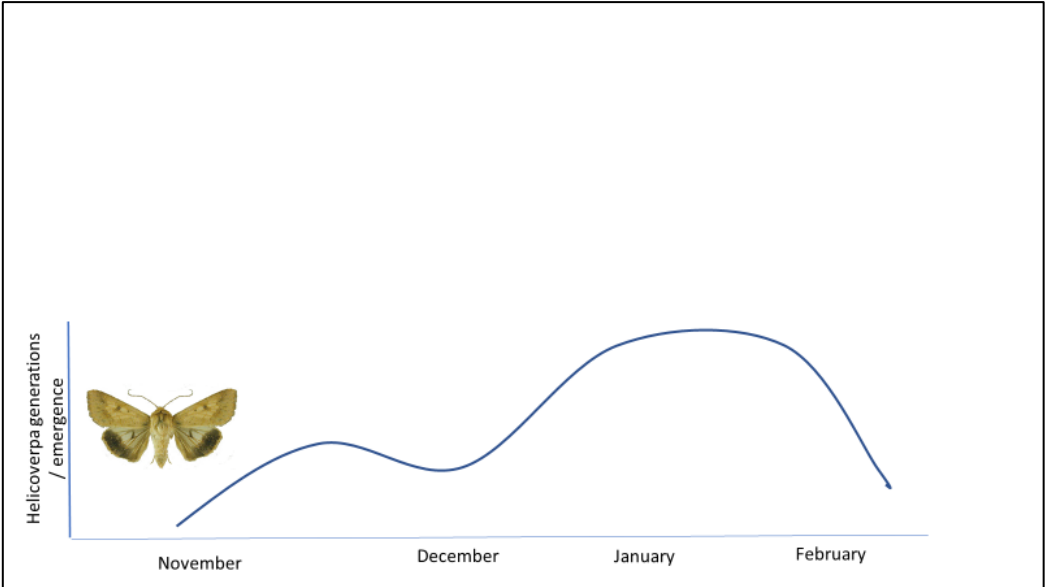


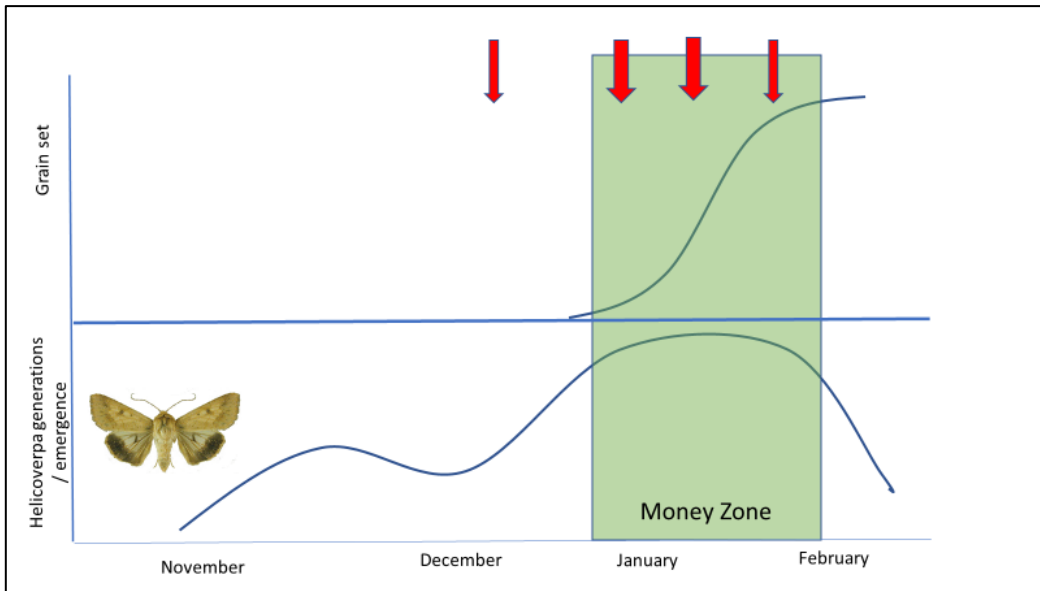
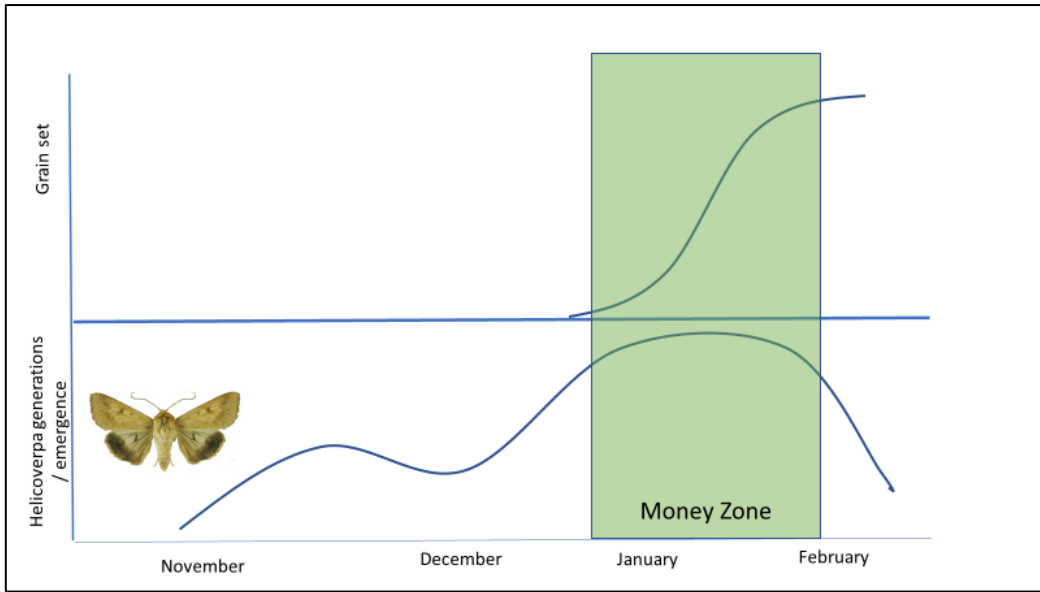
Industry usage – 2019/20

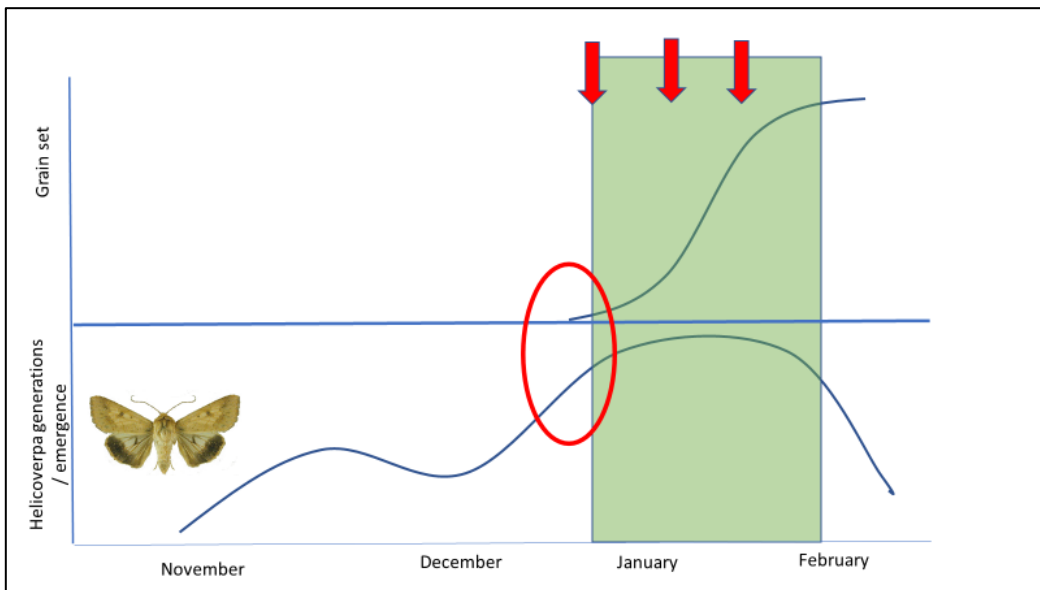
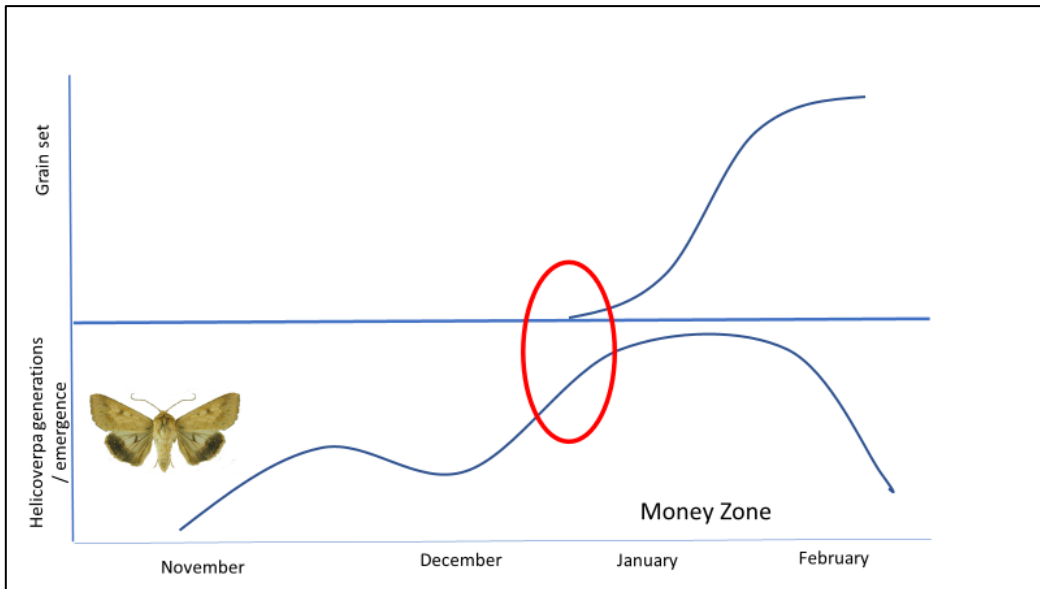


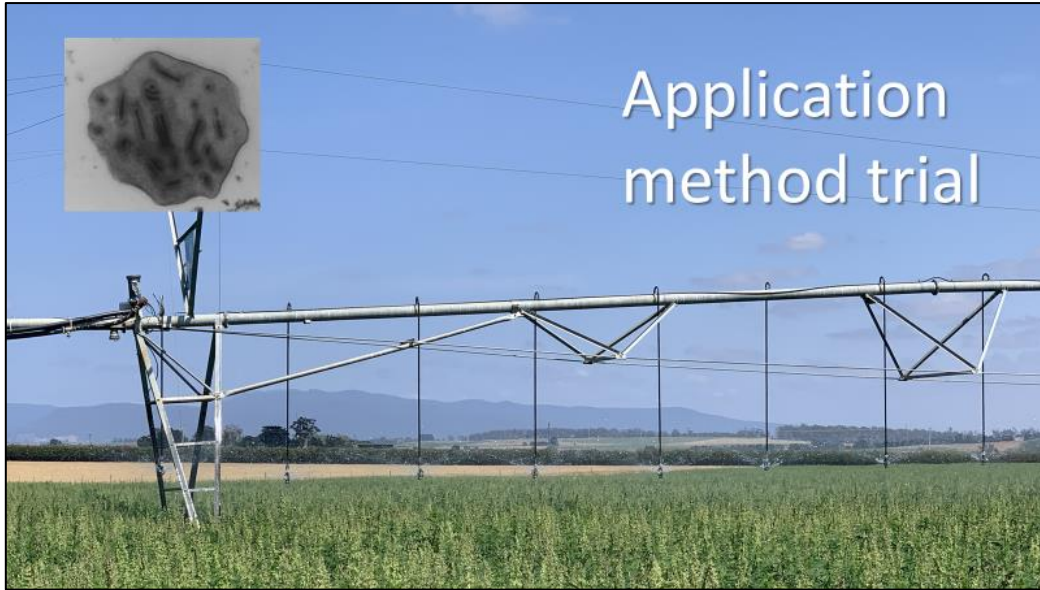
Mode of action – why it works so well in sorghum
Limitations











Irrigation injection
Maximum 10mm
Peristaltic pump
Calibration
Results

Today 8:49 am

Great news. No caterpillars still? On route to Hemp conference to talk about our work. Any words of advice from your end?

No caterpillars. Couldn't even find one the otherday wen i was in there.





Recommendations for Tasmania 2020/21 season



Monitor for emergence mid October onwards (traps)
Mid Bolting start scouting (beat sheet) weekly/10 days
At flowering beat sheet twice weekly, first application
Extreme coverage required, consider water running



Weekly / bi weekly beat sheet, note beneficial insects, top up virus
Protect crop till grain is no longer dough stage

Be prepared to use conventional chemistry if getting out of control



The team

Andrew Linnertson

Ananda Foods

Emily Ruffo

TP Jones

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Session 5 – Managing and Harvesting Your Hemp Crop

GENOTYPE X ENVIRONMENT INTERACTION OF TEMPERATE AND TROPICAL INDUSTRIAL HEMP (*CANNABIS SATIVA L*) VARIETIES WITH EFFECT ON PHENOLOGY AND GROWTH

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ABSTRACT

Industrial hemp (*Cannabis sativa*) has gained worldwide interest as a new crop for seed and medicinal applications and it is being cultivated in temperate to subtropical regions. However, little knowledge is available about the interactions between environment and genotype on time to flowering at lower latitudes. Furthermore, a drying and warming climate might affect plant responses, and thus it is critical to understand the challenges that farmers will face with this crop in the future regarding variety selection and fertilisation. In this study, we assessed and compared the responses of a high latitude variety of industrial hemp (Morphet Late) with lower latitude hemp varieties (ECO-1, ECO-2 and ECO-3) to different day lengths and temperature conditions mimicking a subtropical environment. A series of trials under controlled tropical environments (E1: 11.5 h day length; 25±2°C; E2:12.5 h day length; 25±2 °C; E3:11.5 h day length; 24 °C daily and 15 °C night) were established to test the responses to nitrogen (N) (0, 50, 100, 150 kg/ha of N) including phenology and growth. Phenological data were collected during growth, and final harvest was carried out once all female plants were flowering. We observed significant responses of days to emergence, days to flowering and final biomass between varieties, N rates and different environments. There were also marked growth differences between female and male plants, time to flowering and biomass with different environments of the more photosensitive variety Morphet Late versus ECO-1, ECO-2 and ECO-3. The latter two varieties responded similarly under all conditions, with similar results between N rates, plant early growth rate and total dry plant biomass. This study highlighted the importance of nutrition and environment (day length and temperature) on time to flower, early growth and biomass on the selected tropical and temperate varieties of hemp (*Cannabis sativa L.*)

Keywords: *Cannabis sativa*; tropics; genetic; flowering; nitrogen; daylength

Christmas Island (Indian Ocean Territory of Australia)

- Unique opportunity to undertake research on the transition from mining to agriculture
- Major industry is rock phosphate mining. This may decline by 2030
- There is a critical need to:
 - Find alternative industries to mining for on-going employment of the island community
 - Creating high value products
 - Increase food security - heavy reliance on airfreighted produce



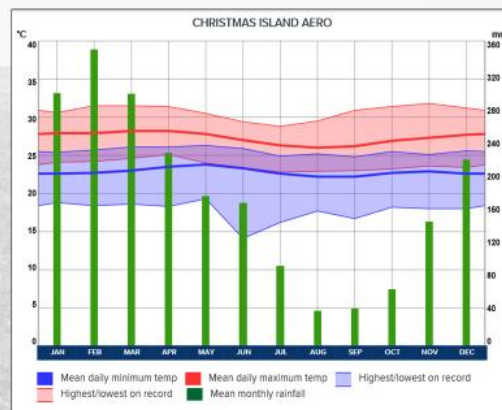
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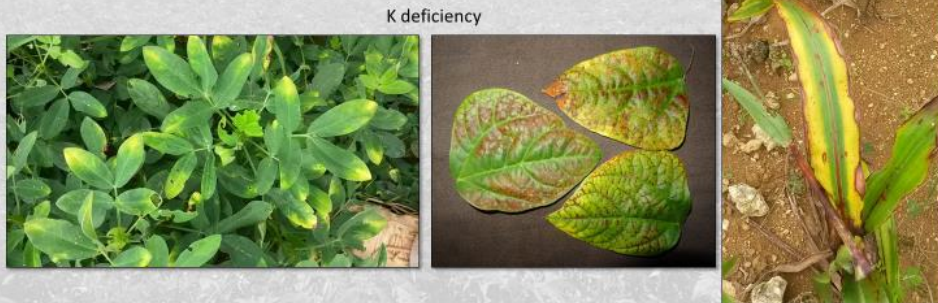
Christmas Island (Indian Ocean Territory of Australia)

- Tropical climate:
 - 80/90% humidity
 - rainfall ~2000mm/yr, in 2016 = ~5000mm
 - Temperature: 27° C (day)/ 24° C (night)
- Photoperiod:
 - 11.5 hrs – 21st of June
 - 12.5 hrs - 21st of December



Challenges for post-mining agriculture

- Scientifically evaluate the feasibility of introducing agriculture on land post-mining
- Reduce the economic dependence on imported products and increase exports (high value crops e.g. hemp)
- Post-mining substrates present abiotic and biotic challenges for plant growth, including:
 - poor fertility
 - post mining effect on abiotic stresses
 - lack of beneficial soil microbes



Growth differences between two tropical/subtropical varieties



Questions

Q1 : how do Genotype and Environment affect the biomass and biochemistry of different hemp varieties?

Q2 : how does N nutrition affect the growth of these varieties in relation to tropical climate?

Experimental design for controlled environment studies

Varieties

- 3 Australian Tropical/sub-tropical (TS) varieties bred by Ecofibre Limited
- 1 Australian temperate variety (TEMP)

Nitrogen treatments

Env. 1 - Christmas Island climate

- N0 = Control (0 kg/ha N)
- N1 = +N 50 kg/ha N
- N2 = +N 100 kg/ha N
- N3 = +N 150 kg/ha N

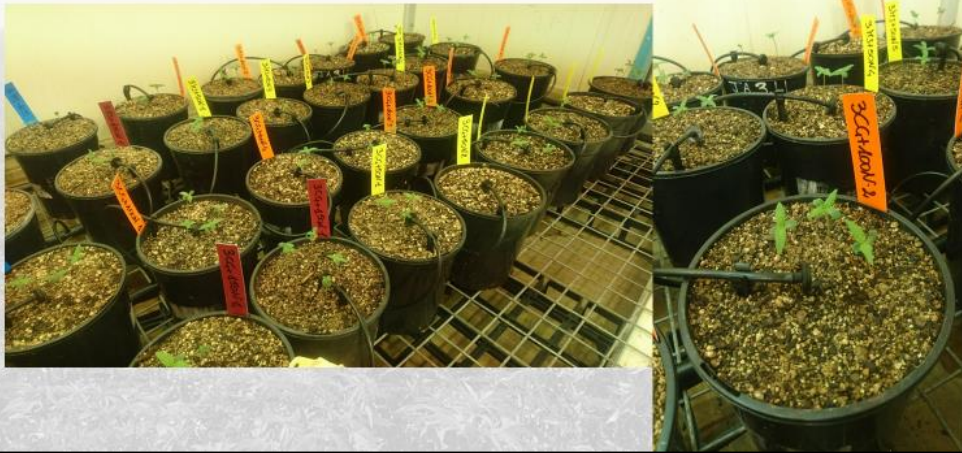
Photoperiod and temperature - Environment:

Env. 1 - Long photoperiod (12.5 hours); T (27°C day/ 24°C night)

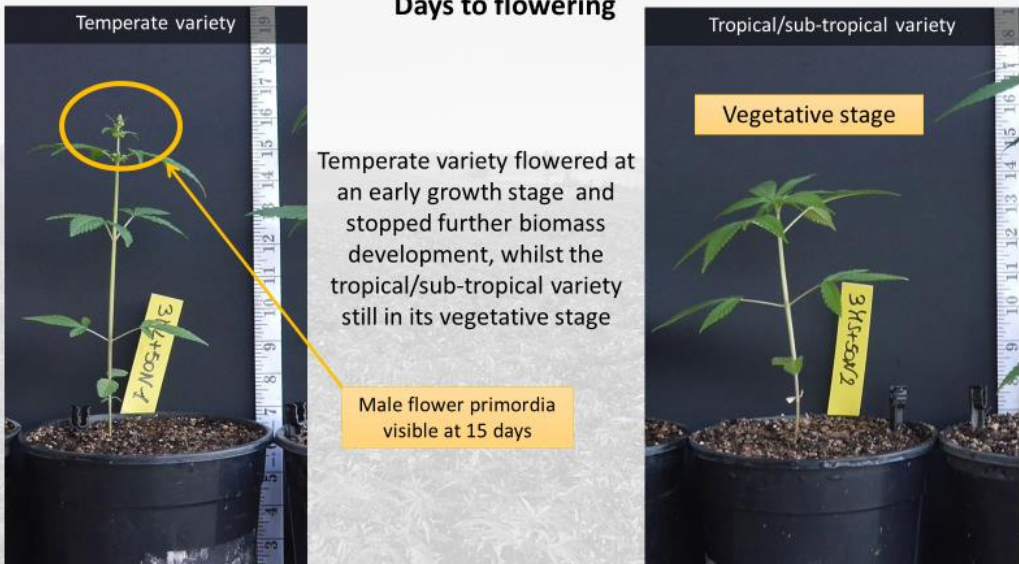
Env. 2 - Short photoperiod (11.5 hours); T (27°C day/ 24°C night)

Env. 3 - Short photoperiod (11.5 hours); T (22°C day/ 10°C night)

Preparation, sowing and first emergence



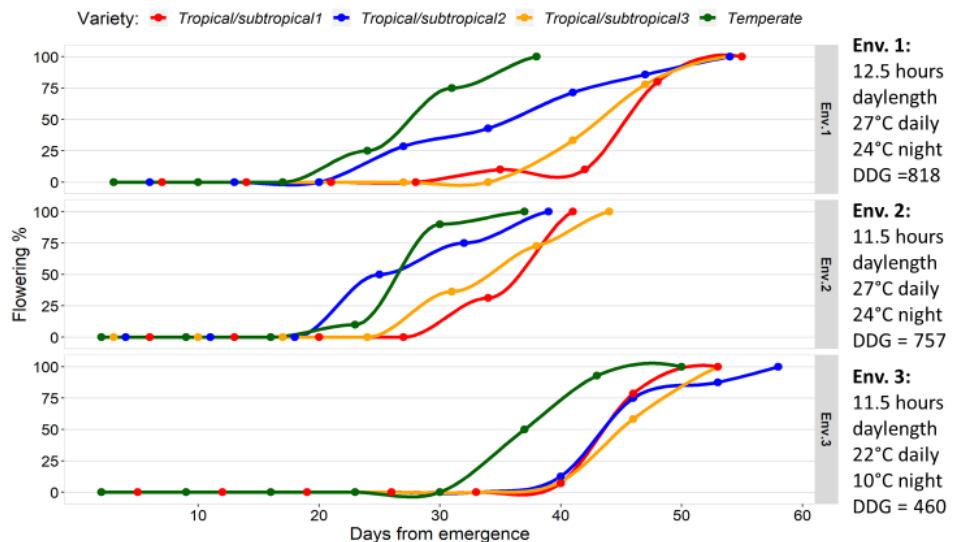
Days to flowering



Temperate variety flowered at an early growth stage and stopped further biomass development, whilst the tropical/sub-tropical variety still in its vegetative stage

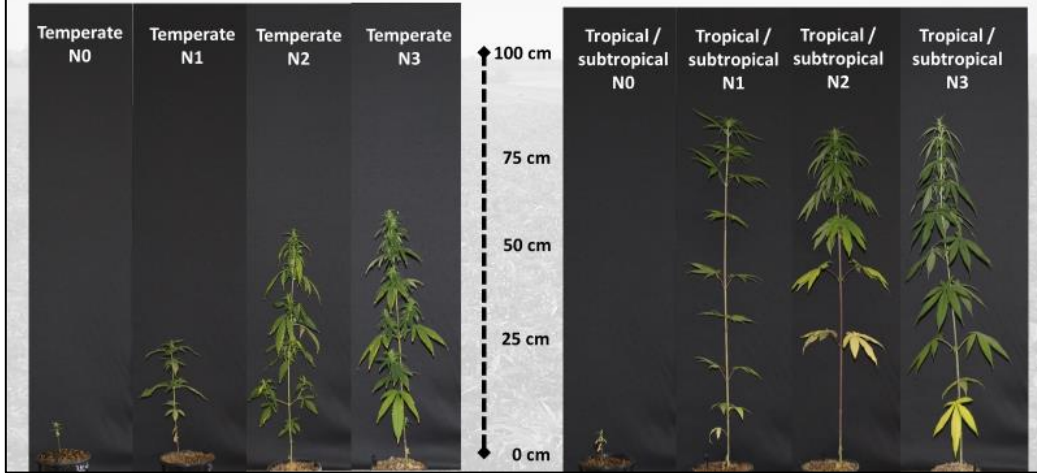
Male flower primordia visible at 15 days

Days to flowering of female plants



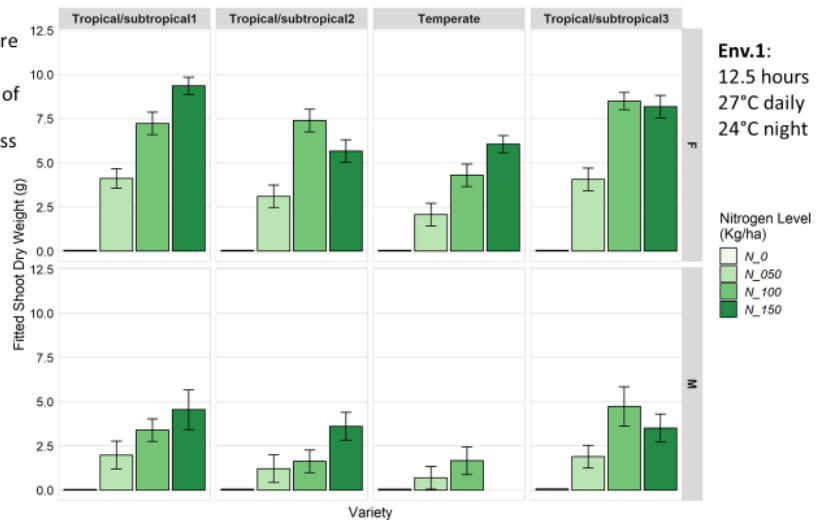
Effect of Nitrogen

Height and biomass are directly correlated to N levels for temperate variety



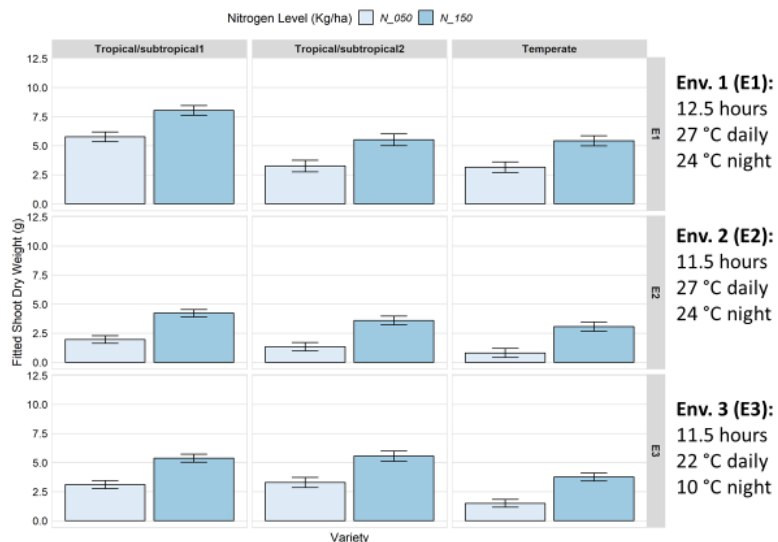
Env. 1: dry weight response on N levels

- Tropical/subtropical varieties respond more effectively to N
- Premature flowering of temperate variety induced lower biomass
- Female biomass is significantly higher than male biomass ($p < 0.05$)



Env. 1, 2 & 3: dry weights of female plants

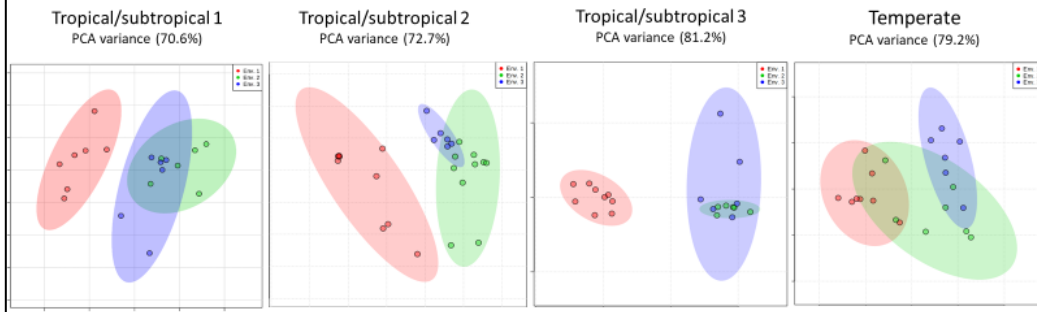
- Longer photoperiod produced more biomass on TS1
- Low temperature delayed flowering time thus produced more biomass: TS2 had higher biomass in lower temperature ($E3 > E2$) ($p < 0.05$)
- TEMP produced less biomass than others TS varieties in E3 ($p < 0.05$)



G x E influence on 10 main cannabinoids Principal Component Analysis (PCA) results

Environments:

1. 12.5 hrs photoperiod / high temp. (25°C)
2. 11.5 hrs photoperiod / high temp. (25°C)
3. 11.5 hrs photoperiod / low temp. (22°C day/10°C night)



Conclusions

- Time to flowering is affected by temperature, and is dependent on genotype
- Longer time to flowering increased biomass accumulation
- Plant biomass is directly correlated with N levels
- Environment affected cannabinoids in tropical/subtropical and temperate varieties
- **Stable and robust genotypes are important to decrease variability**
- Hemp could be an economic option for Christmas Island and other similar remote communities but the influence of G x E must be clearly understood



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Joy Wickendon, Stephanie Lai, Nicholas Gan and Phosphate Resource Limited team.

Thanks for listening!



Session 5 – Managing and Harvesting Your Hemp Crop

PRODUCTION POSSIBILITIES FOR INDUSTRIAL HEMP IN WESTERN AUSTRALIA

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ABSTRACT

Industrial Hemp (*Cannabis sativa* L species) is a versatile crop that has been grown in Western Australia (WA) for many years on a small scale. Due to recent changes in food standards and regulations there has been considerable interest from growers, industry and government to develop industrial hemp (IH) production in WA. IH growers are faced with a wide choice of new varieties both from Australia and overseas, but there is very little information available about how these perform in our local environment. The WA Hemp Growers' Co-op (HempGro) with support from the Department of Primary Industries and Regional Development (DPIRD) undertook an IH variety trial 'Best Seed for Best Region' in 2019. The main objective of this project was to investigate suitable cultivars and optimum sowing windows for industrial hemp production at five locations in the southern WA under rain-fed conditions. Five field trials were conducted at Moora, Pingrup, Manypeaks, Esperance and Capel. Fifteen imported industrial hemp cultivars were sown at three times of sowing in a replicated, randomized block design. Imported cultivars were from Canada, China and France. First time of sowing commenced on 26th September 2019 at Moora and then 2nd October at Pingrup, 3rd October at Manypeaks, 10th October at Capel and 14th October at Esperance. Subsequent sowings occurred at 3 week intervals between September and November as crops emerged, except at Moora due to lack of rainfall. Suitable cultivar selections will be based on agronomic parameters including crop establishment, tolerance to disease, plant height at maturity, growth cycle and grain yield and quality. The plant count and height for each time of sowing and location were analysed using a linear mixed effects model in R using ASReml version 4.1.0.

Key words: Industrial hemp; *Cannabis sativa*; cultivars; time of sowing; rain-fed

INTRODUCTION

Industrial Hemp (IH) is the low tetrahydrocannabinol (THC) variety of the *Cannabis sativa* L. species. It is a versatile and valuable crop with over 2000 known varieties that have been grown for centuries across Asia, Europe and America (Encyclopaedia Britannica, 2019). IH is cultivated for both fibre and seed and has a huge range of applications.

The WA Department of Agriculture trialled a number of IH varieties in 1996-7 in the south-west of WA but the results were poor and the crop was viewed as not having much potential. However, due to recent changes in food standards and regulations there has been considerable interest from growers, industry and government to develop IH production in WA and around the world. Across WA there is a burgeoning farming sector which can see the potential for hemp as an intercrop to

their farming system, a way of sequestering carbon and improving soil structure due to its tap root and numerous secondary roots as well as the heavy shade it produces during the growing season (Amaducci et al 2008). However, the seed varieties used across WA have not proven to be stable or suitable. Additional complications from previously grown seed varieties include crops growing too tall to suit conventional harvesters and not ripening for harvest at the expected time, consequently using valuable land which should have been put under winter crops.

IH growers are faced with a wide choice of new varieties both from Australia and overseas, but there is very little information available about how these perform in our local environment. The WA Hemp Growers' Co-op (HempGro) with support from the Department of Primary Industries and Regional Development (DPIRD) undertook a hemp variety trial 'Best Seed for Best Region' in 2019. The main objective of this project was to investigate suitable cultivars and optimum sowing windows for industrial hemp production at five locations in southern WA under rain-fed conditions.

Methods and Materials

Five field trials were conducted at Moora, Capel, Pingrup, Manypeaks, and Esperance under rain fed conditions. Fifteen imported industrial hemp cultivars were sown at 3 times in a replicated, randomized block design. Imported cultivars were from Canada, China and France (Table 1). Seeding rate was adjusted to a target of 100 plants per square metre (m²) using germination tests and average 1000-grain weights. Each plot was 10 m long and 1.44 m wide.

Plots were sown at a depth of 2-3 cm from the end of September to early January, according to the timing of the optimum rainfall in each location (Table 2). First time of sowing (TOS) commenced on 26 September 2019 at Moora, 2 October at Pingrup, 3 October at Manypeaks, 10 October at Capel and 14 October at Esperance. Subsequent sowings occurred at 3-week intervals between September and November, except at Moora due to lack of rainfall. At Esperance TOS 3 was sown much later in January.

Soil samples were collected from all trial sites prior to seeding. The samples were taken at 10 cm depth randomly from 20–30 positions at each site. The samples were bulked to provide one representative sample per site and were analysed for complete soil chemical analysis (Table 3, Raiment and Lyons 2011). Each site received a basal fertiliser application based on the soil test results. Glyphosate was used to control weeds as required. Plant establishment was recorded by counting plant numbers in two rows each of 1m length in each plot at three locations two to three weeks after seeding. Plant heights were recorded at each site at different dates at each location. Rainfall during the growing season was recorded at or near, each trial site. Crops did not complete their life cycle due to high temperature and lack of adequate rainfall during the growing cycle and were not harvested at any site.

Plant establishment counts and plant heights were recorded for TOS 1 and TOS 2 at all locations. No data were recorded for TOS 3 due to very poor germination except in Esperance which was still growing at time of writing. The plant count and height for each TOS and location were analysed using a linear mixed effects model in R using ASReml version 4.1.0 (Butler 2018).

Table 1. Name, origin and end use of the fifteen imported industrial hemp varieties

Variety	Country of Origin	Use	Days to maturity
Joey	Canada	Grain & Fibre	100-110
Canda	Canada	Grain & Fibre	100-120
CFX 2	Canada	Grain & Fibre	100-110
CRS 1	Canada	Grain & Fibre	100-110
Grandi	Canada	Grain	100-110

Katani	Canada	Grain	100-110
Bama	China	Grain & Fibre	110-190
Han cold	China	Grain & Fibre	115-180
Yuma	China	Grain & Fibre	120-180
Earlina 8 FC	France	Grain	115-120
Fedora 17	France	Grain	<125
Fibror 79	France	Fibre	101-106
USO 1	France	Grain	122-127
Felina 32	France	Grain	133-138
Ferimon 12	France	Grain & Fibre	129-134

Table 2. Sowing dates at trial locations

	TOS 1	TOS 2	TOS 3
Moora	26 September 2019	Not sown	Not sown
Pingrup	02 October 2019	24 October 2019	13 November 2019
Manypeaks	03 October 2019	25 October 2019	14 November 2019
Capel	10 October 2019	30 October 2019	20 November 2019
Esperance	14 October 2019	31 October 2019	16 January 2020

Table 3. Soil analysis results for each trial site at 0-10 cm depth

Location	Soil pH (CaCl ₂)	Total organic matter (%)	Cation exchange capacity (meq/100 of soil)	Total phosphorus (ppm)	Total nitrogen (%)
Moora	6.0	1.55	4.07	182	0.05
Pingarup	5.3	1.72	3.64	126	0.05
Manypeaks	5.0	10.8	13.39	261	0.43
Capel	4.9	7.8	16.6	827	0.26
Esperance	5.6	2.9	4.83	-	0.14

RESULTS AND DISCUSSIONS

Rainfall

There was no substantial rainfall at any site during the growing season (September to January). Rainfall from September 2019 to January 2020 was 21.6 mm at Pingrup, 51.5 mm at Moora, 80.7 mm at Esperance, 93.5 mm at Capel and 104.2 mm at Manypeaks (Table 4). Rain at all sites was well below the long-term average, especially Pingrup which received less than 20% of the average. November and December had the lowest rainfall at all locations. Low rainfall after sowing placed the crops under severe stress, especially in Pingrup. Some rain events occurred after sowing at Esperance, Manypeaks and Capel but not enough rain for substantial grain filling. Only in October at Capel was monthly rainfall greater than the long-term average and that was only by 8.5 mm.

Table 4. Monthly and long time average rainfall at all locations

Months	Rainfall (mm)	Moora	Pingrup	Capel	Manypeaks	Esperance
September	Actual rainfall	28.7	4.4	28.7	24.5	27.9
	Long term average	38.4	32.5	75.4	82.4	58.2
October	Actual rainfall	10.3	13.4	51.5	33.0	28.6
	Long term average	23.8	25.3	43.0	68.1	46.3
November	Actual rainfall	11.9	3.8	9.3	24.0	10.0
	Long term average	13.3	20.2	30.6	49.0	36.6
December	Actual rainfall	0.3	0	2.0	1.7	0
	Long term average	9.1	15.3	13.7	29.6	22.1

January	Actual rainfall	0.3	0	2.0	21.0	14.2
	Long term average	14.2	16.0	10.9	24.4	27.0
Sept. – Jan.	% of long term average	52.1	19.8	53.9	41.1	42.4

Plant establishment counts

There was a significant difference between varieties at both times of sowing (TOS) and all locations except TOS 2 at Manypeaks in plant establishment counts. The trial at Moora failed to germinate fully so this site will not be included in the results. Figure 1 shows the mean plant counts (plants per square metre) for each variety at TOS 1 and 2 for all four locations. Pingrup and Capel had the lowest plant counts for both TOS. Esperance had the highest plant counts for both TOS. Han cold had the lowest plant count in Capel for TOS 1 and 2, and was also the lowest for Pingrup in TOS 1. For TOS 1, Han cold had the highest plant count in Esperance. For TOS 2 in Capel, Bama, Earlina 8, Felina 32, Ferimon 12 and Fibror 79 had a significantly higher plant count than Canda, CFX 2, CRS 1, Han cold and Joey.

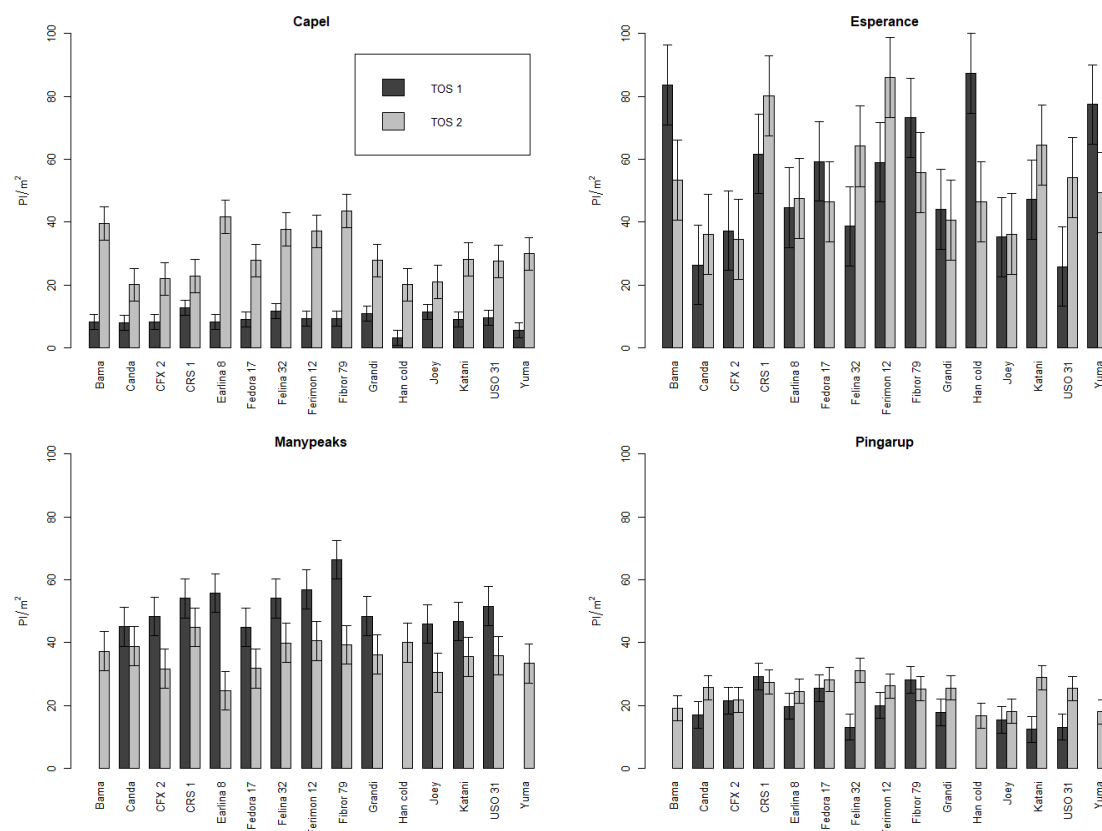


Figure 1. Mean plant establishment counts for each IH variety at TOS 1 and 2. The error bars are the estimated LSD, which can only be compared within one TOS.

In Esperance, for TOS 1 Bama, Fibror 79, Han cold and Yuma had significantly higher plant counts than Canda, CFX 2, Earlina 8, Felina 32, Grandi, Joey, Katani and USO 31. For TOS 2 in Esperance CRS 1 and Ferimon 12 had significantly higher plant counts than Bama, Canda, CFX 2, Earlina 8, Fedora 17, Grandi, Han cold, Joey, USO 31 and Yuma. In Manypeaks, for TOS 1 Fibror 79 had a significantly higher plant count than Fedora 17. For TOS 2 in Manypeaks Canda, CRS 1, Felina 32, Ferimon 12, Fibror 79 and Han cold had significantly higher plant counts than Earlina 8.

In Pingrup for TOS 1 CFX 2, CRS 1, Fedora 17 and Fibror 79 had significantly higher plant counts than Felina 32. For TOS 2 in Pingrup Canda, CRS 1, Fedora 17, Felina 32, Ferimon 12 and Katani had significantly higher plant counts than Han cold, Joey and Yuma.

At Capel and Pingrup the average plant populations across all varieties were 9 plants/m² and 19 plants/m² for TOS 1 and 30 plants/m² and 24 plants/m² for TOS 2 respectively. Better plant establishment was observed at Esperance (53 plants/m² for both TOS) and Manypeaks (52 plants/m² for TOS 1 and 36 plants/m² at TOS 2) due to better rainfall post planting. Plant establishment of all varieties at Capel and Pingrup was poor.

Plant establishment was much lower than the target plant density at all locations. Plant establishment counts varied between TOS 1 and TOS 2. This is likely due to very unreliable rainfall and continuous high temperatures between 34 to 42^oC in mid November. There was very low rain in November and almost none in December at all locations after sowing. All sites received well below the long term average rainfall (Table 4).

Plant heights

Statistical analysis showed that plant heights were significantly different among varieties for both TOS. Figure 2 shows that for plant height in both TOS 1 and 2 there was a significant interaction between variety and location. Pingrup and Manypeaks for both TOS had the lowest plant height, whilst Esperance had the highest plant height for both TOS. For all four locations, Grandi had the lowest or almost the lowest plant height for both TOS.

In Capel for TOS 1 Grandi and Katani had significantly lower plant heights compared to Bama, Canda, CFX 2, Earlina 8, Fedora 17, Felina 32, Ferimon12, Fibror 79, Han cold, Joey, USO 31, and Yuma. For TOS 2 in Capel Felina 32, Fibror 79 and USO 31 had significantly higher plant heights than Grandi. In Esperance for TOS1 Bama, Fibror 79, Han cold and Yuma had significantly higher plant heights compared to the rest of the varieties (Canda, CFX2, CRS 1, Earlina 8, Fedora 17, Felina 32, Ferimon 12, Grandi, Joey, Katani and USO 31). Similarly, for TOS 2 in Esperance Bama, Fibror 79, Han cold and Yuma had significantly higher plant heights compared to the rest of the varieties.

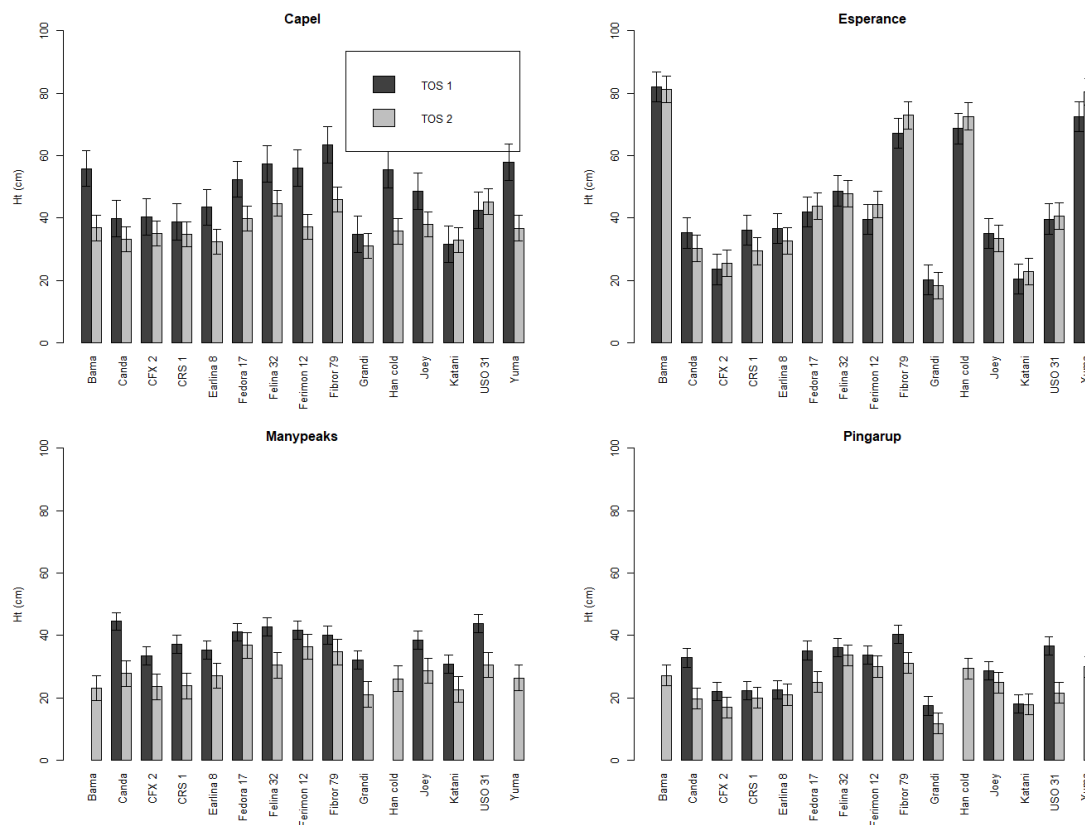


Figure 2 Mean plant heights of each variety for TOS 1 and 2 at each location. The error bars are the estimated LSD, which can only be compared within one TOS.

In Manypeaks for TOS 1 Grandi and Katani had significantly lower plant heights than Canda, Fedora 17, Felina 32, Ferimon 12, Fibror 79, Joey and USO 31. For TOS 2 in Manypeaks Grandi had a significantly lower plant height than Fedora 17, Ferimon 12 and Fibror 79.

In Pingrup for TOS 1 Grandi and Katani had significantly lower plant heights than Canda, Fedora 17, Felina 32, Ferimon 12, Fibror 79, Joey and USO 31. TOS 2 in Pingrup, Grandi had a significantly lower plant height than all of the varieties except for CFX 2 and Katani.

The average predicted plant height was highest at Esperance for TOS 2 (45 cm) and at Capel for TOS 1 (48 cm). Pingrup had the lowest plant height for both TOS 1 (29 cm) and TOS 2 (24 cm). The variety Grandi performed poorly in all locations.

Plant heights tended to be true to type, grain varieties were generally shorter than mixed use and fibre varieties. The Canadian seed grew quickly and set seed early before biomass was established. The French varieties tended to be longer growing and set seed at the top of plant. Again, stress from heat, moisture and wind tended to mean the plant had gone to flower early. Further research on the best time of sowing is required. Late winter sowing when the weather is closer to the Northern hemisphere spring may achieve better results.

CONCLUSIONS

Due to the poor seasonal conditions experienced during these trials, it is difficult to draw conclusions on the suitability of the tested varieties at each location and the different times of sowing. However, information gathered has put a number of ideas on the table for future research around seed sowing depth, time of sowing vs day length, variety and set up.

Future on-farm trials could be more successful if varieties of the same growing length are tested to make management easier. More research is also required on photosensitivity and how this may affect growing patterns in WA.

While the seasonal conditions experienced during the trial were challenging, we have a better understanding of the growing patterns of the varieties. From this we can see where some varieties may fit into our farming systems. Further research is required to gain reliable information for IH varieties with potential to grow and be profitable in dryland conditions in WA.

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Session 5 – Managing and Harvesting Your Hemp Crop

GERMINATION AND EARLY GROWTH OF SEEDLINGS OF INDUSTRIAL HEMP (*CANNABIS SATIVA L.*): VARIETIES LOCALLY AVAILABLE AND IMPORTED IN WESTERN AUSTRALIA

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ABSTRACT

Seed germination and early growth of seedlings of 14 industrial hemp varieties were assessed in Petri dish and glasshouse conditions. Germination data were recorded every 24h for 7 and 20 consecutive days in Petri dish and glasshouse trials, respectively, and cumulative data were used to calculate the final germination percentage and quality index (i.e. speed of germination). Significant variations were observed among the varieties with respect to seed germination and seedling growth. The highest germination was recorded for variety Han FNQ (92% and 70% in glasshouse and Petri dish, respectively) followed by Han FNH (82% and 66%), Fedora 17 (74% and 52%) and Han NE (64% and 62%). The lowest germination was recorded for variety SI1 in both Petri dish and glasshouse trials (10%). The quality index or the speed of germination varied significantly in Petri dish and was highest for varieties Han FNQ and Han FNH (5 seeds germinated/day) followed by Han NE, Han COLD and Yuma 1 (4 seeds/day), and the lowest was recorded for SI1 (1 seed/day). Seedling length and growth rates were highest for variety Han NE (10.46 cm and 5.23 mm/day seedling length and growth rate, respectively) followed by Han FNQ (9.28 cm and 4.64 mm/day) and Han COLD (8.80 cm and 4.40 mm/day). The lowest seedling length and growth rate were recorded for variety Han NW (5.06 cm and 2.53 mm/day). Shoot dry weight and leaf area were highest for variety Puma 3 (0.118 g/plant and 8.70 cm², respectively). Seedling vigour (SV) indices were highest for variety Han FNQ (SV1, 60.79 and SV2, 853.80) followed by the varieties Puma 3 (SV1, 54.83) and Han NE (SV2 666.60).

Keywords: Germination; industrial hemp; quality index; seedling vigour; Western Australia

INTRODUCTION

Industrial hemp (*Cannabis sativa* L.) is a multifaceted crop used for food, fibre and medicine [1, 2]. It is potentially an important crop in Australia as it has been legalised for processing seed and oil into food products [3]. High germination rate is the requirement for hemp seed importation to Western Australia as the importers should not only consider which hemp varieties are suitable for their purposes but also the quality of the hempseed, including types of impurities, cleanliness and a recent germination test [4]. The viability of industrial hemp seed can fall rapidly over a year depending on storage conditions and other factors; hence, the quality of the local and imported

seeds is not always reliable. Evaluation and optimisation of seed germination can assist hemp growers in selecting the right cultivar. The present study was conducted to determine the performance of seed germination and early growth of seedlings of 14 varieties in Petri dish and glasshouse conditions.

METHODOLOGY

In Petri dishes; 10 seeds of a variety were placed in each of 5 Petri dishes (where each Petri dish represented a replicate) previously lined with filter paper soaked with deionised water. The Petri dishes were covered with aluminium foil and kept in darkroom with constant temperature (25°C). In glasshouse, 10 seeds of each variety were sown in each of 5 rows (where each row represented a replicate) in a plastic seedlings tray filled with 2 kg of potting mix. Germination data were recorded every 24 hr for 7 and 20 consecutive days in Petri dish and glasshouse trials, respectively. Cumulative data were used to calculate the final germination percentage and quality index of germination (i.e. speed of germination). Seedlings raised in the glasshouse were used to measure shoot length, growth rate, leaf area, dry weight and seedling vigour.

RESULTS

Final germination percentage ranged from 10 to 70% with a mean of 42.14% and 10 to 92% with a mean germination percentage of 58.29% for Petri dish and glasshouse trials, respectively. In Petri dish, the highest germination was recorded for the variety, HanFNQ (70%) followed by Han FNH (66%) and Han NE (62%). The quality index was highest for the variety, Han FNQ (5.00 seeds germinated/day) followed by Han FNH (4.71 seeds/day) and Han NE (4.43 seeds/day) and the lowest was calculated for SI 1 (0.71 seeds/day). In glasshouse, the highest germination was recorded for the variety, Han FNQ (92%) followed by Han FNH (82%), Fedora 17 (74%) and Han NE (64%). The quality index was recorded highest for the variety, Han FNQ (2.30 seeds germinated/day) followed by Han FNH (2.05 seeds/day) and Fedora 17 (1.85 seeds/day) and the lowest was calculated for SI1 (0.25 seeds/day). The lowest germination was found for the variety, SI1 (10%) in both Petri dish and glasshouse trials. Seedling length and growth rate were recorded highest for variety Han NE (10.46 cm and 5.23 mm/day seedling length and growth rate, respectively) followed by Han FNQ (9.28 cm and 4.64 mm/day) and Han COLD (8.80 cm and 4.40 mm/day). The lowest seedling length and growth rate were recorded for the variety Han NW (5.06 cm and 2.53 mm/day). Shoot dry weight and leaf area were recorded highest for the variety Puma 3 (0.118 g/plant and 8.70 cm², respectively). Seedling vigour (SV) indexes were recorded highest for the variety Han FNQ (SV1, 60.79 and SV2, 853.80) followed by variety, Puma 3 (SV1, 54.83) and Han NE (SV2 666.60) and the lowest was recorded for the variety, SI1 (SV1, 7.06 and SV2, 48.90).

CONCLUSION

Regarding seed germination, variety Han FNQ performed best in both Petri dish and glasshouse, whereas variety Han NE had the highest seedling length and growth rate. The variety Puma 3 showed the highest biomass as it had higher shoot weight and leaf area. These three varieties also had the highest seedling vigour, indicating their potential as new cultivars in Western Australia for fibre, seed and biomass production.

ACKNOWLEDGEMENTS

We thank WA DPIRD, Fibre and Land International Group Pty Ltd, Premium Hemp Australia and WA Hemp Growers' Co-op Ltd for supplying seeds of 14 industrial hemp varieties.

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Session 6A – Food Value

UNDERSTANDING CONSUMER ATTITUDES, BEHAVIOURS, AND INTENTION TO CONSUME A NOVEL FOOD USING HEMP FOOD AS A MODEL

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ABSTRACT

Food manufactured from the seed of the hemp plant *Cannabis sativa* were legalised in Australia for human consumption in November 2017. Despite what appears to have been a long pro legislation campaign by hemp industry stakeholders and others, the now legal status of hemp food does not seem to have been conveyed to those for whom the industry depends on for success, the Australian consumer. A mixed methods approach was adopted to evaluate consumer attitudes one year after the introduction of hemp food into the Australian consumer market. In semi-structured qualitative interviews, it was found all the participants invited to participate remained unaware of the legalisation and availability of hemp food. An incidental finding of the study identified a negative implicit bias toward consuming hemp food. An evaluation of the qualitative interviews through a constructivist lens has sought to understand implicit attitudes toward hemp through personal statements reflecting socially constructed views of hemp's relationship to its illicit cousin, marijuana. In the second phase of the study, more than half of a nationally representative sample (n=2354) who responded to an online quantitative questionnaire were also not aware that hemp food had been legalised.

This paper reports on consumer awareness using demographics such as postcode, age and education. The quantitative online questionnaire also employed psychometric tools to evaluate consumer's intention to consume hemp food, personality factors, food neophobia, factors important to food choice, as well as sensation seeking and impulse control. The relevance of each of the evaluated constructs and how they might contribute to understanding consumer attitudes, behaviours and intention to consume hemp food is discussed. This paper represents a summary of the initial findings of a study for which there is an anticipated potential for extrapolation to consumer attitudes toward other discrete novel foods, and the role that implicit bias has in food choice. Beneficiaries in the short term include hemp producers, hemp food manufacturers and marketing firms. Longer term beneficiaries include food producers, manufacturers and marketing firms in general, as well as clinicians who might wish to better understand the processes of food choice when developing programs which promote healthier eating behaviours to their clients.

Keywords: Hemp food; consumer attitudes; consumer behaviour; intention to consume novel foods; implicit attitudes

The study

- Sequential mixed methods approach
- Most important initial findings
 - consumers' lack of awareness of the legalisation of hemp foods,
 - the implicit negative bias towards hemp foods due to its incidental association with its illicit cousin, marijuana
 - Seemingly slow uptake of regular consumption of hemp foods among those who have accepted hemp foods relatively soon after introduction

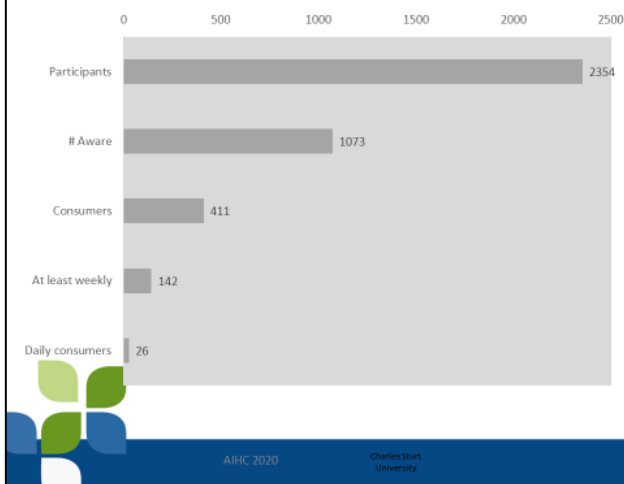


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Participant awareness and consumption

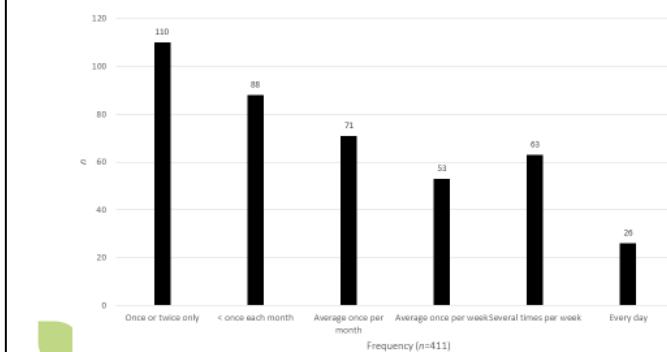


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Hemp food consumption frequency



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Consumption by hemp food category

Product	n	% yes	% overall
Hemp seed oil	174	16.2	7.4
Raw hulled hemp seeds	137	12.8	5.8
Hemp snack bar	114	10.6	4.8
Hemp protein powder	107	10.0	4.5
Restaurant/café hemp	68	6.3	2.9
Hemp flour	68	6.3	2.9
Hemp 'corn chips'	63	5.9	2.7
Hemp chocolate bar	58	5.4	2.5
Other hemp snack foods	55	5.1	2.3
Salad containing hemp	48	4.5	2.0
Hemp 'peanut butter'	44	4.1	1.9
Toasted hemp seeds	41	3.8	1.7
Hemp oil capsules	38	3.5	1.6
Other hemp spread	34	3.2	1.4
Hemp coffee	33	3.1	1.4

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Aware consumer archetype



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Hemp food consumer archetype



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Where to next?



- Understanding role of personality in novel food acceptance
 - Openness to experience
 - Extraversion
 - Food neophobia
 - Sensation seeking
- Evaluating factors contributing to intention to consume
 - Social norms
 - Personal factors
 - Control
- www.hempfoodresearch.com



Australian Industrial Hemp Conference 2020 Charles Sturt University



Thank you

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OPTIMIZING PROCESSING CONDITIONS FOR EXTRACTION OF PROTEINS FROM HEMP SEED MEALS

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ABSTRACT

Hemp seed meal (HM) is rich in high quality storage proteins that are highly digestible and have high arginine content. However, hemp seed meal proteins (HMP) have poor functionality limiting their use in formulated foods. This study investigated optimum conditions for extraction of the proteins from HMs.

Hemp meal solutions (10%w/w) were either heated at 65 or 95°C with or without salt (0.25 to 0.8M NaCl) and the solubility of proteins was evaluated after centrifugation of the mixture at 10000 g for 20 minutes at 20°C. The HM solutions were also treated with ultrasound (20% and 80% amplitude) during heating was also investigated to improve solubility of the HMP.

Commercially available HMP had poor solubility (6 to 12%). The extraction of proteins was enhanced by heating at 65°C for 10 h and at pH 9 (20%) but increased significantly by addition of salt (0.8 M) during heating (>80%). Increasing the extraction temperature without the addition of salt did not increase the proportion of soluble proteins. The ultrasound treatment for (80% amplitude) for 15 minutes at 65°C and pH 9, without salt addition almost doubled the extractability of proteins (42% yield) as compared to untreated samples.

These results confirm that salt is necessary for extraction of proteins from HM, and further solubility improvements can be made by choosing optimal process parameters (temperature, pH, ultrasound).

Keywords: hemp seed meal; hemp proteins; yield; solubility; functionality; ultrasound

Need for alternate sources of proteins

- Climate-change combined with population growth poses a huge threat to food security and noncommunicable diseases: Require 70% more food by 2050
- Consumers are driving innovations in the space of plant-based foods. Drivers: sustainability, health, lifestyle choices, technological advances
- Ideal attributes for novel source of protein:

- | | |
|----------------------|---------------------------|
| ✓ Sustainable | ✓ Low-allergenicity |
| ✓ High-quality | ✗ Superior extractability |
| ✓ High digestibility | ✗ Highly functional |



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Regulatory frame-work for use of hemp as food in NZ

- Amended regulations to permit hemp seed to be sold as food are in force from 12 November 2018.
- The **ONLY** part of the hemp plant (low THC *Cannabis sativa*) that can be used in food is the **SEED**.
- Food made from the leaves, flowers, buds, stems, or any other part of the low THC *Cannabis sativa* plant is **NOT** allowed
- Whole seeds require permit, dehulled seeds don't



<https://www.mpi.govt.nz/dmsdocument/31633-a-guide-to-hemp-seeds-as-food>

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Dehulled hemp seeds have high nutritional value



Fats: 45 % w/w

Rich in polyunsaturated fats
 ω -6 and ω -3 fats
In desirable ratio of 3:1



Proteins: 35 % w/w

High digestibility
Rich in essential amino acids
Proteins contain upto 10% Arginine

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Hemp seed proteins

- High quality protein composition, similar to casein and soy
- PDCAAS value: 0.48 to 0.61
- Rich source of essential amino acids
- *In vitro* digestibility higher than soy proteins (upto 30%): lower concentration of antinutrients
- Low allergenicity

Table 3. Comparison of Essential Amino Acid Content of HPI,^a SPI,^a and Casein^b to FAO/WHO Suggested Requirements^c

amino acids	amino acid content ^d			FAO/WHO suggested requirements ^e			
	HPI	SPI	casein	1 year old	2-5 year old	10-12 year old	adult
His	29.3	29.0	27	26	19	19	16
Ile	41.5	44.8	49	46	28	28	13
Leu	69.0	70.0	84	93	88	44	19
Lys	43.3	53.9	71	86	58	44	16
SAA ^f	16.2	9.9	26	42	25	22	17
ARM ^g	87.8	90.1	100	72	63	22	19
Thr	47.8	41.0	37	43	34	28	9
Trp			14	17	11	9	5
Val	51.8	44.1	60	55	35	25	13

(Tang et al. 2006)

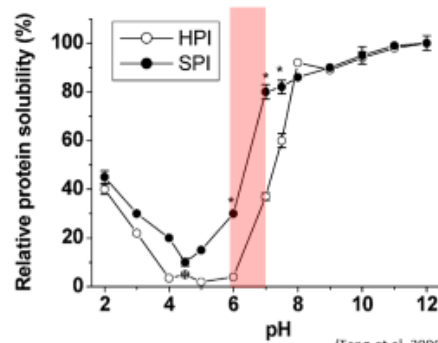
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Technological challenges for use of hemp proteins in foods

- Poor solubility in water, affects extractability, functionality
- Proteins in hemp consist of 2 types of proteins:
25% albumins: soluble in water
75% globulins: require salt for solubilisation



(Tang et al. 2006)

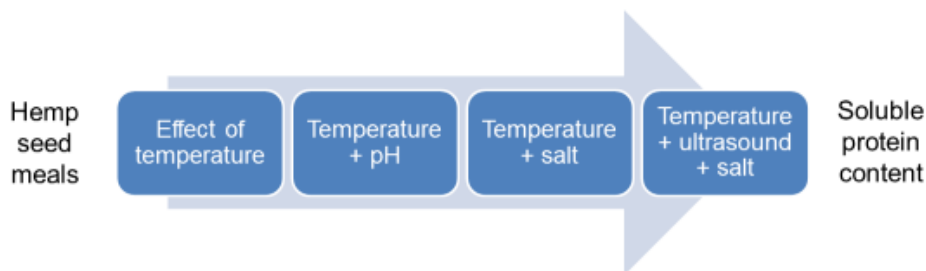
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Objective

Optimize parameters for maximum recovery of proteins from hemp seeds meals



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Protein contents of commercially available hemp seed meals



48%



56.2%



46.2%



65.1%

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Particle size distribution of powders

Mesh size (μm)	Percentage (w/w)	
	Sample 1	Sample 6
≥ 600	4.8	0.2
425 - 600	22.7	17.7
180 - 425	61.9	48.9
150 - 180	8.4	23.6
90 - 150	2.1	9.2
75 - 90	0.0	0.3
63 - 75	0.0	0.0

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Effect of temperature on protein extraction

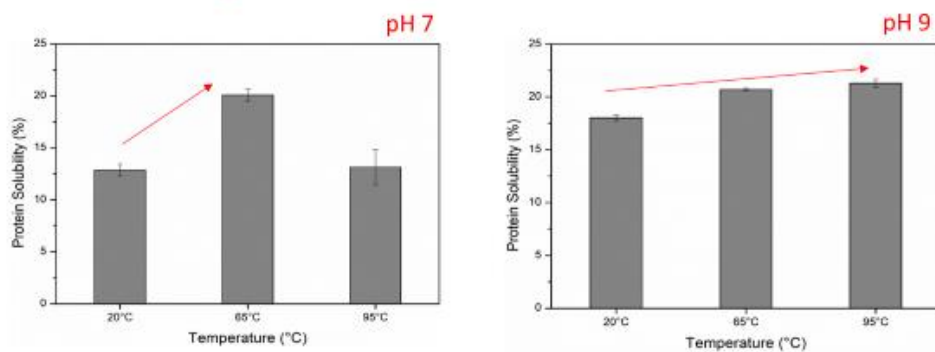


Figure 1. Extractable proteins from hemp seed meals at different pH. Extracted protein expressed as % (w/w dry weight) of the total protein in hemp seed meal.

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Effect of temperature and pH cycling

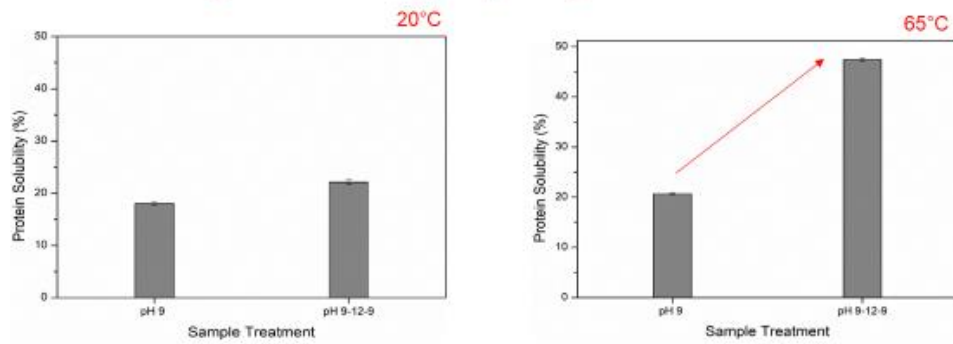
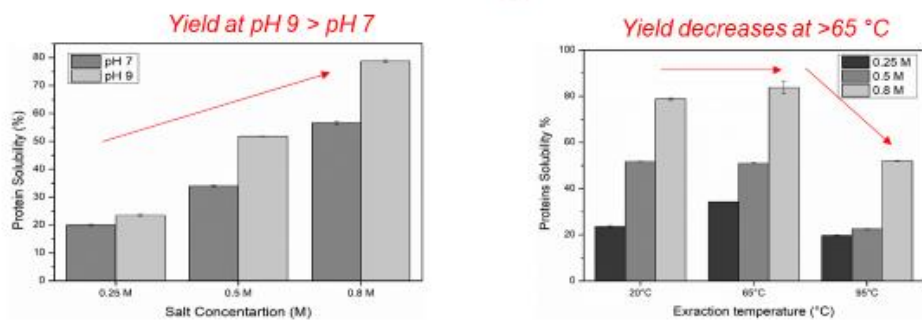


Figure 2. Effect of pH cycling on the extractable proteins from hemp seed meals at different temperatures. Extracted protein expressed as % (w/w dry weight) of the total protein in hemp seed meal.

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Effect of salt concentration and pH



(A) Different salt concentrations and different pH at 65°C

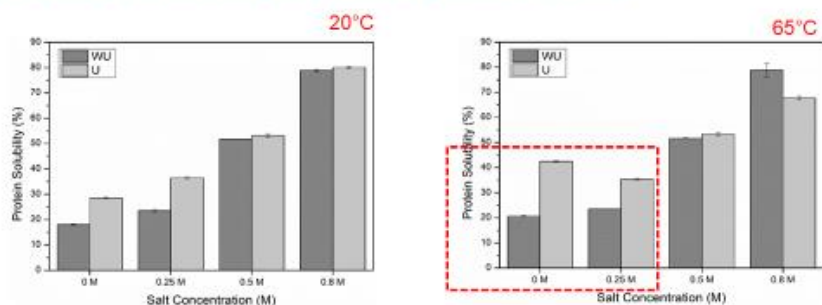
(B) Different salt concentrations and different temperatures at pH 9

Figure 3. Extractable proteins from hemp seed meals.

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Effect of ultrasound on protein extractability



Effect of salt and ultrasound not cumulative

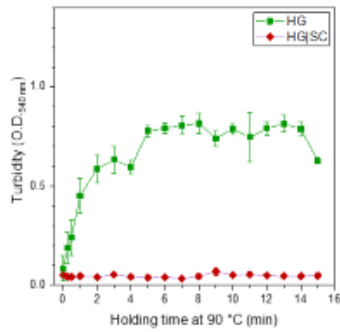
Figure 3. Effect of ultrasound on extractability of proteins at pH 9. Samples exposed to ultrasound at 80% amplitude for 1 h at different temperatures.

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Ongoing work at the Riddet Institute

Stabilization of hemp proteins by strategies



Settling at the bottom



No settling



Hemp globulin heat aggregation is inhibited by the chaperone-like action of caseins

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1. Introduction

Increasing demand for high quality protein is expected by 2050 due to the rapid growth of population and increasing living standards, and there will be a change of animal protein to no relative in future. Partial replacement of animal-derived protein with plant protein had been

made solvent (L-3334) and an acidic solvent (L-3334), the other two forming one intramolecular disulfide bond within the acidic solvent and the two cysteine bridge the two disulfide groups (Gómez, Gómez, Pizarro, Martínez, & López, 2018). The relative protein structure is already related to the key glycoprotein, so relative protein structure should also be stabilized by electrostatic and hydrogen bonds

Chuang et al. 2019 Food Hydrocolloids (93) 46-55

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Summary

- Optimal temperature and pH of extraction for proteins from hemp-seed meals is 65° and pH 9
- Hemp proteins have high extractability at high salt concentrations
- The use of ultrasound presents a promising technique for extraction of hemp proteins
- Technological functionality of hemp proteins could be improved by blending with different proteins e.g. dairy

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Planned work

- Fine-tuning functional properties of proteins for specific applications
- Use of hemp proteins to develop natural emulsifiers
- New product development: Plant-based meat alternatives containing hemp

The Riddet Institute is supporting MIHI (Movers in Hemp Innovation), a collaboration of NZ's Māori and non-Māori hemp growers and businesses, to develop innovative value-added products for global markets. The MIHI group has recently received a NZD 50000 development grant from the High Value Nutrition, National Science Challenge, New Zealand

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Trang Phan



Dr. Alejandra Fani-Acevedo



Dr. Arup Nag



Dist. Prof. Harjinder Singh

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Thank you



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Session 6A – Food Value

DIETARY MINERALS IN SEEDS OF INDUSTRIAL HEMP (*CANNABIS SATIVA L.*) VARIETIES DIFFER WITH THE ORIGIN OF SOURCES

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ABSTRACT

The seeds of Cannabis (*Cannabis sativa L.*) has been considered as a vital source of nutrition for thousands of years in ancient world culture. However, industrial hemp has not been studied extensively for its nutritional potential though hempseed, which contains a considerable amount of oil, protein, dietary fibre, vitamins and minerals. Here, we assessed the dietary mineral concentration in seeds of 14 industrial hemp varieties locally available and imported in Western Australia to see the differences among the varieties in respect to six macro-minerals (Ca, K, Mg, Na, P and S) and 12 trace metals (Al, As, Cd, Co, Cu, Fe, Mn, Mo, Pb, Zn, Cr and Ni). Briefly, hempseeds were oven-dried, ground and digested with HNO_3 (concentrated Nitric acid) followed by HClO_4 (concentrated Perchloric acid) and solutions were analysed by ICP-OES (Inductively Coupled Plasma-Optical Emission Spectrometry) technique. Significant variations were observed among the varieties with respect to different macro- and micro-minerals concentration.

Overall hempseeds are rich in the macro-minerals, P (0.883%), K (0.729%) and Mg (0.406%) and the micro-minerals, Fe (156.06 mg/kg), Mn (120.07 mg/kg) and Al (35.63 mg/kg). Among the 6 macro-minerals, Ca (0.215%), K (1.00%), Mg (0.517%) and Na (0.046%) were found highest in the French monoecious variety, Felina 32. The P (1.058%) and S (0.314%) concentrations were highest in the Canadian monoecious variety, Morpeth and the Chinese dioecious variety, Han NW respectively. The French monoecious variety, Ferimon was lowest in Ca (0.106%) and Na (0.001%) and the Chinese dioecious variety, SI 1 was lowest in Mg (0.296%) and P (0.589%). The Chinese dioecious variety, Han FNH was lowest in K (0.647%), and Morpeth was lowest in S (0.197%). Among the 16 micro-minerals, As and Cd were not detected in any of the varieties though Pb was detected in the French monoecious variety, Santhica (0.42 mg/kg), followed by Chinese dioecious varieties, Puma 3 (0.33 mg/kg) and Han COLD (0.37 mg/kg). The variety, Felina 32 was highest in Al (93.00 mg/kg), Cu (17.61 mg/kg), Fe (219.49 mg/kg), Mo (1.07 mg/kg) and Zn (90.24 mg/kg) but was found lowest in Cr (1.45 mg/kg) and Ni (0.73 mg/kg) content. The Chinese dioecious variety, Yuma 1 was highest in Co (0.46 mg/kg) and Mn (175.55%) concentrations and the Chinese dioecious varieties, Bama 4 and Puma 3 were highest in Ni (4.30 mg/kg) and Cr (4.95%) respectively.

Keywords: Industrial hemp; seeds; dietary minerals; ICP-OES

What is hemp and hemp seed?

- Industrial hemp is a **non-drug** variety of the species, *Cannabis sativa* L.
- It is tall, fast growing, annual herbaceous crop under the family Cannabaceae.
- Cross-pollinated and short-day plant with a deep and fibrous tap root.
- Traditionally being used for food, fibre and medicine for many years.



Fig 1. Cannabis sativa, scientific drawing from c1900
https://en.wikipedia.org/wiki/Cannabis_sativa

What is hemp and hemp seed?

- Hemp seeds are basically the fruit or nut of the hemp plant
- It is composed of a protective outer shell called 'hemp hull' and an inner soft kernel called 'hemp heart'.
- Hemp hull is a good source of minerals and dietary fibre and hemp heart is rich in oil, proteins and vitamins.
- Overall, the whole hempseed contains 35.5% oil, 24.8% protein, 27.6% dietary fibre, 6.5% moisture and 5.6% ash (Callaway 2004).



Fig 1. Whole hemp seed Vs. hulled hemp seed
<http://www.oilseedcrops.org/hemp/>

Global Hemp Seed Production

- 28,060 hectares area under cultivation and 102,415 m tonnes of hempseed production in 2017.
- France and China are the major producers (95.34%), France alone contributed 80.37% in global hemp seed production.
- Global average yield is 3.65 tonnes/hectare, France is the highest yield achiever (6.70 tonnes/hectare) followed by Spain (5.93 tonnes/hectare) and China (2.53 tonnes/hectare).

FAOSTAT, 2017
<http://www.fao.org/faostat/en/>

Why Hemp Seed is Important?



- **Hemp seeds are versatile**, they have so many uses. They can be eaten raw as snack as well as can be used in regular food products like, muesli, cereals, snack food, nondairy milk, salads, dressing etc.
- **They're high in plant-based protein**, an 'all-in-one' superfood that contains complete digestible protein as 100% raw and can be produced as naturally occurring plant-based protein powder.
- **They're low in carbohydrate**, can be used as natural low-carb diet that contain mostly protein, fats and dietary fibre.
- **They're exceptionally rich in omega 3 and 6**, having one of the best ratios (normally in between 2:1 and 3:1) of any plant food which is considered to be optimal for human health.
- **They're good source of vitamins and minerals**, rich in vitamin B1, B3 and E and P, K, Mg, Fe, Mn and Zn.

Previous Study and Knowledge Gap



- Vonapartis et al. (2015) determined the fatty acid composition as well as the concentrations of crude protein, oil, ash, cellulose, hemicellulose and lignin in seeds of ten industrial hemp cultivars grown in Que'bec, Canada.
- The macronutrient content, amino acids composition and protein quality in hemp seeds and hemp foods derived from hemp seeds grown in Western Canada were determined by House et al. (2010).
- Callaway (2004) determined the seed chemical composition from whole seed of the Finola hemp variety and its seed meal and discussed the nutritional value and quality of hemp seed oil and protein.

Previous Study and Knowledge Gap



- Majority of the studies regarding hemp seed nutrition conducted mainly focusing on the composition of macronutrients and discussing the nutritional value of hemp seed oil and protein.
- The nutritional potential of hemp seed in respect to micronutrients (vitamins and minerals) were overlooked. Like vitamins, minerals (macro- and micro-minerals) help growth and development of the body and stay healthy.
- Minerals have diverse functionalities and potentials in body's metabolism and homeostasis. **For example, the body uses minerals to perform many functions from building strong bones to transmitting nerve impulses. Some minerals are even used to make hormones or maintain a normal heartbeat.**

In This Study

- Nutritional potentials of 14 industrial hemp varieties locally available in Western Australia were assessed in respect to macro- and micro-mineral concentrations in seeds.

Varieties	Expression	Country of Origin	Supplier	1000 Seed Weight (g)
Ferimon	Monoecious	France	WA Hemp Growers' Co-op Ltd (HempGro)	18.50 ef
Fedora 17	Monoecious	France	WA Hemp Growers' Co-op Ltd (HempGro)	21.11 de
Santhica	Monoecious	France	WA Hemp Growers' Co-op Ltd (HempGro)	19.18 def
Felina 32	Monoecious	France	Premium Hemp Australia and DPIRD	15.13 f
Bama 4	Dioecious	China	Premium Hemp Australia and DPIRD	34.62 b
Han NE	Dioecious	China	Premium Hemp Australia and DPIRD	28.81 c
Han FNH	Dioecious	China	Premium Hemp Australia and DPIRD	23.65 cde
Yuma 1	Dioecious	China	Premium Hemp Australia and DPIRD	35.29 b
Han FNQ	Dioecious	China	Premium Hemp Australia and DPIRD	24.05 cd
Han NW	Dioecious	China	Premium Hemp Australia and DPIRD	26.77 c
Puma 3	Dioecious	China	Premium Hemp Australia and DPIRD	35.64 b
Han COLD	Dioecious	China	Premium Hemp Australia and DPIRD	35.54 b
SI 1	Dioecious	China	Premium Hemp Australia and DPIRD	62.29 a
Morpeth	Monoecious	Canada	Food, Fibre and Land International Group Pty Ltd (FFLI)	21.17 de

Methodology



Fig 1. Seeds of 14 industrial hemp (*Cannabis sativa* L.) varieties locally available and imported into Western Australia. From top left corner to right, (1) Bama 4; (2) Han NE; (3) Han FNH; (4) Yuma 1; (5) Han FNQ; (6) Han NW; (7) Puma 3; (8) Han COLD; (9) SI 1; (10) Ferimon; (11) Fedora 17; (12) Santhica; (13) Felina 32 and (14) Morpeth.

Functions of dietary minerals

Minerals	Functions
Boron (B)	Bone development and maintenance, muscle development and strength and can help alleviate vitamin D deficiency.
Calcium (Ca)	Production and upkeep of bones and teeth.
Chromium (Cr)	Breakdown fat, carbohydrates and some hormones like insulin.
Cobalt (Co)	Production of red blood cells
Copper (Cu)	Effective healing of wounds as it helps the blood to clot, for the colouring or pigmentation of hair and fertility.
Iron (Fe)	A lack of iron can lead to iron deficiency anaemia.
Manganese (Mn)	Formation of bone and performing functions in the pituitary gland, liver, pancreas, kidney
Molybdenum (Mo)	Protect against certain cancers.
Selenium (Se)	Strengthen immune system and supports thyroid function.
Silicon (Si)	Silicon helps to make bone, blood vessels, cartilage, tendons and strong nails. Avoid premature ageing.
Sodium (Na)	Regulate the amount of water in cells, control the overall fluid balances and keep nerves and muscles working.
Zinc (Zn)	Depressed growth, hair loss, eye and skin lesions, reduced appetite, brain functions and immune system.

Methodology



- Two grams of seeds of each variety were oven-dried at 70 °C for 72 hours and ground into fine powder. Sample digestion was done following the methods developed by Simmons (1975).
- Briefly, 0.20 g to 0.25 g of ground seed sample of each variety was placed into conical flasks and digestion was first carried out by adding 6 mL of cHNO_3 followed by heating the flasks at 120 °C for approximately 20 minutes.
- The flasks were then allowed to cool at ambient temperature for approximately 5 minutes and the second step of digestion was carried out by adding 1 mL cHClO_4 and heating the flasks at 150 °C until solutions turned colourless and emitted white fumes.

Methodology



- The flasks were then allowed to cool and reheated at 170-180 °C for 10 minutes to dehydrate any silica that might have been present in the digest.
- The flasks were allowed to cool again and warm at 80 °C by adding 4 mL Milli-Q® H_2O to dissolve any KClO_4 crystals.
- The warm solutions were then transferred to 10 mL vials, each of them containing 50 μL of Yttrium (Y) internal standard solution and then volume up to 10 mL with Milli-Q® H_2O .
- The samples were then ready for elemental analysis using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Sample concentrations were determined and errors were corrected as described by Simmons (1978).

Results



Overall, hempseeds are rich in the macro-minerals, phosphorus (P), potassium (K) and magnesium (Mg).

Macro-mineral Concentration:

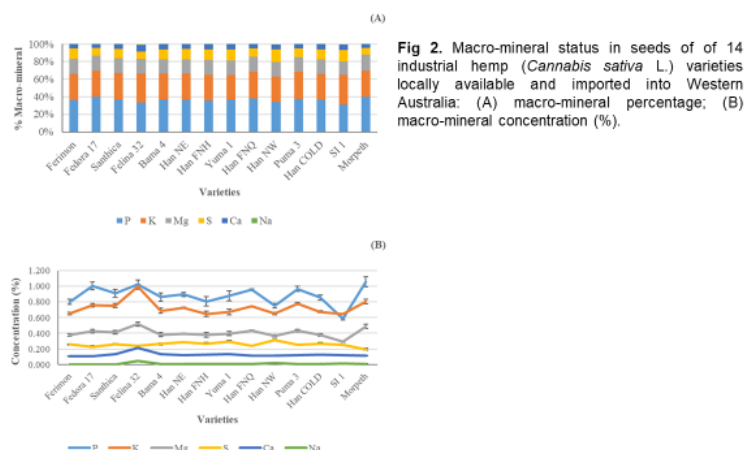
- Among the six macro-minerals (P, K, Mg, S, Ca, Na) considered in this study, Ca (0.215%), K (1.00%), Mg (0.517%) and Na (0.046%) were found highest in the French monoecious variety, Felina 32.
- The P (1.058%) and S (0.314%) concentrations were highest in the Canadian monoecious variety, Morpeth and the Chinese dioecious variety, Han NW respectively.
- The French monoecious variety, Ferimon was lowest in Ca (0.106%) and Na (0.001%) and the Chinese dioecious variety, SI 1 was lowest in Mg (0.296%) and P (0.589%).
- The Chinese dioecious variety, Han FNH was lowest in K (0.647%), and Morpeth was lowest in S (0.197%).

Results

Table 2: Macro-mineral concentration (%) in seeds of 14 industrial hemp (*Cannabis sativa* L.) varieties.

Variety	Concentration (%)					
	P	K	Mg	S	Ca	Na
Ferimon	0.801 bcd	0.653 d	0.381 cd	0.259 bcd	0.106 e	0.001 f
Fedora 17	1.005 ab	0.757 bcd	0.426 abc	0.230 de	0.107 e	0.001 f
Santhica	0.909 abc	0.754 bcd	0.414 abc	0.263 abcd	0.134 bc	0.001 f
Felina 32	1.021 ab	1.000 a	0.517 a	0.242 cde	0.215 a	0.046 a
Bama 4	0.864 abc	0.689 bcd	0.382 bcd	0.264 abcd	0.132 bcd	0.007 e
Han NE	0.895 abc	0.726 bcd	0.393 bcd	0.288 abc	0.123 bcde	0.010 cd
Han FNH	0.806 bcd	0.647 d	0.380 cd	0.269 abcd	0.127 bcd	0.009 cde
Yuma 1	0.877 abc	0.672 cd	0.393 bcd	0.296 ab	0.136 b	0.008 de
Han FNQ	0.956 abc	0.743 bcd	0.434 abc	0.238 cde	0.115 de	0.009 cde
Han NW	0.753 cd	0.654 d	0.368 cd	0.314 a	0.117 cde	0.019 b
Puma 3	0.967 abc	0.780 bc	0.432 abc	0.257 bcd	0.118 bcde	0.010 cde
Han COLD	0.858 abc	0.675 cd	0.380 cd	0.270 abcd	0.126 bcd	0.010 cde
Sl 1	0.589 d	0.648 d	0.296 d	0.252 bcd	0.118 bcde	0.012 c
Morpeth	1.058 a	0.802 b	0.489 ab	0.197 e	0.114 de	0.008 de
Min	0.589	0.647	0.296	0.197	0.106	0.001
Max	1.058	1.000	0.517	0.314	0.215	0.046
Mean	0.883	0.729	0.406	0.260	0.128	0.011
Sd. Error	0.042	0.021	0.020	0.009	0.003	0.001

Results



Results

Overall, hempseeds are rich in the micro-minerals, iron (Fe), manganese (Mn) and aluminium (Al).

Micro-mineral Concentration:

- Among the 12 micro-minerals (Fe, Mn, Zn, Al, Cu, Cr, Ni, Mo, Pb, Co, As and Cd) considered in this study, Al (93.00 mg/kg), Cu (17.61 mg/kg), Fe (219.49 mg/kg), Mo (1.07 mg/kg) and Zn (90.24 mg/kg) were found highest in the French monoecious variety, Felina 32.
- As and Cd were not detected in any of the varieties though Pb was detected in the French monoecious variety, Santhica (0.42 mg/kg), followed by Chinese dioecious varieties, Puma 3 (0.33 mg/kg) and Han COLD (0.37 mg/kg).
- The Chinese dioecious variety, Yuma 1 was highest in Co (0.46 mg/kg) and Mn (175.55 mg/kg) concentrations and the Chinese dioecious varieties, Bama 4 and Puma 3 were highest in Ni (4.30 mg/kg) and Cr (4.95 mg/kg), respectively.

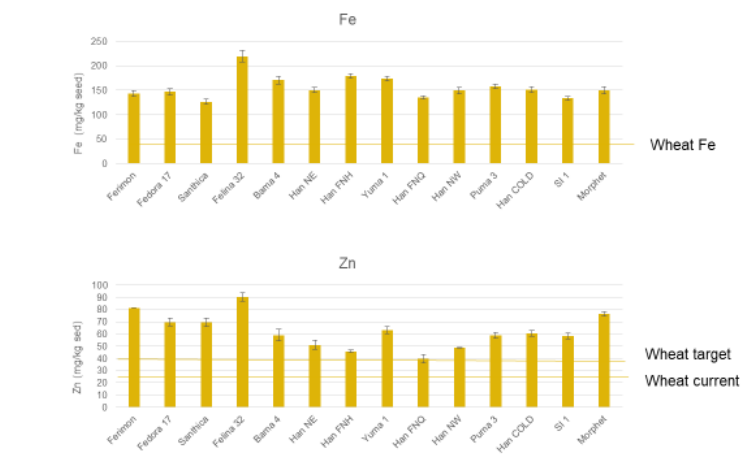
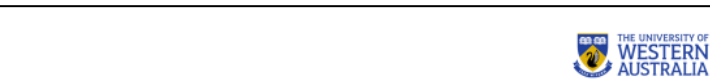
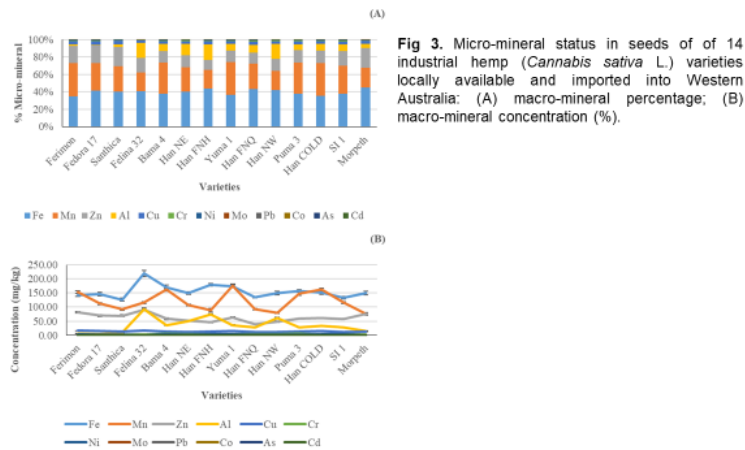
Results



Table 3: Micro-mineral concentration (%) in seeds of 14 industrial hemp (*Cannabis sativa* L.) varieties.

Variety	Concentration (mg/kg)											
	Fe	Mn	Zn	Al	Cu	Cr	Ni	Mo	Pb	Co	As	Cd
Detection Limit (DL)	2.0	0.5	0.5	0.2	0.5	0.2	0.2	0.3	0.3	0.1	0.4	0.1
Ferimon	143.08 cd	153.19 ab	81.21 ab	6.27 fg	16.09 b	2.00 f	4.12 a	0.34 e	<DL	0.16 def	<DL	<DL
Fedora 17	146.56 cd	112.34 cd	69.74 bcd	3.70 g	14.46 cd	2.42 e	2.83 c	0.75 bc	<DL	0.11 f	<DL	<DL
Santhica	126.05 d	92.33 def	69.45 bcd	8.70 fg	13.41 de	1.85 f	1.77 d	0.45 d	<DL	<DL	<DL	<DL
Felina 32	219.49 a	115.92 c	90.24 a	93.00 a	17.61 a	1.45 g	0.73 e	1.07 a	<DL	<DL	<DL	<DL
Bama 4	170.73 bc	162.27 ab	58.98 def	35.81 e	13.20 de	4.94 a	4.30 a	<DL	<DL	0.31 bc	<DL	<DL
Han NE	150.12 bcd	106.85 cde	51.08 efg	49.59 d	10.88 g	3.95 b	1.79 d	0.34 e	<DL	0.13 ef	<DL	<DL
Han FNH	179.14 b	89.14 ef	45.66 fg	73.92 b	13.21 de	3.81 bc	3.21 bc	0.80 b	<DL	0.15 def	<DL	<DL
Yuma 1	173.82 bc	175.55 a	62.95 cde	35.78 e	15.13 bc	3.94 b	4.26 a	<DL	<DL	0.46 a	<DL	<DL
Han FNO	134.88 d	92.16 def	39.73 g	27.34 e	11.15 g	3.99 b	2.71 c	0.78 b	<DL	0.18 def	<DL	<DL
Han NW	149.17 bcd	79.91 f	48.67 efg	61.26 c	11.48 fg	3.47 c	1.82 d	0.67 c	<DL	0.11 f	<DL	<DL
Puma 3	157.48 bcd	147.11 b	58.73 def	28.16 e	14.12 cd	4.95 a	2.57 c	<DL	0.33	0.35 abc	<DL	<DL
Han COLD	151.44 bcd	162.12 ab	60.49 cdef	32.75 e	14.21 cd	2.95 d	4.03 a	<DL	0.37	0.41 ab	<DL	<DL
SI 1	133.22 d	115.82 c	58.31 def	27.61 e	10.70 g	4.16 b	3.83 ab	<DL	<DL	0.27 cd	<DL	<DL
Morpeth	149.60 bcd	76.34 f	76.55 abc	14.94 f	12.75 ef	2.20 ef	0.90 e	0.78 b	<DL	<DL	<DL	<DL
Min	126.05	76.34	39.73	3.70	10.70	1.45	0.73	0.34	<DL	0.11	-	-
Max	219.49	175.55	90.24	93.00	17.61	4.95	4.30	1.07	0.42	0.46	-	-
Mean	156.06	120.07	62.27	35.63	13.46	3.29	2.78	0.66	0.37	0.24	-	-
Sd. Error	5.91	4.23	2.88	1.63	0.22	0.07	0.12	0.01	0.02	-	-	-

Results



Conclusion

- Seeds of the French monoecious variety Felina 32 are rich in dietary mineral concentrations among the 14 industrial hemp varieties used in this study.
- They had highest concentration of four macro-minerals (Ca, P, Mg, Na) and five micro-minerals (Al, Cu, Fe, Mo and Zn) out of the 18 macro- and micro-minerals considered in the study, indicating the nutritional potential of this variety for seed production for human consumption.

Session 6A – Food Value

HEMP IS A SAFE FOOD – USING LABORATORIES TO VALIDATE THE CLAIM

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ABSTRACT

The major points presented at The Conference are discussed below. This will not be a promotional presentation but a generic information guideline for all food manufacturers/processors on their rights and pitfalls when dealing with testing laboratories.

Keywords: Ingredients; disinfection; shelf-life; analyses; reports

WATER QUALITY

Water used in the production of food must meet the Australian Drinking Water Guidelines (ADWG). Town supplied water generally does not require testing. However, rain-water, bore water, river or dam water is required to be tested. Storage tanks are a major concern as all water contains bacteria, including town supplied, and will adhere to the base and walls of a tank and be impervious to direct disinfection of the water. Tanks need to be drained, cleaned and disinfected regularly. The only routinely recommended microbiological analyses specified in the ADWG are a Faecal Coliform Count and an E. coli Count, both are required to have <1 cfu/100mL.

FOOD SURFACE TESTING

The cleaning and disinfection of surfaces that come into contact with food must form part of a food safety plan. Areas such as bowls, benches, storage tubs, large cutting knives, slicing machines and cutting boards must be cleaned and disinfected prior to use. As with any component of a food safety plan this control point must be monitored. Only by performing direct bacterial level testing can a food producer ensure that the documented process is effective. It is not recommended that door handles, walls, floors or any surface presently in use be tested. Only test properly cleaned and disinfected surfaces that come in contact with food. It is best to test these areas just prior to use rather than immediately after cleaning and disinfection.

Testing for total aerobic bacteria (Standard Plate Count) is more useful than testing for any specific food pathogen such as *Salmonella* species or *Listeria* species, or indicator bacteria such as *Escherichia coli*. The Australian Standard AS 1162-2000 "Cleaning and sanitizing dairy factory equipment" specifies that a Standard Plate Count of <6 cfu/cm² by the swab sampling method, and <15 cfu/cm² by the agar contact method, is regarded as an acceptable level to validate the proper cleaning and disinfection of a food contact surface. By using a standard swab an area no larger than 25 cm² (5cm x 5cm) should be tested. The area of a standard swab is approximately 1 cm², it is impossible for a swab of this size to remove the microorganisms from a 100 cm² area and falsely low results are likely to be the result. It is also essential to use a dry swab when testing a wet surface and a moist swab for testing a dry surface.

FOOD SAFETY PROGRAM VALIDATION, SHELF-LIFE DETERMINATIONS

All food businesses are required to have a food safety program. Once this has been completed it has to be validated to prove it is effective in ensuring the provision of safe food. Laboratory testing is required to validate the established food safety program.

To validate a food safety program a set of analyses need to be performed on the final product. These are primarily microbiological analyses as specified in the Food Standards Australia and New Zealand documents "Food Standards Code 1.6.1" and, in the case of hemp food products, the "Compendium of Microbiological Criteria for Food". This later document replaces the previous FSANZ "Guidelines for the microbiological examination of ready to eat foods".

Many food manufacturers will combine the validation of the food safety program with the validation of the shelf life to save analyses costs.

Both a 'Use By' or 'Best Before' shelf life requires validation.

With regards to the "Compendium of Microbiological Criteria for Food" there are three categories of analyses: spoilage organisms, indicator organisms and pathogens. Spoilage organisms are evaluated by the Mesophilic Aerobic Bacteria which is also known as a Standard Plate Count or Plate Count. Indicator organisms include *E. coli* and *Enterobacteriaceae*, however, in Australia *E. coli* is generally only used. The list of food pathogens includes Coagulase positive *staphylococci*, *Clostridium perfringens*, *Bacillus cereus*, *Campylobacter*, *Salmonella*, *Listeria monocytogenes* and *Vibrio parahaemolyticus* (applicable for seafood only). In some hemp food products, such as dried seeds, a Mesophilic Aerobic Bacteria count is not applicable as specified in the Compendium.

The number of times the food needs to be evaluated during the shelf-life and the period of testing is too often solely based on the laboratory advice. This may lead to over testing and high expenses. It is important that you get advice from regulatory bodies before you decide on a validation protocol.

In general, it is not necessary to test for spoilage, indicator and pathogenic microorganisms at every testing episode. It is necessary for all these three groups at the start of any shelf life evaluation for two reasons. Firstly, it validates the food safety program and secondly if there is a fail at the initial round of analysis then the shelf life evaluation can be cancelled.

The next issue is how long to run the shelf life. You should not have the last round of testing performed at the end of the expected shelf life period. It is necessary to perform the final round of testing at approximately 10% - 25% past the end shelf life. At this final testing it is not necessary for spoilage microorganisms to be at an acceptable level, but it is essential that indicator and pathogens are within acceptable limits. Also, by proving that the food is still safe past the stated shelf life you can allow for a degree of temperature abuse of your products that will accelerate microbial growth and also the fact that the general public will often consume a product after its stated shelf life.

The final and often most contentious issue is how many times during the shelf life period it is necessary to test the product and what microorganisms should be evaluated. Obviously testing performed immediately after production and the testing performed at the last round should embrace all three groups of microorganisms. The number of times the product requires testing will vary depending on the shelf life period. In general, for shelf life periods under 10 days it would only be necessary to test three times: Day 0 and final date plus 25% for the full list of microorganisms and at the expected shelf life end for spoilage organisms. For longer periods you may need additional testing rounds, but again these would only be for spoilage and possibly indicator organism.

Some food producers will require Yeast and Mould count as part of the spoilage organism group. Be aware there are no guidelines for result interpretation in any FSANZ document.

The validation of the food safety program will need to be repeated every 6 months to two years depending on the risk of the product and the target consumer. It should also be noted that if you make a significant change to a product recipe then you will need to revalidate the food safety program and the shelf life. Examples:

- Possibly a change of an ingredient supplier
- Addition of a risk ingredient
- A change in the target consumer to a high risk category – infants, elderly or a health care facility

ROUTINE QUALITY CONTROL OF PRODUCTS

Unless specified by a customer, you do not have to have documented laboratory evidence that each batch of product meets the criteria as specified in the applicable FSANZ document. Once you have validated your food safety program it is not necessary to routinely repeat this testing unless you have a significant change to your product recipe. It should also be noted that if you change ingredient suppliers then you need to prove this has not affected the microbiological condition of the product. If this cannot be proven, then a new shelf life validation will have to be performed. It may be necessary to revalidate everyone to two years depending on the risk status of your product or if the target consumer is in a high risk group, e.g. infant food or food specifically designed for the elderly or in a health care facility.

In general, however, analysis of spoilage and possibly indicator microorganisms would suffice as a monitoring tool for ongoing quality assurance.

Allergen testing

Most food allergies are caused by peanuts, tree nuts, milk, eggs, sesame seeds, fish, shellfish, soy, lupin and wheat. The Food Standards Code requires these foods to be declared on labels whenever they are present as ingredients or as components of food additives or processing aids. Laboratory testing for these allergens is often needed to substantiate claims made on labels.

Using a Biological Testing Laboratory

1. Specific analyses

Standard Plate Counts or Mesophilic Aerobic Bacteria Count must be performed by the laboratory by incubating the culture plate for 3 days at 30 °C. This is specifically specified in the FSANZ document. Some laboratories are using a method known as Petrifilm where the cultures are incubated for 2 days at 35 °C or 37 °C. This form of testing is in direct conflict to the FSANZ Food Standards Code and the Compendium of Microbiological Criteria for Food and therefore cannot be used to evaluate this analysis. These two methods are not equivalent and the 2 day @ 35/37 °C version cannot be validated against the 3 day @ 30 °C version. Contact your laboratory service provider and direct them to advise you of the culture incubation details for performing this analysis.

Ensure that E. coli testing results have a minimum detection level of <3 cfu/gram. A result of <10 CFU/gram is useless for ready to eat foods and most foods listed in FSANZ documents where an acceptable result is <3 CFU/gram.

It is important that you know what limits of detection are required for all the analyses you request to be analysed and communicate this to your laboratory service provider.

2. Measurement of Uncertainty

Every measurement is subject to some degree of uncertainty. Measurement uncertainties can come from a variety of sources and usually a combination of more than one. Such uncertainties can be estimated using statistical analysis of numerous sets of duplicate measurements. All NATA accredited laboratories are required to determine the measurement of uncertainty (MU) for quantitative analyses. At this time qualitative analyses such as presence/absence testing e.g. Salmonella/Listeria in 25 grams and *E. coli*/Faecal coliforms presence/absence testing in swabs are not required to have MU estimates.

Measurement uncertainty reflects the range within which the true result lies at a stated level of probability (often 95%). It is different for each laboratory and within the laboratory it is a different value for each type of analysis. However, MU should not differ significantly between laboratories using the same technique for the same analysis.

To explain what MU means presume for a specific test and sample a laboratory reported a *Bacillus cereus* result of 50 CFU/gram and that this result had a MU range of 39 to 64. Basically this means that if that laboratory had tested the same sample for *Bacillus cereus* 100 times, 95 times the result would be somewhere between 39 CFU/gram and 64 CFU/gram. It is important to note that the reported result of 50 CFU/gram is not necessarily the true result, the true result is somewhere between lower MU result and the upper MU result.

Looking at the following table, there are for different results for an analysis where the acceptable limit is 100 CFU/gram. The four results are 210, 110, 90 and 50 CFU/gram.

- a) Result 210 CFU/gram: This is a fail as both the upper and lower MU range (270 & 160) are above the acceptable limit of 100.
- b) Result 50 CFU/gram: This is a pass as both the upper and lower MU range (39 & 64) are below the acceptable limit of 100.
- c) Result 110 CFU/gram: The reported result is above the acceptable limit. However, this cannot be directly interpreted as the upper MU range result (140) is a fail however the lower MU range result (86) is a pass.
- d) Result 90 CFU/gram: The reported result is below the acceptable limit. However, this cannot be directly interpreted as the upper MU range result (120) is a fail however the lower MU range result (70) is a pass.

However, it could be stated that it is more likely that the scenarios where the reported result is above the acceptable limit (110) is more likely to be a fail than the cases where the reported result is below the acceptable limit (90).

It is a requirement in both cases (c) and (d) that the decision be made whether to regard the result as a pass or fail based on a risk analysis.

The factors influencing the risk analysis decision to release a product for a food production company would include:

- How many analyses had the upper MU range above the acceptable limit?
- Do the target consumers include people with decreased immune systems such as under 2-years old, in health care facilities including aged care and hospitals
- What stage of the shelf life the product was at the time of analysis?

It must also be remembered that the interpretive comments on laboratory reports i.e. ticks or crosses, or statements of acceptability must be based on the MU range of the reported result to specifications or compliance limits not the actual reported result. Therefore you should contact

your laboratory in writing advising them that the MU range is to be displayed for all numeric results on every report in a format that is easily interpreted. If the laboratory advises you that they cannot or will not report the MU range directly to you the contact NATA and advise them of this failure to meet your request. NATA contact details are at <https://www.nata.com.au/contact-us/nata-offices>

3. How frequently does laboratory testing need to be performed?

There is no requirement to perform routine batch testing once the food safety program and shelf life have been validated. Some clients may require laboratory reports to be supplied with each purchase. However, minimal testing (usually spoilage bacteria) may alert you to a developing problem.

4. How to evaluate a laboratory

Here are my key points I would recommend when a food producer has to select a laboratory.

- Don't use a laboratory that recommends an analysis when they cannot substantiate it by providing you with the acceptable limits (with a reference).
- Get references from other similar food production customers.
- Make sure the laboratory will assist you with result interpretation.
- Make sure the laboratory has the expertise to assist you with troubleshooting. Will they come on site and visit you?
- Get copies of a sample reports. How easy are they to read and interpret?
- Make sure all reports show the measurement of uncertainty range in a readable format.

REFERENCES

AS 1162-2000 Cleaning and sanitizing dairy factory equipment

FSANZ Compendium of Microbiological Criteria for Food Revised Jan 2018

Australia New Zealand Food Standards Code – Standard 1.6.1 – Microbiological limits in food

Australia New Zealand Food Standards Code – Schedule 27 – Microbiological limits in food

Session 6B – Hurd/Shiv Value

GROWING HEMP IS NOT EASY: GROWING A HEMP CROP FOR HURD

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Same Variety different sowing dates



October 2015

Bob & Susan Doyle

February 2016

What are you growing for

- Every decorticator wants a different product delivered
- Every food processor has different specs on the seed
- Know how to handle your crop before you plant
- Do they want Organic ?
- Do they do chemical residue tests ?

Logistics

- How far away is your processor ?
- Get an offtake before you grow and know all the above
- Know your logistics

What Row spacing for what outcome ? Seed or Fibre ?

Hemp is a easy crop to grow ??????????

- Do not Believe what you read on social media ??????????????????
- Hemp is the hardest crop you will ever wish to grow
- Hemp is a summer crop (long day length) !!!!!
- Hemp seed needs to be dried to 12% within 4 hours from harvest
- Harvest is at 18 to 22% moisture
- Processors pay at 7% moisture
- Hemp is easy to harvest for grain

Rotational crop

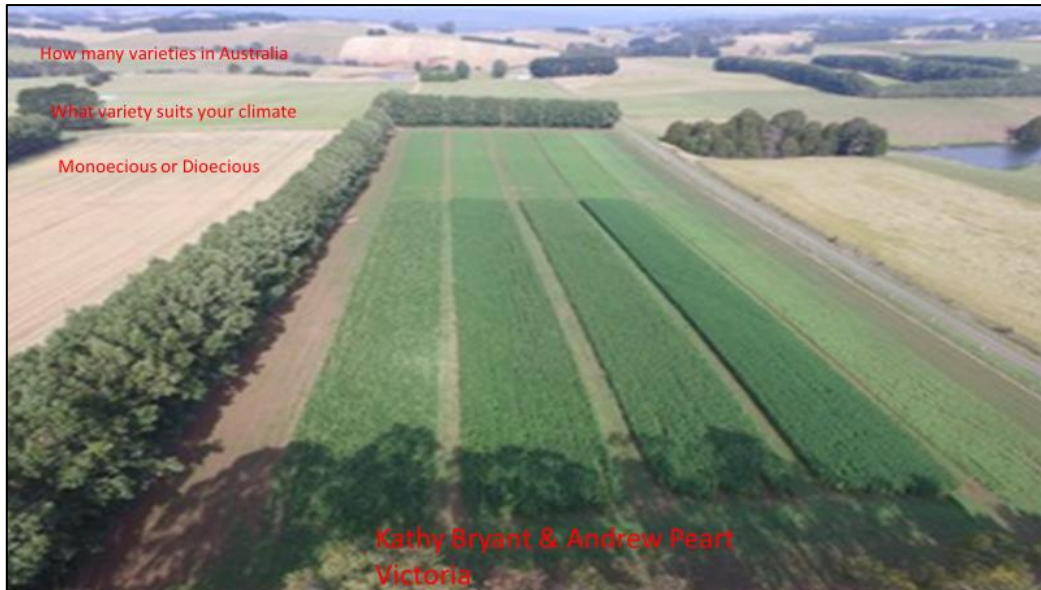
- Hemp is a large user of fertiliser But not a large taker from the soil.
- Hemp is the best rotation crop you will find.
- Do a Germination test before seeding rate
- What are you doing with your crop
- Strange things have happened this year

Growing hemp

- Young seedlings must be kept in moist soil, too much will kill them
- Hemp is a very weak seedling until it gets ground coverage, 30 cm
- Once crop is established you can back off the water
- A large bale of hemp weighs 250 Kg (hay weighs 750 Kg)
- Biomass crops are difficult to cut and handle

Growing a biomass crop

- Hemp is an irrigated crop, it needs water
- A hemp biomass crop will need 400 to 700 mm of water Ha
- Deep rip, some fertiliser deep, into moist soil
- Seed at 10 to 15mm deep



We offer consultancy

- We import 9 varieties of hemp seed from China
- Can import machinery from China
- Have contacts all around Australia and overseas
- 15 years of experience
- Come from a farming background



Colin Steddy
info@thehempcorp.com.au
 0407195340
 Growing the hemp industry together

HEMP HURD IN THE AUSTRALIAN BUILDING MARKET: CHALLENGES AND POTENTIAL ECOLOGICALLY AND ECONOMICALLY SUSTAINABLE PRODUCTION MODELS

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ABSTRACT

Hempcrete building materials are currently the primary product produced from hemp fibre crops in Australia and there is a growing interest from the broader community in the potential for emissions management, through a combination of hemp carbon farming and zero carbon hemp construction. The demand from the emerging housing market is for affordable, Australian, chemical free hurd that ensures not only the health and wellbeing of building occupants, but also of farm workers, hemp processors and builders. These conditions have implications for almost every phase of the crop's management.

Early adopters of hemp construction are conscious consumers with positive environmental outcomes as their objective. Many people who build with hemp and use hemp products, also do so for health reasons. Breathable hemp hurd and lime composite buildings don't harbor moulds and have proven to create excellent indoor air quality, presenting a healthy alternative for chemically sensitive occupants.

The challenges the Australian industry faces however are to produce hurd that is the primary constituent of hemp buildings as an affordable commodity to meet the growing demand and to do so in economically and ecologically sustainable ways, taking into account Australia's population distribution. In the absence of developed bast markets, to date Australian hemp hurd produced from decorticated fibre crops has been close to double the price of imported hurd. Hurd is also a very light and bulky material to transport, so the emissions associated with freight from the farm to the processor and then from the processor to the client, are significant, as is the cost of freight. Neither shipping hemp from overseas nor from one side of Australia to the other is sustainable and the carbon neutrality of buildings produced from materials sourced over such long distances becomes questionable.

With the global demand for hempseed and oil, most Australian hemp farmers have focused on grain production and perhaps the best solution to meeting the demand for hurd to supply the Australian hemp building industry's needs, is to encourage production of late-planted bulkier dual-purpose crops. If these were grown using organic farming methods as is far more common in Europe and if the fibre from grain crops was processed and regionally supplied, the market demand for low carbon footprint, chemical free Australian hurd could be met.

A recent project with farmers in Ashford, NSW has successfully demonstrated that a mobile processing system they have developed and manufactured can cost-effectively process and separate the fibre from bulkier grain stubble into building grade materials. While in general there are greater

dust outputs and slightly lower hurd yields than from bales from fibre crops, grain stubble can be processed for construction materials creating an opportunity for additional returns to Australian hemp seed farmers.

Keywords: Hurd; dual purpose hemp; processing

Who we are



- AHMC has been involved in varietal trials, hemp farming and processing since 1999 in the NSW Hunter Valley, Northern Rivers and Central West where 4-5m high organically farmed hemp crop was produced by lucerne farmers with 1/3 of the water used for lucerne.
- Involved in hemp building materials research since 2000 through involvement with UNSW and now UTS. Strong board with technical expertise and 80+ years experience.
- Manufacturing certified BCA compliant Hemplime building products in Sydney since 2008 – 150+ homes; 3 commercial buildings to date - 2 in Aust, 1 in Singapore. Homes in all Australian states and almost all climate zones. Multiple award winning homes.
- Delivered training to 450 builders, owner builders and building designers in the past 5 years

Our goals



- To manage climate risk, reduce emissions, support carbon farming through facilitating carbon neutral, renewable construction with hemp
- To build with Australian hemp and re-invigorate the Australian manufacturing sector. All but 6 of our homes have been built with Australian hemp. (Currently importing sustainably farmed hemp from Europe to meet a shortfall in Australian hurd supply.)
- To be global leaders in mainstreaming hemp construction, to move it well beyond residential construction and to develop design solutions through which hemp can be used to retrofit existing infrastructure.
- To develop a range of building products that deliver on environmental and social goals as well as address equity.

The potential of hemp lime construction when there is regionally produced fibre



- Above ground carbon sequestration capacity of fibre crops – av. yield 10 - 12 tonnes dry material per ha
 - Small cabin with walls 200mm thick locks up 1 - 2 tonnes hemp (without subfloor or roofing insulation)
- Soil carbon storage - 1 tonne per ha
 - Larger home 4 – 6 tonnes of hemp incl subfloor and roofing insulation.
- GWP (Global warming potential) each kg of hemp stored in buildings averts 1.5 CO₂-e kgs of emissions - the biomass both harvests emissions and averts increased warming.
 - Large commercial buildings can store 500 tonnes of carbon

Challenges to sourcing Australian hurd



- Australia's size, its socio-economic demographic and population distribution
- The absence of developed bast markets
- Australia's farmers are producing hemp grain not fibre crops
- Processing in the past has focused on decortication which requires high levels of investment and results in expensive hurd.

The current hemp building market



- early adopters keen to model renewable construction, support Australian green industry development and Australian manufacturing of low embodied energy products
- people with compromised health who want to live in mould free buildings
- people seeking to reduce the operational energy use of their homes/infrastructure
- Hemp enthusiasts who understand the above

Challenges to mainstreaming hemp building



- Hemp for a carbon neutral hemp building solution needs to be produced regionally and can, and probably needs to be farmed organically
- significant market penetration requires hemp to be readily available at reasonable cost
- we don't yet have a cohesive industry and there is no industry wide uniform messaging
- consistent quality is critical and to compete with established building products we need history, data, transparent processes and builders consistently building to standards.

Long term economic, environmental and social outcomes and opportunities



- Most Australian buildings have a life expectancy of 20 years – hemp is very durable
- Moisture in buildings is the leading cause of building failure
- Moisture in buildings and resultant mould are major contributors to poor health in Australia. 75% of allergies are attributable to moulds
- Currently most Australian building materials are imported and shipped. Shipping is the most polluting form of transport and shipping emissions are one of the least regulated parts of our global transportation system. They account for between 3-4% of global emissions and are predicted by the IMO to increase by 250% by 2050.

The value of regional processing



- Averted carbon footprint from burning the fibre produced from grain crops
- It can give us cost competitiveness with other building materials
- Where we can produce building quality hemp from grain stubble as well as fibre crops, we can increase returns to grain farmers improve economic viability and create the incentive for increased production – more carbon farming
- If farmers can get their fibre to market easily hemp will be farmed in rotations improving land and water use.



Better than zero carbon housing - Hunter Valley NSW

Regional grower group of 13 or 14 hemp farmers. Local processing mill. 4 – 5m industrial hemp biomass crops grown in 90 – 100 days.

Shepherds Ground Ecovillage – Australian Hemp sourced from 40kms away, Australian Binder materials sourced in NSW and manufactured in Sydney



The first 4 completed Hemp homes in Shepherds Ground Ecovillage , Butterwick Hunter Valley NSW. This Share-farming Ecovillage seeks to be a model for sustainable food production and living. Builder: Hannan Build, Dungog

A potential solution – the Ashford Mobile Hemp Processing Unit

- 10 years development phase in NSW central west by hemp farmers who were unable to get a market for their hemp fibre
- Minimal later stage development funding through Jobs NSW funding
- In Nov/Dec 2019 grain stubble from South Queensland was processed by the Ashford processor for 6 homes in Qld and NSW.
- The unit is mobile – it is in a 40ft container, can be transported on a tilt truck and delivers a bagged product.
- Affordable first stage processor that can produce hemp for building and for a range of other products. Est cost – less than \$200,000.
- It will never replace the need for some decorticators but it can give many regional Australian communities the opportunity for value adding.

Why go there? Models from the UK

Adnams Brewery and Distribution Centre, Suffolk (Hemp Technology UK)

Adnams Brewery Hailed as Greenest Warehouse in Britain

2400 sqm Brewery and Distribution Centre

Overhanging eaves and a buffer space at each warehouse entrance, help maintain ambient temperatures inside and prevent excessive heat gains or loss of cold from the warehouse area.

In fact, Adnams, the **first commercial building in the U.K. to be built using lime hemp, requires no refrigeration units at all – a remarkable feat for a beer company.** All refrigeration is accomplished via the natural properties of the structure itself.



Award winning large objects store - London Science Museum

Hemp is highly effective at managing humidity - excellent for storage of historic aircraft, vehicles, artefacts and other archival materials.



Second biggest Marks & Spencer Store in the world

- 148,000 sq ft of selling space over two floors First store to use hemp and lime external wall panels.
- the store loses less than 1° C of heat overnight, compared to 9° C loss in other store environments.
- 42% more energy efficient than their other stores and 40% fewer carbon emissions than an equivalent store.



Social Housing –The Triangle, Swindon (Kevin McLeod)

42 residential hemp dwellings & 6 apartments



Proactive government initiatives and the potential of hemp construction

2009 - 10, UK Government Low Carbon Investment Fund (LCIF) £6.3m invested in constructing 283 low carbon affordable homes built with a range of innovative, highly insulating, renewable materials plus 2 year funded monitoring project of the occupied hemp homes demonstrated that:

•“the insulating properties ... mean that heating plant can be reduced in size, reducing corresponding energy consumption and carbon emissions, in the range between 50% and 80% lower than in buildings with conventional brick and block construction insulated to the same U-value as the hemcrete construction

•The lower energy demand in-use, combined with the negative embodied carbon footprint (carbon sequestration potential) of the hemcrete structure at **-4.3 tonnes CO₂ (compared with +10.7 tonnes CO₂ for brick- block house of same dimensions)**”

<http://www.nfccc.co.uk/publications/report-renewable-hemcrete-house-co-heating-tests>

Australian Hemp Masonry
Company

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Thank you

PHYSICAL PROPERTIES OF AN AUSTRALIAN HEMP FOR HEMPCRETE APPLICATION

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ABSTRACT

The purpose of this study is to determine the key properties of Australian hemp particles which are used for manufacturing hempcrete. Hemp characteristics have a wide variability due to the influence of the environment conditions in various farmed areas. This study focuses on the measurements of the mechanical, thermal and acoustic performances of three Australian hemp: Unretted hemp hurd, retted hemp hurd and hemp fines. Hemp hurd is usually used in non-load bearing building walls, and hemp fine, which is the by-product of hemp manufacturing industry, is usually incorporated into a render.

The experimental results show that the main impact of the retting process is a decrease in bulk density and leading to an improvement in thermal and acoustic properties. Without compaction, the bulk density ranged from 97 and 118.8 kg.m⁻³, the max sound absorption coefficient from 0.88 and 0.99 and the thermal conductivity from 64 to 97 mW.m⁻¹.K⁻¹.



Hemp fines have excellent thermal and acoustic properties and appear to be an efficient aggregate to produce an insulating render. The Australian hemp investigated in this study showed very similar characteristics to European hemp.

Keywords: Hemp concrete; bio-aggregates; thermal performances; acoustic performances; mechanical characteristics

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1 - Introduction

Bio-based material

Hemp crop [Daly et al. 2009] *Hemp stalks [Nguyen, 2010 ; Tran Le et al., 2010]*

1. Introduction

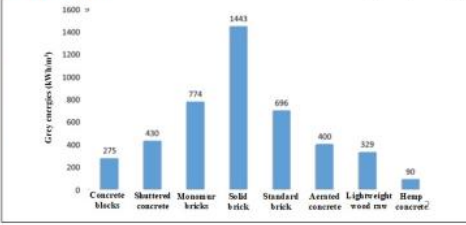
2. Objectives

3. Hemp characterization

4. Hempcrete characterization

5. Conclusions

Grey energies [Tran, 2010]



Material	Grey Energy (kWh/m³)
Concrete blocks	275
Shuttered concrete	430
Masonry bricks	774
Solid brick	1443
Standard brick	696
Arched concrete	400
Lightweight wood m	529
Hemp concrete	90

Hemp + Binder + Water = Hempcrete

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Renewable plant

Lower density

Good acoustics properties



Excellent moisture buffer capacity

Good thermal insulation properties


Improve fire resistance properties

No-load bearing material


Variability of properties


Render



Blocks [Daly et al. 2009]



Spraying



Timber frame

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2 - Objectives



In Europe → Several studies on hemp and hempcrete [Niyigena et al. 2016]

In Australia → Few studies [Gregor 2014]


↓

Main features of different hemp farmed in NSW (Hunter valley)

Influence of the **retting** → Dew retting for 6 weeks

↓

2 binders / 3 different hems → 

↓

Mechanical, thermal, acoustic tests

Hemp

↙ ↘

Hempcrete

4

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3 - Hemp characterization

RILEM recommendations

H-F: hemp fines (short fiber and shiv separated + dust) → Render
 H-S-R: retted smaller chop hemp shiv → Wall application
 H-S-UR: unretted smaller chop hemp shiv

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RILEM TC 236-BBM recommendations [Amziane 2017]

Raw material water content (in the bags)
 ↓
 Dried samples
 Change in mass lower than 0.1 % over 24 h → 60° during 8 days

Bulk density
 → Weighing
 Water absorption (1 min to 48 h)
 → Immersion
 Particle size distribution
 → Sieving methods

Sound absorption coefficient
 → Impedance tube

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Sound absorption

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Impedance tube 100 mm in diameter
 School of Mechanical and Manufacturing Engineering (WAVES)

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RILEM TC 236-BBM recommendations [Amziane 2017]

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Sound absorption coefficient

- Impedance tube
- Thermal conductivity**
- Hot wire

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Thermal conductivity

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Sensor
Diameter = 60 mm

Plastic mould
Diameter = 150 mm
High = 150 mm

Hemp



Transient plane source technique / Hot Disk system
University of Sydney

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RILEM TC 236-BBM recommendations [Amziane 2017]

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Sound absorption coefficient

- Impedance tube
- Thermal conductivity**
- Hot wire

↓

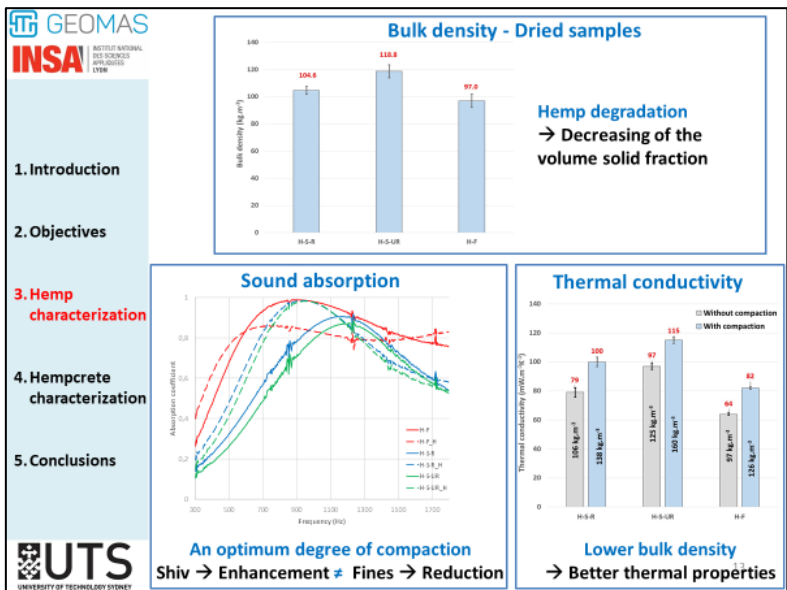
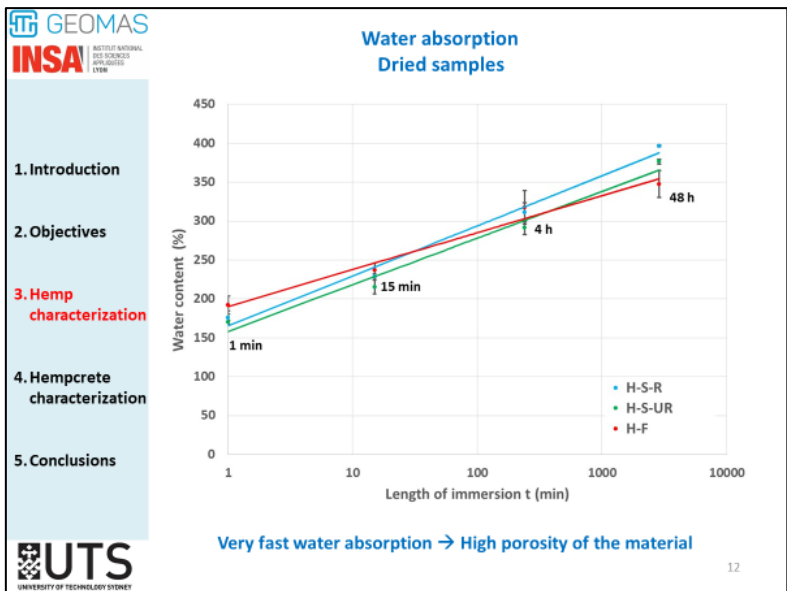
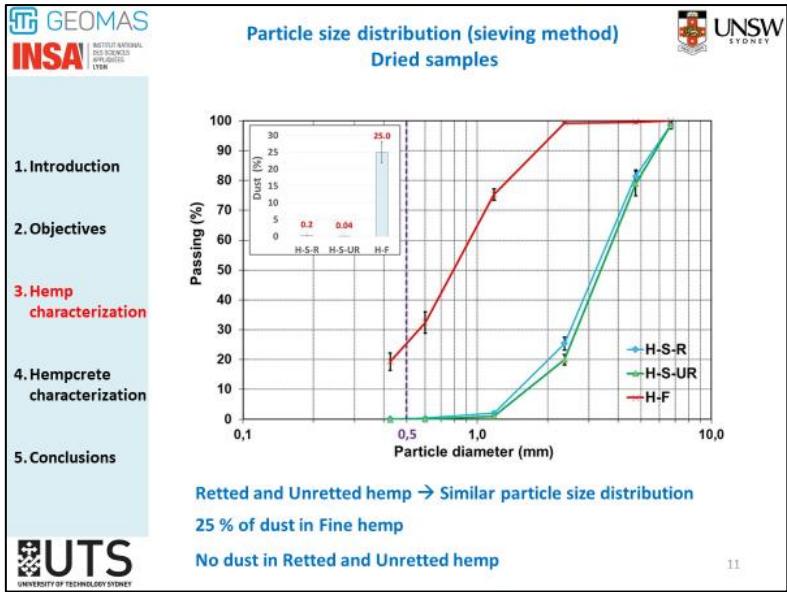
2 bulk densities

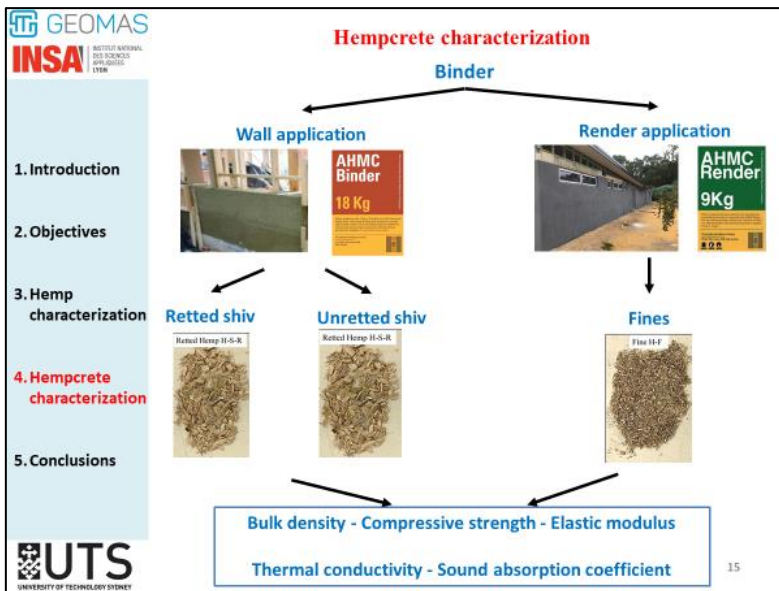
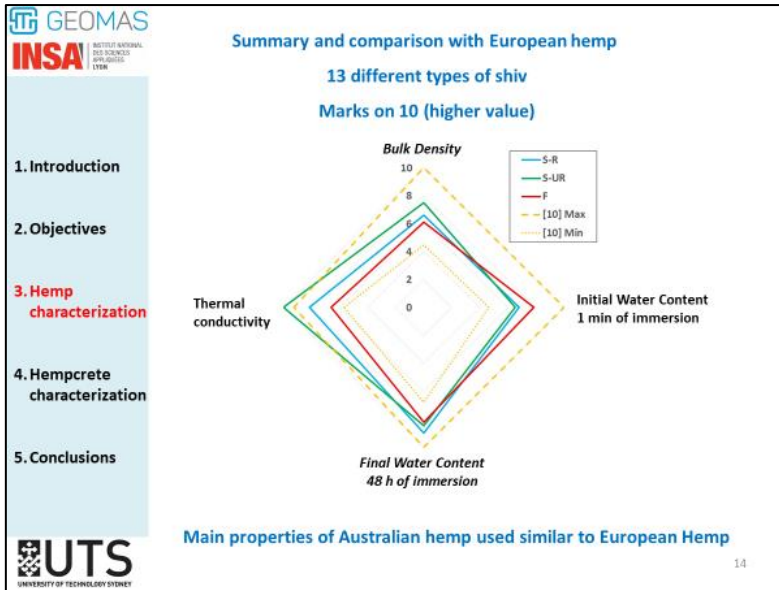
- 30% rise of the bulk density

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GEOMAS INSA SUSTAINABLE MATERIALS FOR CONSTRUCTION

4 - Hempcrete characterization

AHMC binder mix (Retted and Unretted hurd)
B-S-R and B-S-UR mix

Quantity (l)	Hemp hurd (kg)	Binder (kg)	Water/Binder Ratio	Shiv/Binder Ratio
45	5	9	1,11	0,56

AHMC Binder 18 Kg

High ratio

$\div 2.8$

AHMC new render mix (Fine inside the render bag)
R-F mix

Quantity (l)	Hemp fines (kg)	Binder (kg)	Water/Binder Ratio	Hemp/Binder Ratio
10	1.5	7.5	1,07	0,2

AHMC Render 9Kg

Low ratio

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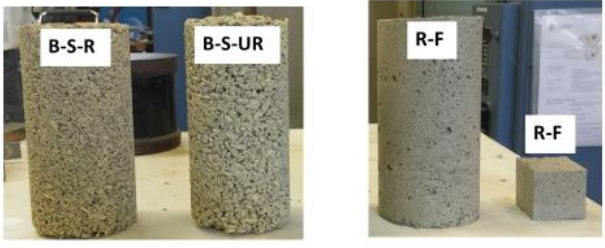
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9 samples
28 days curing

Binder - Shiv
Cylindrical specimens 100 x 200 mm

Render - Fine
Cubic specimens 50x50 mm
Cylindrical specimens 100 x 200 mm

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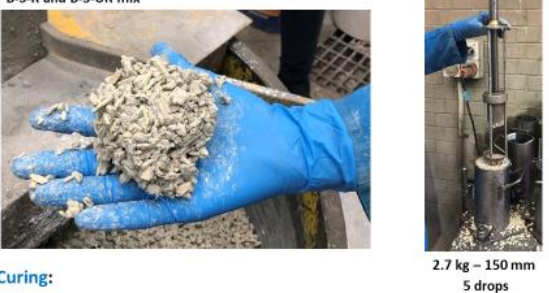
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Placing:

- Binder → 3 layers compacted with a hand soil compactor
- Render → Shacking table

B-S-R and B-S-UR mix



2.7 kg – 150 mm
5 drops

Curing:

- 1 day in the mould
- then inside in the Lab → between 15 and 25°C - 60 % RH

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Bulk density - 28 days




Specimen	Bulk density (kg/m³)
B-S-R	348.7
B-S-UR	368.3
R-F	745.9

Compressive strength - 28 days



Specimen	Compressive strength (MPa)
B-S-R	0.16
B-S-UR	0.15
R-F	1.85

Elastic modulus - 28 days



Specimen	Elastic modulus (MPa)
B-S-R	40.54
B-S-UR	54.16
R-F	575.50

Retting → No influence
Mechanical properties → Hemp/binder ratio

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Cutting samples – 28 days

Sound absorption

Thermal conductivity

B-S-R samples

Retting → No influence
Thermal and acoustic properties → Hemp/binder ratio - Porosity

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5 – Conclusions

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Tested hemp → Similar acoustic, thermal and mechanical properties
Retting process → Decrease of the bulk density

Further researches
Structural applications → Insulation panels, blocks
Compaction process and structural behaviour
Minimise the carbon footprint → Binder
Geopolymers

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Australian Industrial Hemp Conference – 25-28 February 2020 – Perth, Australia

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THE AUSTRALIAN HEMP MASONRY COMPANY

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IT DRAWS CARBON FROM THE AIR AND IS AN INSULATOR AND IS AS HARD AS ROCK?

STEM CELL RESEARCH LAB

WHY ARE WE NOT FUNDING THIS?

A STUDY OF MICROSTRUCTURE AND INTERFACIAL INTERACTIONS IN HEMPCRETE

Xupei Yao, Kwesi Sagoe-Crentsil* and Wenhui Duan*

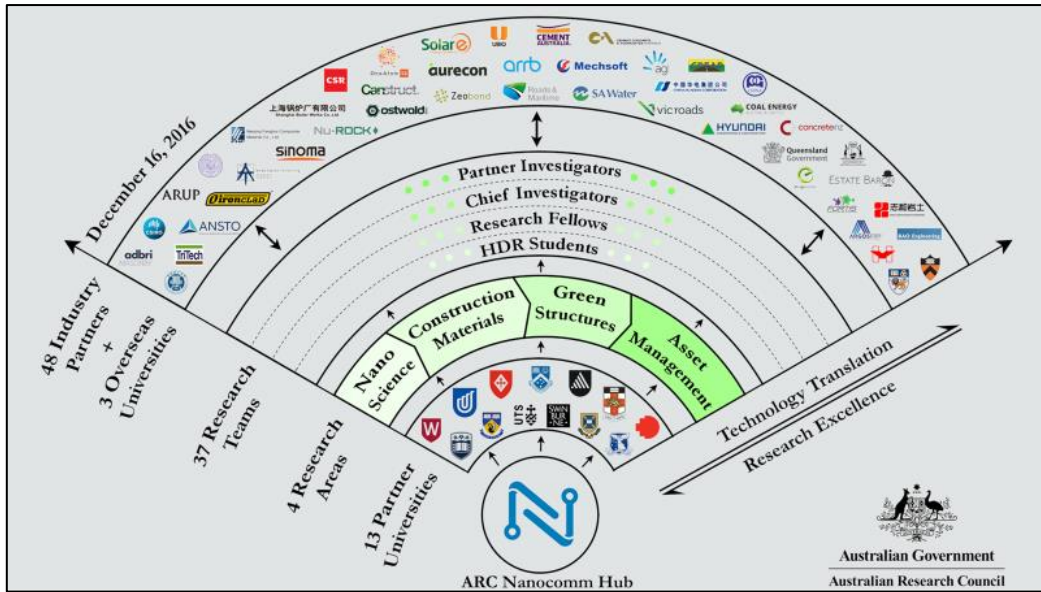
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ABSTRACT

Concrete construction incorporating hemp shiv as aggregate substitute in hydraulic and non-hydraulic binders is rapidly emerging as a commercially viable and environmentally sustainable practice. However, to accelerate constructability and diversify building products derived from hemp shiv concrete hinges on the development of comprehensive performance and durability data to assist product specification. In this study, we evaluate chemical and physical interactions between hemp shiv and binder matrices. The key object is to gain fundamental understanding of factors governing product performance to deliver improved mixture design leveraging mechanical, light-weighting and acoustic characteristics of hemp shiv. Scanning electron microscope (SEM) was used to analyze microstructures of different phases in hempcrete, including the interface between shiv and lime matrices. Furthermore, the development of chemical phases were examined by conventional methods including Energy Dispersive X-Ray Spectroscopy (EDX), to provide insight into long-term phase stability and durability performance. Results obtained reveal processes of microstructure evolution of hemp shiv concrete in both plastic and hardened states enabling a clearer understanding of underlying mechanisms controlling product performance, particularly, strength development, drying shrinkage and moisture permeability.

Keywords: hempcrete; carbon negative; mechanical properties; durability; green construction material



Manipulating Interface

2D nanosheets tailoring fibrecement interface

MAIN CONTRIBUTION

Graphene oxide (GO) nanosheets tailoring the interface between cement and carbon fiber (CF) fibers. The tailoring mechanism involves the GO nanosheets acting as a bridge between the two materials, improving the interfacial bonding and mechanical performance of the composite.

RESULTS

The tailoring mechanism involves the GO nanosheets acting as a bridge between the two materials, improving the interfacial bonding and mechanical performance of the composite.

CONCLUSION

The tailoring mechanism involves the GO nanosheets acting as a bridge between the two materials, improving the interfacial bonding and mechanical performance of the composite.

TEAM

ARC Nanocomm Hub, ANSTO, and various international partners.

AI in Concrete

Spatial Distribution of Pores in GO-cement Composite, Analyzed by Radial Distribution Function

Graphene Oxide (GO) nanosheet is found to be the ideal additive to improve the engineering performance of cementitious material. Understanding the effect of GO on pore structure of cementitious materials provides essential information for the study of GO-cement composite. A novel Radial Distribution Function (RDF) based method is applied to study the effect of Graphene oxide on the spatial pore distribution of cement paste. The effect of GO on pore structure of cementitious materials is investigated in detail.

MAIN CHALLENGES

- Analysis of pore structure of cementitious materials is a complex task.
- Traditional methods are limited in their ability to analyze the spatial distribution of pores.

EXPERIMENTS

Micro-CT scanning of GO-cement composite.

CONCLUSION

The RDF method is a powerful tool for analyzing the spatial distribution of pores in cementitious materials.

TEAM

ARC Nanocomm Hub, ANSTO, and various international partners.

Nanoscience

Protection in Underground

Developing An Innovative Protective Structure on A Continuous Miner (CM) against Coal Burst Hazards

Coal or rock burst is a sudden and violent failure of coal or rock as a result of dynamic loading in underground coal mines. These dynamic hazards can lead to damage to mining systems and devastating harm to mine workers. Recently coal and rock burst incidents have occurred in Australian underground coal mines, resulting in two fatalities in an underground development gaitway using continuous miner (CM). There is a need to develop an effective protective structure on the CM to limit the loss of labour for workers working on the CM.

ENERGY RELEASE OF COAL BURST

Characterization of coal burst energy release and its relationship to the development of an innovative protective structure that can be installed on the CM to limit the loss of labour for workers working on the CM.

TEST AND DESIGN OF A PROTECTIVE STRUCTURE

Development of a protective structure that can be installed on the CM to limit the loss of labour for workers working on the CM.

CONCLUSION

The protective structure is designed to limit the loss of labour for workers working on the CM.

TEAM

ARC Nanocomm Hub, ANSTO, and various international partners.

Pavement Roughness

Next Generation Robotic Transverse Profiler

BACKGROUND

Current methods for measuring pavement roughness are labor-intensive and prone to human error.

DATA ACQUISITION

The proposed system uses a laser and ultrasonic sensors to measure pavement roughness.

PRACTICALITY

- Compact and portable
- Easy to use
- Low cost
- High accuracy
- Robust
- Easy to maintain
- Operational in all weather conditions

POSITIONING & CONTROL

Real-time monitoring and control of the profiler.

TEAM

ARC Nanocomm Hub, ANSTO, and various international partners.

System and asset management

R&D Focus

Investigating microstructure of Hempcrete:

- Fundamental science underpinning constituent interactions in Hempcrete
- Identifying fundamental parameters that control Hempcrete performance
- Engineered Hempcrete products

Target Hempcrete functionalities:

- Assess critical performance indices of Hempcrete ie mechanical and durability performance
- Hempcrete mix design and rheology
- Unit cost reduction and binder specification
- Research directions to widen product scope and application
- Specification for designing with Hempcrete and compliance



Table of Contents

Introduction

Experiment design

Interactions in Hempcrete

- Microstructure analysis
- Compressive strength

Benchmarks of Hempcrete

- Merits and demerits
- Potential advanced binders in Hempcrete

Conclusion



Background



Hemp



Hempcrete-based block



Hempcrete-based construction



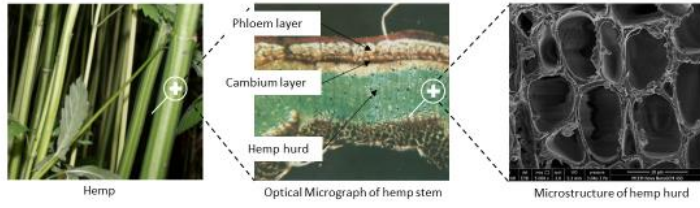
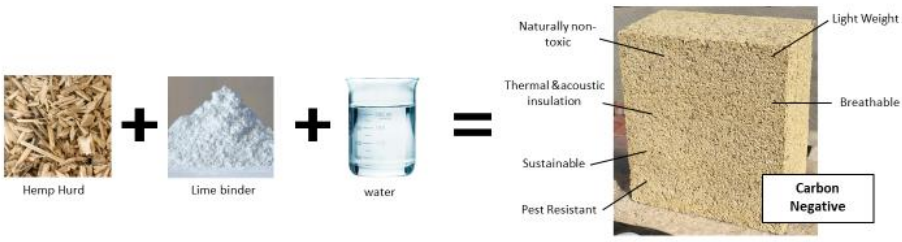
Hempcrete-based wall

Hempcrete:

- Composites of hemp hurds and lime
- Building block
- Wall system
- Wide potential application

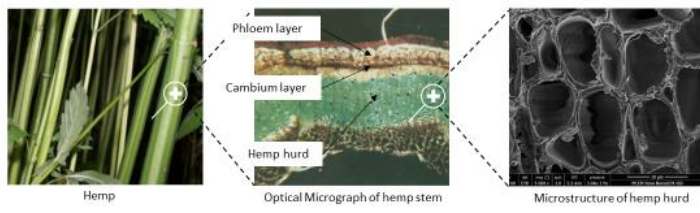
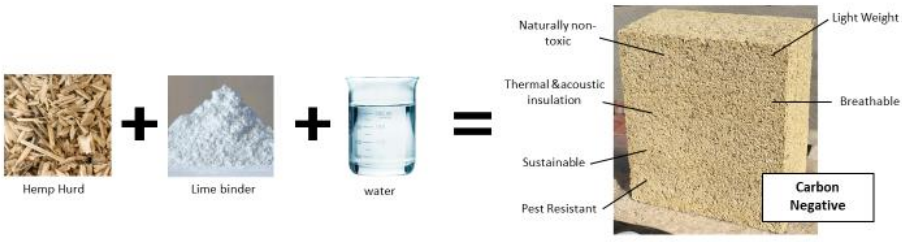


Introduction



- Limited understanding of microstructure
- Unclear interaction between hemp and binder

Introduction



- Limited understanding of microstructure
- Unclear interaction between hemp and binder

Experimental

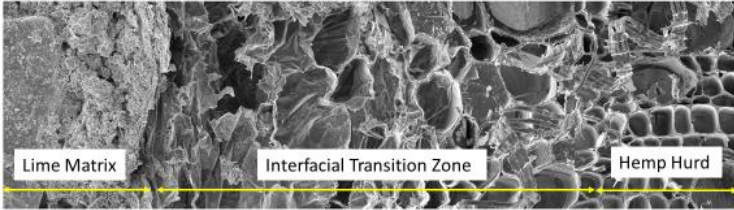


Compressive strength test

Microstructure Analysis

Interfacial Transition zone in Hempcrete

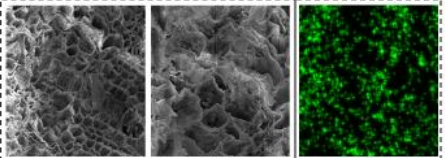
MONASH University nanocomm



Interfacial transition zone:

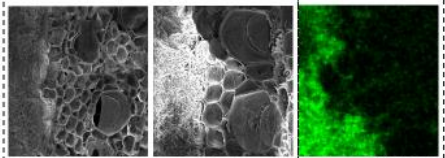
- Transferring load between aggregate and matrix
- Dominating the mechanical performance
- Influencing the transport properties and durability

Microstructure of the cross section of fully hydrated Hempcrete



Microstructure of ITZ Ca element distribution

ITZ in cement/hemp composites(7 days)

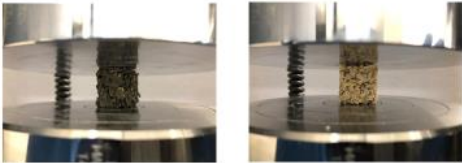


Microstructure of ITZ Ca element distribution

ITZ in lime/hemp composites (7 days)

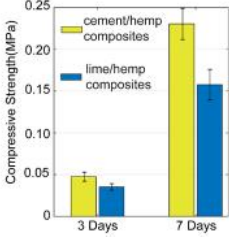
Mechanical property of Hemp-based composites

MONASH University nanocomm



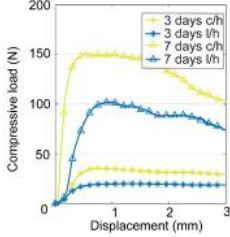
Improved compressive strength with cement binder:

- Cement slurry penetrates hemp hurd
- Strong chemical interactions with hemp hurd due to cement hydration
- Densified ITZ improves load transfer efficiency



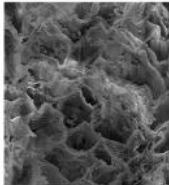
Compressive Strength (MPa)

3 Days 7 Days

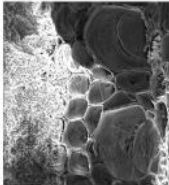


Compressive load (N)

Displacement (mm)



Dense ITZ between cement/hemp



Porous ITZ between lime/hemp

Quantification of the influence of ITZ

MONASH University nanocomm

Correlation between Shear modulus (E) and ITZ (H_{ITZ})

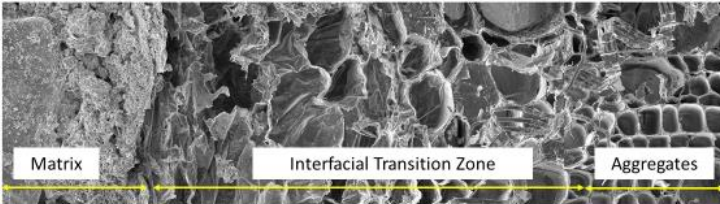
$$\frac{E_{bulk}}{E_{matrix}} = 1 - \left(\frac{E_{matrix} + \frac{4}{3} G_{matrix} H_{ITZ}}{R_a^3 H_a} \right) c + O(c^2)$$

- G_{matrix} : Coefficient of matrix
- H_a : Coefficient of aggregates
- R_a : Aggregates Radius
- c : Volume fraction of aggregates

Correlation between diffusivity (σ) and ITZ (H_{ITZ})

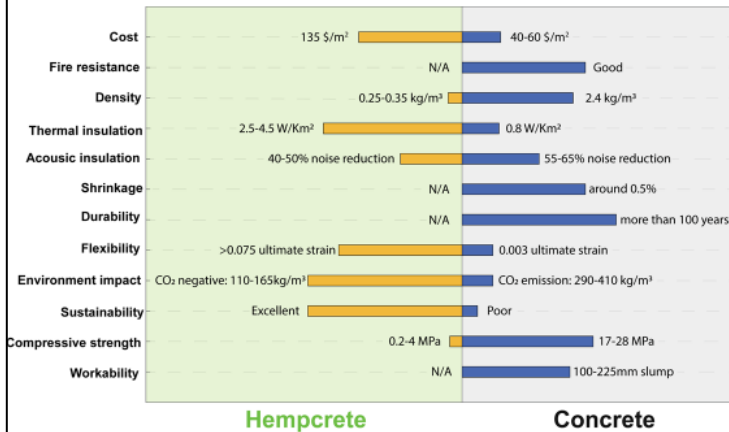
$$\frac{\sigma_{bulk}}{\sigma_{matrix}} = 1 + \left(\frac{3H_{ITZ}}{R_a^3 H_a} \right) c + O(c^2)$$

- H_a : Coefficient of aggregates
- R_a : Aggregates Radius
- c : Volume fraction of aggregates



[Garboczi and Bentz 1997]

Benchmarks of Hempcrete and concrete



Standards for concrete testing:

- ASTM-C143 (Workability)
- ASTM-C1608-17(Shrinkage)
- ASTM-C138 (Density)
- ASTM-C512(Creeping)
- ASTM-C873(Compressive strength)
- ASTM-C191-19 (Setting time)
-

Lack of standards for Hempcrete

Potential advanced binders for Hempcrete

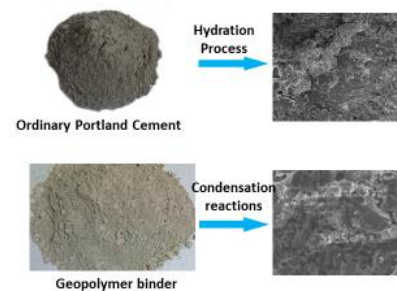


Advanced Binders

- Higher Strength and durability
- Controllable Setting time

Understanding the fundamental interaction:

- Tailored functionality and performance



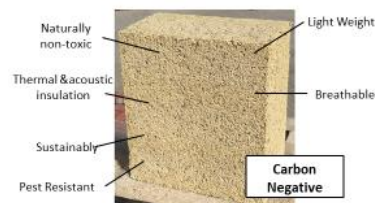
Conclusions

Hempcrete:

- Great potential for wide application
- Sustainable and environmental-friendly
- Initial stage in research and application

Challenges of Hempcrete:

- Lack of standards for testing and mixing
- Fire/Acoustic/Thermal rating
- Low mechanical performance/Drying Shrinkage
- Unclear properties for construction design
- Shotcrete/Panels – Construction speed/efficiency
- Architectural Design - Sustainable buildings
- Australian Standards/Guidelines
- Insulation/Particleboard(MDF)



**ASSESSMENT OF AUSTRALIAN HEMP HURD RESIDUE (*CANNABIS SATIVA L.*)
FOR THE PRODUCTION OF ENVIRONMENTALLY
FRIENDLY LIGHTWEIGHT BIOCOMPOSITES**

Johannes Fehrmann

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500 Yarra Boulevard,
Richmond, VIC

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ABSTRACT

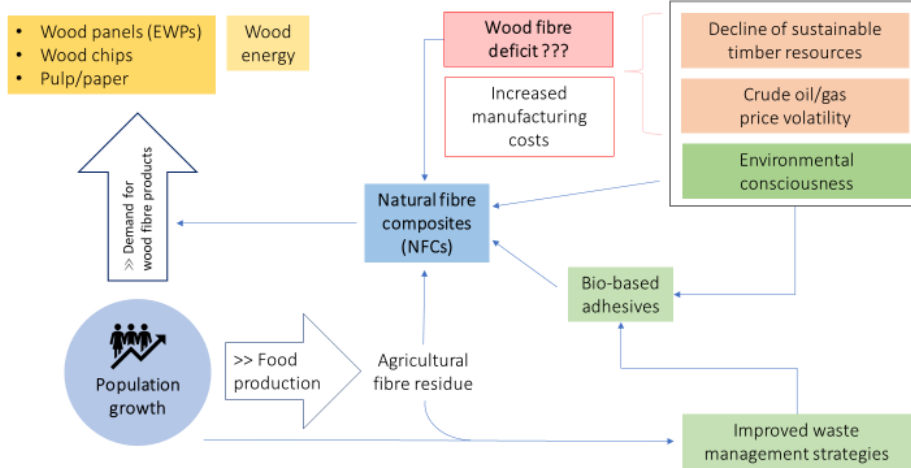
A decline in the availability of sustainable timber fibres has led to concerns about future supply shortages and drives research into alternative lignocellulosic fibres for novel building materials and natural fibre composites (NFCs). Australia's emerging hemp industry focusses predominantly on grain production which renders the remainder of the stem a by-product with opportunities for further value-adding. Fibres from the stems' xylemic inner core (hurd) are attractive as a result of their chemical resemblance to wood, inherent low density, and favourable environmental characteristics. The first objective of this study characterises the hemp hurd particles (furnish) using particle size distribution and granulometry measurements via digital image analysis. Objective two assess the interfacial bonding capacity of selected particle combinations and three different adhesive systems. Objective three investigates a satisfactory minimum adhesive ratio where performance criteria are met, and nonessential adhesive is avoided. A selection of mechanical and physical property tests will be performed with test specimens of hemp hurd composites (HHCs) following AS/NZS 4266.1:2017 Reconstituted wood-based panels – Methods of testing – Part 1: Base panels. Single-layer, low-density (<300 kg/m³) homogenous and mixed HHCs are manufactured targeting a thickness of 12 mm. These HHCs comprise variations of three particle size categories (coarse: >2–4 mm, medium: >1–2 mm and fine: >0.6–1 mm) at two different compaction ratios (x2.0 and x2.5) and two adhesive ratios (high/low). A methylene diphenyl diisocyanate adhesive (MDI), a Bio-Epoxy system and a phenolic resorcinol formaldehyde (PRF) adhesive were selected for their ability to cure at room temperature (cold-setting) and improved resistance to moisture. The adhesives are formaldehyde-free (MDI, Bio-Epoxy) or suitable for structural use (exterior) with waterproof bonds that do not release formaldehyde (PRF). Results will identify permissible adhesive ratios, favourable particle size combinations and compaction ratios related to performance characteristics. The findings of the study will provide insight into possible applications and products manufactured from hemp hurd, e.g. core layer for a lightweight sandwich or structural insulated panel and inform choices for further investigation.

Keywords: Hemp hurd; lightweight composites; mechanical properties; waste valorisation; cold-setting adhesives

1. BACKGROUND



1. BACKGROUND



1. BACKGROUND

Emerging hemp industry in Australia focusses on grain production

- Hemp seeds/oil for human consumption
- Value adding potential for residual biomass
- Hurd/fibre crop



https://www.yendocompany.com/bio-media/cannabiprodukt/bacta/980d811440c14293460c27076a100c07/organic_cannabis_hemp_seed.jpg
<https://www.remedynatural.com/files/content/uploads/2018/08/Cannabis-activa-1-768x1192.jpg>

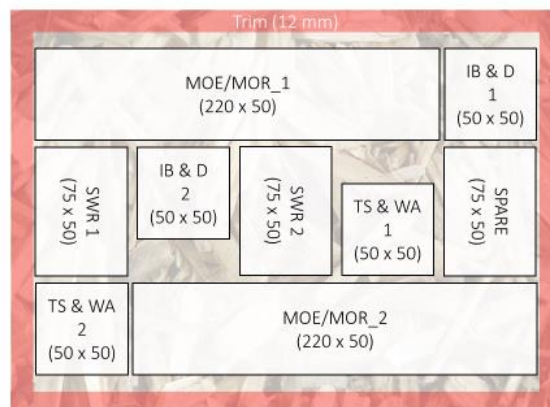
- Aim:** Develop lightweight panels manufactured with hemp hurd and evaluate their performance characteristics
- Objective 1:** Characterise ground hemp hurd using granulometry measurements (digital image analysis)
- Objective 2:** Assess interfacial bonding capacity of manufactured panels
- Objective 3:** Identify optimal adhesive application, pressing parameters, and panel compositions

Methodology

Testing to Australian particle board standard *AS/NZS 4266.1:2017*

- Bending strength/stiffness (MOR/MOE)
- Internal bond strength (IB) and Density (D)
- Screw withdrawal strength (SWR)
- Water absorption (WA) and Thickness swelling (TS)

Cutting pattern



Study design

Factors						Unique panels	Replicates
Panel configuration				Adhesive type			
	Coarse > 2.0 - 4.0 mm	Medium > 1.0 - 2.0 mm	Fine > 0.6 - 1.0 mm	Type	Bio-Epoxy, PRF, MDI		
1	100%	-	-	homogeneous	Compaction rate		
2	-	100%	-	homogeneous	250%	200%	
3	50%	50%	-	mixed	Adhesive loading		
4	25%	50%	25%	mixed	high*	low	

*quantity conditional to adhesive type

Progress overview

Industry contribution



Hemp hurd
(chipped)



Phenol resorcinol formaldehyde adhesive (PRF)



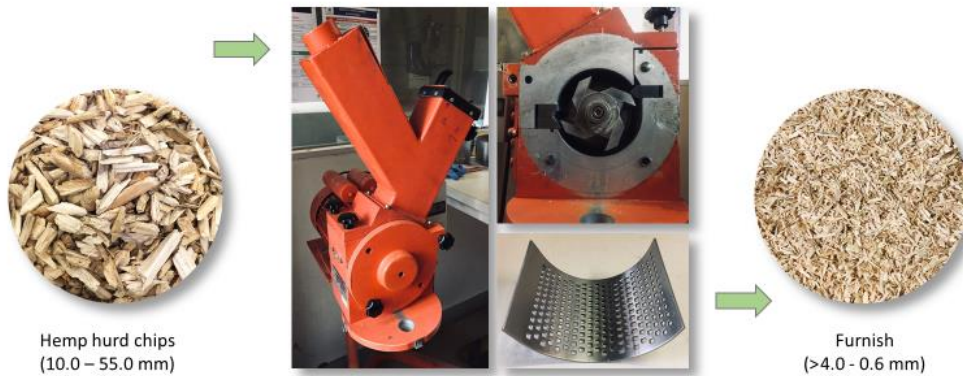
Bio-Epoxy adhesive



Methylene diphenyl diisocyanate adhesive (MDI)

- Improved resistance to moisture (stable)
- Ability to cure at room temperature (cold setting)
- Formaldehyde-free (Epoxy, MDI) or not releasing formaldehyde (PRF)

Hemp hurd milling

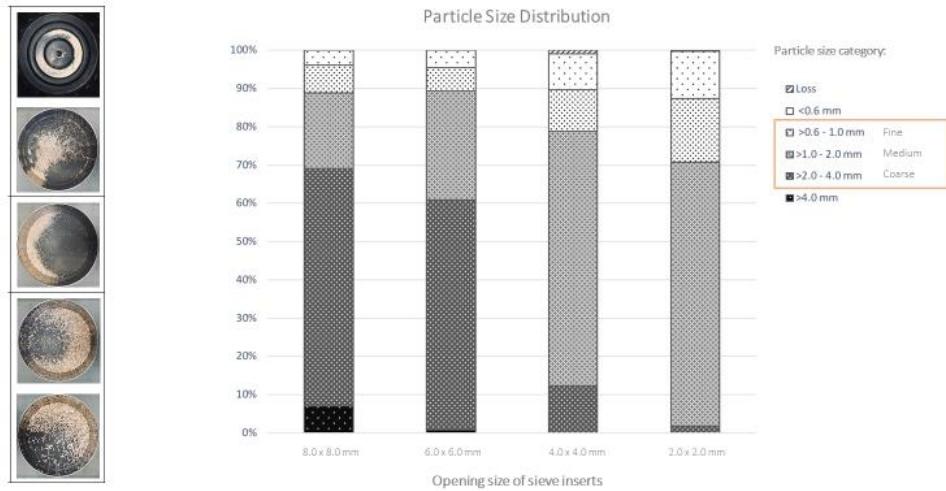


Granulometry analysis

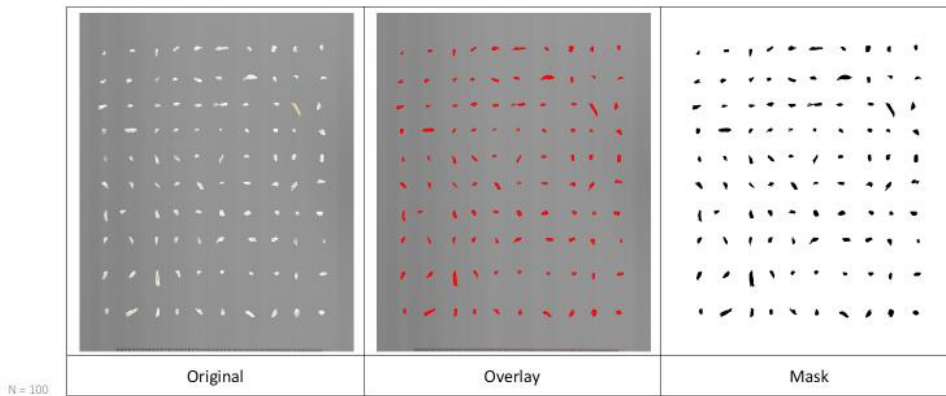
Mechanical screening



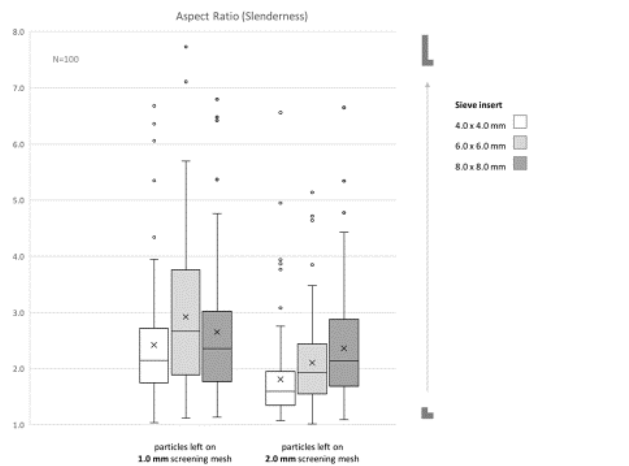
>4.0 mm	>2.0 – 4.0 mm	>1.0 – 2.0 mm	>0.6 – 1.0 mm	<0.6 mm



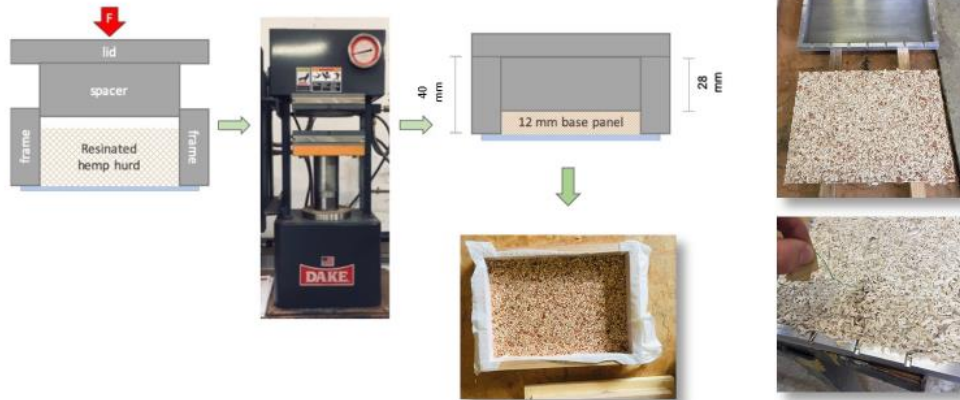
Particle geometry - Digital image analysis



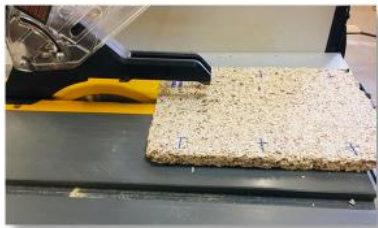
Particle geometry
Aspect ratio/Slenderness



Prototype panel manufacturing



Specimens preparation



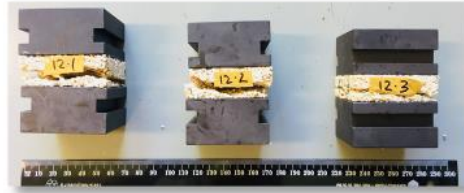
- PRF C_2.5_10%
- PRF C_2.5_20%
- PRF C_2.5_40%
- EPX C_2.5_40%



Preliminary testing: Pull-off (Adhesion)



Preliminary testing: Internal bond strength



4. FUTURE WORK

4. Future work

1. Preliminary trial

Complete technical preparation with MDI adhesive

2. Main trial

Manufacture hurd composite panels based on results of preliminary trials

3. Specimen preparation and testing → data analysis → thesis

- insight into possible applications and potential products
- inform choices for further investigation

5. REFERENCES

5. References

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2. Sadrmanesh, V. and Y. Chen, *Bast fibres: structure, processing, properties, and applications*. International Materials Reviews, 2018: p. 1-26.
3. Jami, T., D. Rawtani, and Y.K. Agrawal, *Hemp concrete: carbon-negative construction*. Emerging Materials Research, 2016. 5(2): p. 240-247.
4. Schöpfer, C., A. Kharazipour, and C. Bohn, *Production of innovative hemp based three-layered particleboards with reduced raw densities and low formaldehyde emissions*. Vol. 36. 2009.
5. Sam-Brew, S. and G.D. Smith, *Flax Shive and Hemp Hurd Residues as Alternative Raw Material for Particleboard Production*. BioResources, 2017. 12(3): p. 5715-5735.

Thank you

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Material support

Mr. Darren Christie
(Australian Hemp Manufacturing Company)



Session 7A – Health Value

LICENSING AND REGULATION OF HEMP FARMING AND PROCESSING IN AUSTRALIA

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Richmond, VIC

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ABSTRACT

Cannabis sativa L is one of the earliest cultivated plants documented in human written and archaeological history, highly valued for its fiber, food and medicinal components. Despite these benefits, legal cultivation throughout much of the world practically ceased in the mid-20th century. However, recently established regulatory schemes are now enabling Cannabis cultivation and processing, encouraging the re-emergence of Cannabis-based industries.

In Australia, Cannabis cultivation and processing is regulated at both Federal and State/Territory levels of government. These regulations control medicinal Cannabis crops Federally via the Office of Drug Control while food, fiber and cosmetic crops are regulated by State/Territory departments of agriculture.

While it may be the same species of plant cultivated under both industrial hemp and medicinal Cannabis licenses, it is the tetrahydrocannabinol (THC) content of the Cannabis variety and the intended use of the crop that defines which type of license must be held by farmers. Furthermore, cannabinoids are scheduled medicines and state-regulated standards for their availability and control also influence Cannabis cultivation and dealings with derived products.

While regulations aim to categorise Cannabis cultivation and crop uses as either industrial or medical, the practical and commercial application of these regulations is not always clear. For example, there may be activities, materials and products with commercial value that may be targeted under both licensing schemes. Leading to further confusion, international jurisdictions have taken different approaches when regulating hemp and medicinal cannabis cultivation and processing into products.

My presentation will outline the regulatory environment and licensing processes for Cannabis cultivation in Australia, highlighting similarities and differences between industrial hemp and medicinal Cannabis activities. I will use a range of Cannabis products as examples to discuss how licensing and regulations influence production processes.

Keywords: Hemp; cannabis; regulation; license; legislation

Licensing and regulation of hemp farming and processing in Australia

Matthew Hayes, PhD.

Outline:

1. Cannabis regulation in Australia.
2. Drugs scheduling of Cannabis in Australia.
3. Low-THC (hemp) licencing in Australia.
4. Regulation of low-THC (hemp) products in Australia.



United Nations Office on Drugs & Crime (UNODC) administers the Single Convention on Narcotic Drugs (1961)

- 186 signatories world-wide, including Australia.
- Articles 23 & 28 regulate production & supply of narcotic drugs (opium, Cannabis) & limit to research & medical applications.
- In Article 28 Cannabis cultivation is excluded from regulation when grown for fibre & food.
- Article 28 exclusion is for non-therapeutic purposes where narcotic substances are in low concentration.



The Narcotic Drugs Act (1967) enables Australia to meet its obligations to the UNODC

- Office of Drug Control (ODC) oversees licencing & measures to control narcotics supply in line with national demand for medicinal and research purposes.
- SUSMP: Standard for the Uniform Scheduling of Medicines and Poisons, including Cannabis.
- SUSMP implemented via state legislation with some state-state variations.
- SUSMP traps Cannabis & derived metabolites, therefore limits dealings with Cannabis materials.
- (Amendments to Narcotics Drugs Act and Therapeutic Goods Act enabled Medicinal Cannabis regulation in Australia).



Scheduling of Cannabis and Cannabis-derived metabolites

Schedule 1	Not currently in use
Schedule 2	Pharmacy Medicine
Schedule 3	Pharmacist Only Medicine
Schedule 4	Prescription Only Medicine OR Prescription Animal Remedy
Schedule 5	Caution
Schedule 6	Poison
Schedule 7	Dangerous Poison
Schedule 8	Controlled Drug
Schedule 9	Prohibited Substance
Schedule 10	Prohibited substance of significant danger to health as to warrant prohibition of sale, supply and use.

Schedule 4
 Cannabidiol (CBD) preparations for human use with < 1% THC.
 > 75 mg/kg / 75 ppm but with < 1% THC



Scheduling of Cannabis and Cannabis-derived metabolites

Schedule 1	Not currently in use
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Schedule 8	Controlled Drug
Schedule 9	Prohibited Substance
Schedule 10	Prohibited substance of significant danger to health as to warrant prohibition of sale, supply and use.

Schedule 8
 Cannabis plant parts, extracts and tetrahydrocannabinols.

- Cultivated, produced or manufactured in accordance with the Narcotic Drugs Act 1967. ie. Medicinal Cannabis licence.
- Imported in accordance with Customs (Prohibited Imports) Regulations 1956. ie. Licence to import controlled substances.



Scheduling of Cannabis and Cannabis-derived metabolites

Schedule 1	Not currently in use
Schedule 2	Pharmacy Medicine
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Schedule 4	Prescription Only Medicine OR Prescription Animal Remedy
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Schedule 7	Dangerous Poison
Schedule 8	Controlled Drug
Schedule 9	Prohibited Substance
Schedule 10	Prohibited substance of significant danger to health as to warrant prohibition of sale, supply and use.

Schedule 9
 Cannabis, except where specified in other schedules.

- Without a licence, this is where your material would be scheduled.



Scheduling of Cannabis and Cannabis-derived metabolites

Scheduling limits and exceptions

- Tetrahydrocannabinols: 50 mg/kg / 50 ppm / 0.005%.
- Cannabidiol: 75 mg/kg / 75 ppm / 0.0075%.
- Unviable hemp seed & parts, hemp seed oil, subject to above limits.
- Processed hemp fibre with < 0.1% THC.

To conduct activities with materials above these limits, licencing is required:

Medicinal Cannabis Licence:

- \$10K application fee
- \$30K annual fee
- 12-24 month wait for licence and permit.
- High security requirements & regulatory burden.



Scheduling of Cannabis and Cannabis-derived metabolites

Scheduling limits and exceptions

- Tetrahydrocannabinols: 50 mg/kg / 50 ppm / 0.005%.
- Cannabidiol: 75 mg/kg / 75 ppm / 0.0075%.
- Unviable hemp seed & parts, hemp seed oil, subject to above limits.
- Processed hemp fibre with < 0.1% THC.

To conduct activities with materials above these limits, licencing is required:

Low-THC or Industrial Hemp Licence:

- \$0-1100 application fee
- \$200-\$2000 annual costs
- ~3 month wait for licence.
- Relatively straight-forward security & record-keeping requirements.



Scheduling of Cannabis and Cannabis-derived metabolites

Scheduling limits and exceptions

- Tetrahydrocannabinols: 50 mg/kg / 50 ppm / 0.0050%.
- Cannabidiol: 75 mg/kg / 75 ppm / 0.0075%.
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- Processed hemp fibre with < 0.1% THC.

To conduct activities with materials above these limits, licencing is required:

Other licences:

State Poisons licence to store & distribute scheduled drugs.

- Security & record-keeping requirements depend on the schedule of substance.
- Schedule 8 substances require vault and access control procedures.
- Annual renewal.

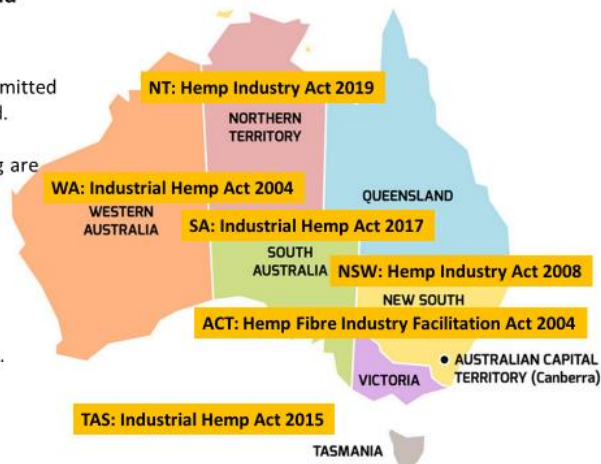
Licence to import controlled substances

- Required to import viable *Cannabis* spp. seed.
- Annual application.
- Import permit for each consignment.



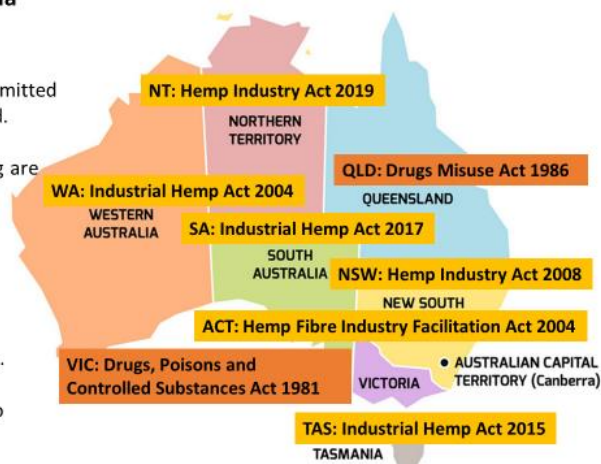
Low-THC (hemp) licencing in Australia

- State by state approach
- Differences in legislative approaches, permitted activities & materials that can be handled.
- Limitations of low-THC Cannabis licencing are similar state-state:
 - For food, fibre & cosmetics
 - No extraction of cannabinoids
 - Non-therapeutic applications
 - No joking!
- Cannabinoid scheduling limits are very low, extracts likely to be a scheduled drug.
- Most states have implemented low-THC hemp legislation to enable the industry.



Low-THC (hemp) licencing in Australia

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- Differences in legislative approaches, permitted activities & materials that can be handled.
- Limitations of low-THC Cannabis licencing are similar state-state:
 - For food, fibre & cosmetics
 - No extraction of cannabinoids
 - Non-therapeutic applications
 - No joking!
- Cannabinoid scheduling limits are very low, extracts likely to be a scheduled drug.
- QLD & VIC amended poisons legislation to enable hemp industry.
- Regardless of the legal basis state-state, requirements for licensees are similar.



Low-THC (hemp) licencing in Australia: general requirements

Good character	National Police check Referees
Financially stable	All partners/owners Credit history/financial statement
Site & security	Owned/Leased Prevents easy unauthorised access Not on main road Fenced Lockable storage areas Low-THC signage
Certified seed source	From < 0.5% crop
Record keeping	Seed acquired Seed sown Seed harvested Seed retained Plant destruction
Notifications	Sowing Sampling/testing Harvest Off-site movements Annual report
THC testing	For each variety



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THC testing	For each variety

- Manage supply to meet domestic medical & R&D demand.
- Avoid diversion of narcotics to black markets.

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Certified seed source	From < 0.5% crop
Record keeping	Seed acquired Seed sown Seed harvested Seed retained Plant destruction
Notifications	Sowing Sampling/testing Harvest Off-site movements Annual report
THC testing	For each variety

- Ensure hemp is low-THC.
- Grown for food & fibre.

Low-THC (hemp) licencing in Australia: costs and additional details

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	NZ
Licence fees	POA	\$572, \$200	POA	\$497.80	\$1,159.00	\$0.00	\$443.30	\$328.00	\$511.11
Licence term	5 years	5 years	5 years	3 years	5 years	5 years	3 years	3 years	1 year
THC sampling/testing	POA	\$300	POA	\$750-\$2000	\$750-\$2000	\$200	\$750-\$2000	\$750-\$2000	(\$750-\$2000)
THC concentration	1% / 0.5%	1% / 0.5%	1% / 0.5%	1% / 0.5%	1% / 0.5%	1% / 0.5%	1% / 0.35%	1% / 0.5%	0.35%

Low-THC (hemp) licencing in Australia: allowed activities under low-THC (hemp) licences

Activities allowed

Possess for supply: viable seed storage under security, distribution to licensees for cultivation or processing.

Cultivate: grow a crop for commercial purposes; store viable seed; sell seed or stalks for processing.

Process: dehull seed, further processing into food or oil products; stalk processing for fibre.

Research: trials, breeding, agronomy...

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Cultivate: grow a crop for commercial purposes; store viable seed; sell seed or stalks for processing.

Process: dehull seed, further processing into food or oil products; stalk processing for fibre.

Research: trials, breeding, agronomy...

Research licences in ATC, QLD & NT

- Category 1 & 2 researcher licences allow research using cannabis plants with higher THC concentrations.
- Higher security requirements; research program scrutiny; scientific experience and relevant skills.

Industrial hemp plants: THC < 1%; usual grower licence.

Class A research plants: THC > 3%; must be grown in locked glasshouse; CAT 1 researchers only.

Class B research plants: THC > 1%, < 3%; CAT 1 or CAT 2 researchers.

- Field trials with agronomic aims.
- Plant breeding programs for developing new or improved varieties of industrial cannabis.
- Supply Class A or Class B research cannabis plants or seed to other researcher licencees.

Low-THC (hemp) licencing in Australia: sometime you don't need a licence.

Possess, manufacture, supply or import:

- Non-viable industrial hemp seeds.
- Products derived from industrial hemp seeds (hemp seed oil, hemp hearts).
- Harvested industrial hemp stalks that have been stripped of their leaves, flowers and seeds.
- Processed products derived from industrial hemp stalks (eg textiles, building materials).
- QLD: seed handlers (viable) do not need a hemp licence but security & record-keeping required.



Low-THC (hemp) licencing in Australia: food & fibre products

In the manufacture of raw food & fibre ingredients, drugs schedule limits apply:

- Tetrahydrocannabinols: 50 mg/kg / 50 ppm / 0.005% w/w.
- Cannabidiol: 75 mg/kg / 75 ppm / 0.0075%.
- Processed hemp fibre with < 0.1% THC.



In retail food and beverage, FSANZ - Standard 1.4.4 - Prohibited & restricted plants & fungi:

- Seed-derived products must be sourced from low-THC Cannabis & contain non-viable & hulled seed only.
- < 10 mg/kg total THC in seed-derived oil.
- < 5 mg/kg total THC in other food products from seed.
- < 2 mg/kg total THC in beverage.
- < 75 mg/kg CBD in food.



- No health claims or labelling associated with cannabinoids.
- No psychoactive claims or labelling.
- Label cannot include words like Marijuana, Cannabis or images of the plant or leaf.
- No nutritional claims or labels associated with cannabidiol.



Low-THC (hemp) licencing in Australia: cosmetic products

In the manufacture of cosmetics, drugs schedule limits apply

- Cosmetics have a complex definition, especially when compared with therapeutic goods.

	Cosmetics	Therapeutics
Where it is used	Surface or oral skin, hair, nails, teeth, mouth	Surface or internal
Why it is used	Protect the body Alter the body's odours Change the body's appearance (e.g. colouring, tinting or bleaching) Maintain body in good condition (e.g. moisturise, exfoliate or dry) Perfume or cleans the body	Test susceptibility to disease Control or prevent conception Influence, inhibit or modify a physiological process Prevent, diagnose, cure, a disease, ailment, defect or injury Test for pregnancy
Types of claims	Prevents appearance of aging Promotes healthy-looking skin Moisten & revitalise appearance Relax: taught skin or via aroma	Anti-aging Restores skin health Rejuvenate, revitalise living tissue Relax muscles or anti-stress
Regulatory authority	National Industrial Chemicals Notification and Assessment Scheme (NICNAS); Australian Competition and Consumer Commissions (ACCC)	Therapeutic Goods Administration (TGA)

Low-THC (hemp) licencing in Australia: CBD products

- In Australia CBD is a Schedule 4 drug, prescription-only medicine.
- Extraction of CBD under Australian low-THC licences is illegal.
- UK, EU and USA states CBD is legal (various limitations & exceptions) and is often hemp-derived.
- TGA is reviewing CBD scheduling:

The TGA is currently undertaking a safety review of CBD at lower doses, although there are only limited published studies. Based on the outcome of these studies, it is possible that relaxation of the scheduling status of low dose CBD (e.g. to over the counter) could be considered during 2020.



Session 7A – Health Value

A GLOBAL OVERVIEW OF THE MEDICINAL CANNABIS INDUSTRY

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ABSTRACT

Paul Mavor is an Australian registered pharmacist who for the last five years has specialised in medicinal cannabis. This talk will give an overview of the industry and include medical evidence, research, cultivation, dosage forms and what is happening in other parts of the world. Australian industry is gearing up to be a world leader in this exciting new or rediscovered field. Paul will attempt to separate fact from fiction and discuss whether medicinal cannabis is a pharmaceutical disruptor.

Health House Holdings Ltd is an International distributor of medicinal cannabis and was founded to pursue opportunities in the burgeoning global medicinal cannabis market. Since 2014, the Board and founding shareholders of the Company have been pioneers in the medicinal cannabis sector establishing a number of publicly-listed companies including AusCann Group, Zeldia Therapeutics and CannPal Animal Therapeutics.

In March 2019, Health House Holdings Ltd acquired Health House International Pty Ltd, a business that was granted the first licence in Australia to import and distribute medicinal cannabis. Health House International Pty Ltd is fully operational wholesale distribution business serving the expanding Australian market and is well positioned to expand into New Zealand and South East Asia.

Session 7A – Health Value

INDUSTRIAL CANNABIS: AN ESSENTIAL NUTRIENT

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ABSTRACT

The UN continues to delay their decision on Industrial Cannabis, this means that plants rich in Cannabinoids yet have little to no psychoactive THC are still listed as a Schedule 2 drug. In Australia access to CBD rich flower and leaf is still under strict regulation.

Environmentally speaking, the ill-informed prohibition that began in the 1930s halted multiple advancements including fuel and plastics from sustainable resources. We have yet to understand the effects prohibition has had on our health. The Cannabis plant is the only known source of cannabinoids, a nutrient essential for health, a nutrient that works in tandem with a body system discovered 50 years after prohibition. The endocannabinoid system plays an intrinsic role in human reproduction and requires cannabinoids to function optimally. Any restricted access to industrial hemp denies human-beings access to a food vital for human conception and denies humans the right to correct any deficiencies in the endocannabinoid system.

Essential Nutrients are defined as nutrients that the body cannot make or produce in sufficient quantities on its own so therefore need to be obtained through the diet. They include the building blocks of carbohydrates, lipids and proteins, certain vitamins and minerals, and water. The World Health Organization (WHO) defines nutrients as essential for growth, reproduction and good health. “An essential nutrient is a nutrient required for normal physiological function that cannot be synthesized in the body – either at all or in sufficient quantities – and thus must be obtained from a dietary source” [1].

Bioflavonoids are a category of plant phytochemicals currently being considered as “Lifespan Essential” meaning that they are needed to achieve full lifespan by reducing chronic disease. Citrus bioflavonoids, polyphenols from tea, quercetin and proanthocyanidins from red wine are all currently being researched and are classified by common biochemical characteristics [2].

“Dietary Reference Intake (DRI) values exist for vitamins and minerals and provide a guideline on the optimal dose range to avoid deficiency and prevent toxicity. Polyphenols are widely distributed in plant foods, and have been linked to improved human health through reduced risk of chronic diseases, cardiovascular in particular. Although they do not cause classical deficiencies, recently they have been discussed as ‘lifespan essentials’ “because they are needed to achieve a full lifespan by reducing the risk of a range of chronic diseases” [3].

The scientific body of evidence for the establishment of a DRI of phytocannabinoids is growing everyday and rivals data on bioflavonoids. It’s time to start thinking about phytocannabinoids as a food with a focus of study daily intake recommendations rather than just a treatment or medicine.

Phytocannabinoids are classified as plant phytochemicals that communicate with the endocannabinoid system. Food sources of phytocannabinoids include anandamide from cacao, beta caryophyllene from black pepper and the 140 plus cannabinoids from *Cannabis sativa*, which directly react with the CB1 and CB2 receptors.

Human Breast milk contains an abundant source of endocannabinoids, a specific type of neuromodulatory lipid that teaches a newborn child how to eat by stimulating the suckling process. If a mother's diet is rich in essential fatty acids omegas 3 and 6 in the same balance as found in Hemp Seed oil, she will produce enough for the infant. Once a child has been weaned they depend on an outside source of phytocannabinoids to maintain optimal homeostasis [4]. Humans and cannabis plants have coexisted for thousands of years. Until 100 years ago it was the largest cultivated crop in human history. If the polyphenols from tea are considered lifespan essential the nutrients from the plant we evolved alongside should also prove essential.

During three distinct human developmental stages (i.e. embryonic implantation, prenatal brain development and postnatal suckling), the endocannabinoid system appears to play an essential role for development and survival. Thus, during early pregnancy, both successful embryonic passage through the oviduct and successful implantation into the uterus require critical enzymatic control of optimal anandamide (a phytocannabinoid) levels at the appropriate times and sites [5, 6].

A study done in 2008 examined the concept of clinical endocannabinoid deficiency (CECD), and the prospect that it could underlie the pathophysiology of migraines, fibromyalgia, irritable bowel syndrome, and other functional conditions alleviated by clinical cannabis. Conclusion: Migraine, fibromyalgia, IBS and related conditions display common clinical, biochemical and pathophysiological patterns that suggest an underlying clinical endocannabinoid deficiency that may be suitably treated with cannabinoid medicines [7].

The past 100 years of prohibition have brought us the opportunity to understand the impact plant nutrients have on human health by providing research as we reintroduce them into our food supply. Continuing research into the classification of phytocannabinoids is necessary to change the global perception on this plant and address health problems that could have been caused by its removal from our diet.

Keywords: Phytocannabinoids; cannabinoid deficiency; Dietary Reference Intake (DRI); industrial hemp; nutrition

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Session 7A – Health Value

BROAD SCALE FARMING TECHNOLOGIES FOR CANNABIS CULTIVATION

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ABSTRACT

For the past 20 years the Canadian Hemp industry has been building within the regulatory framework allowed. The majority of the 140,000 acres of Cannabis in Canada is grown for food. In 2018, North America saw drastic changes to regulations allowing for harvesting of the leaf and flower. This began with full legalization in Canada and the US Farm bill passing shortly thereafter for hemp/industrial cannabis. This has caused a green rush of farmers planting thousands of acres with very little attention to harvesting and processing. Independent research combining broad scale agricultural practices with large scale processing facilities has been underway in Montana. Examining agricultural practices that utilize the tri-use crop potential of hemp/industrial cannabis. Harnessing the potential of triuse-crop Industrial Cannabis farming on a broad scale level will be a key factor in determining the global viability of this emerging market.

Keywords: Broad Acre; industrial hemp; industrial Cannabis; tri-use crop; extraction; processing

What is the first thing that comes to mind?



Industrial Hemp Applications



Vodka ??

Industrial Hemp Applications

Perception of Cannabis



Industrial Hemp Applications

AHT LP | 05



What is Industrial Hemp?



Proto-Germanic hanapiz , probably borrowed from the Scythian word and became the Greek kannabis

What is Industrial Cannabis?



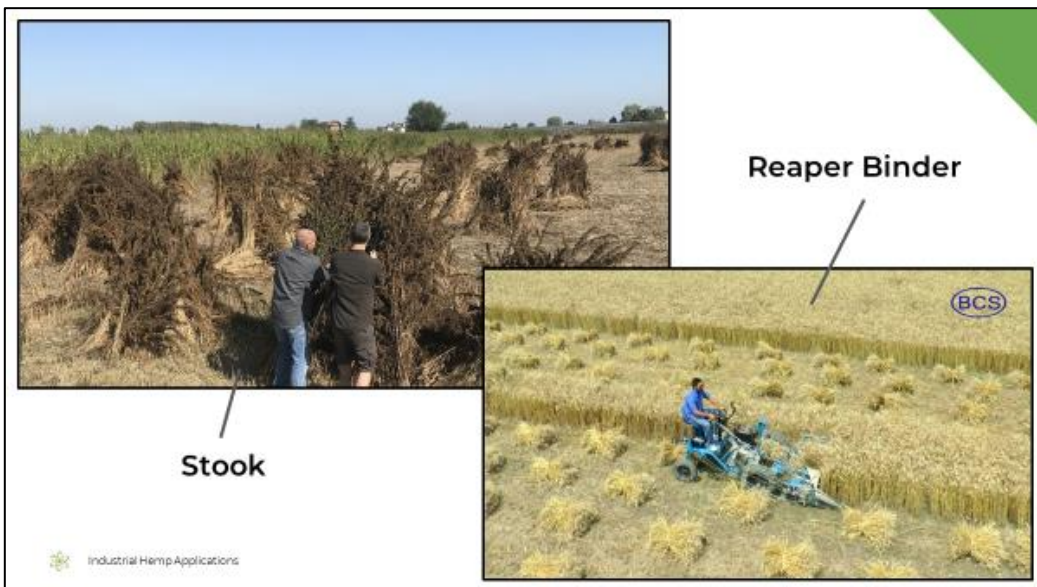
 Industrial Hemp Applications

Harvesting

Side Discharge Draper Header



 Industrial Hemp Applications



Drying



Silage Wrap Bale

Industrial Belt Drying



Stook Dried

Industrial Hemp Applications



Solar Bio-mass Drying

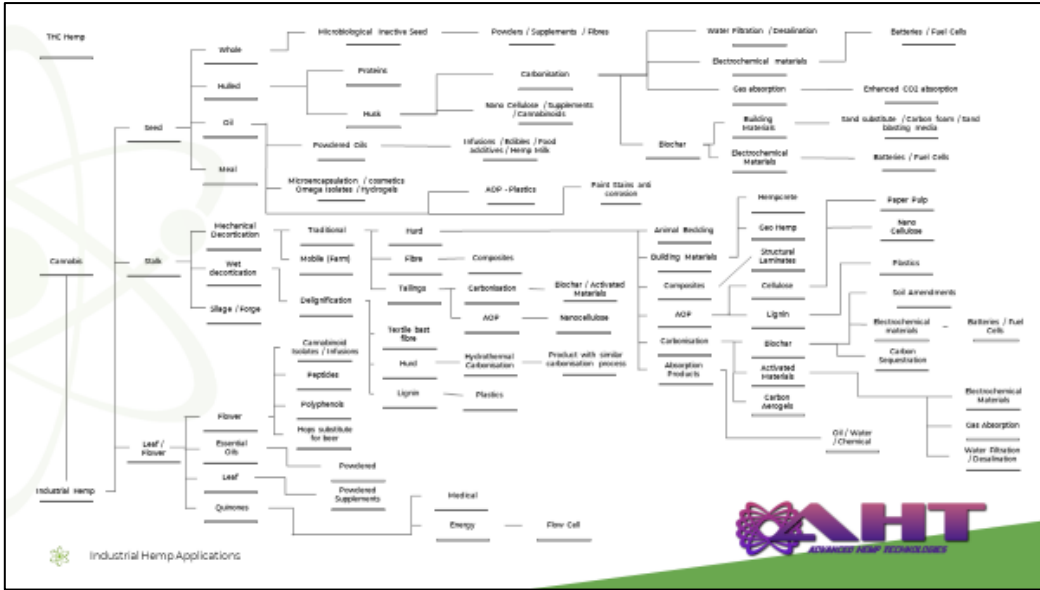
Freeze Drying



Industrial Hemp Applications

Whole Plant Utilization: Just a Concept?

Industrial Hemp Applications



Why am I doing this?

CBD.....FUEL OF THE FUTURE?

- Under alkaline conditions and in the presence of air, Cannabidiol oxidized to a Quinone.
- Quinones and Carbon make green battery

Session 7A – Health Value

R&D AND REGULATORY CONSIDERATIONS FOR OUTDOOR MEDICINAL GRADE HEMP (CANNABIS)

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Case Study – Outdoor cultivation Medicinal Cannabis and Academy

1. **Finding Buyers (legal)**
2. Plant Requirements
3. Regulatory Constraints
4. Site Selection
5. Licenses, permits - local authorities
6. Cultivation
7. TGA manufacturing licenses



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1 – Finding Buyers

- ODC application, wait – **12 to 18 months**
- LOI **are worthless**
- ODC issues cultivation permits **only** if you **path to market**
- German Market (flower) was only **7 tons last year**
- **Export market** – Medicinal Cannabis facilities are going up **everywhere**



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2 – Plant Requirements

Outdoor Considerations

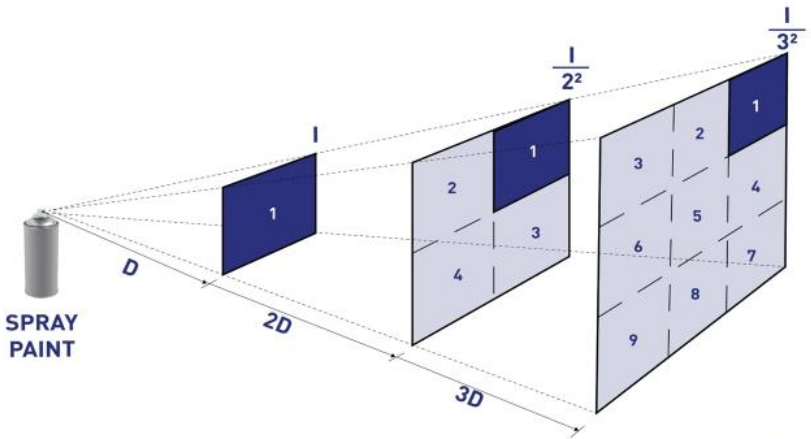
- Sunlight
- Temperature
- Humidity
- No pollen

Facility Design



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Pollen – 5km – 10 miles – **We don't really know** Follows the "Inverse Square Law"



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3 – Regulatory Constraints 25,000 sqm outdoor grow of high THC

Case study – Security and ODC

- Farm - \$1m (ignored)
- **Security – \$0.5m**
- Head house and equipment - \$1.5m
- Capitalized Opex – 0.5m
- **Total Capex - +- \$2.5m**

- Or about \$100/sqm
- Greenhouse is about \$2,000/sqm
- Indoor is about \$4,000/sqm
- 0.02c/g – 0.20c/g – 0.40c/g



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3 – Regulatory Considerations EU GMP and Marketing Authorisation

- Through the Australian Government **Mutual Recognition Agreements (MRA)** with Europe
- **All** TGA licensed manufacturing facilities can get **EU GMP**
- **EU GMP** does not drive the design decisions the **process (plant) does**.
- **TGO 93** (a Therapeutic Goods Order issued by the Australian Department of Health)
- International **pharmacopeia** and **local** regulations, like the TGO 93 / 100



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3 – Regulatory Considerations Pharmacopeia – 20

1. Pharmacopoea Slovaca
2. Indonesian Pharmacopoeia
3. Brazilian Pharmacopoeia
4. **British Pharmacopoeia (BP)**
5. ~~British Pharmaceutical Codex~~
6. Pharmacopoeia of the People's Republic of China (Chinese Ph
7. Czechoslovak Phar
8. **German Pharmacopoeia (GP)**
9. Pharmacopoeia of the United Mexican States (Mexican Pharmacopoeia)
10. Portuguese Pharmacopoeia
11. Indian Pharmacopoeia
12. **Japanese Pharmacopoeia (JP)**

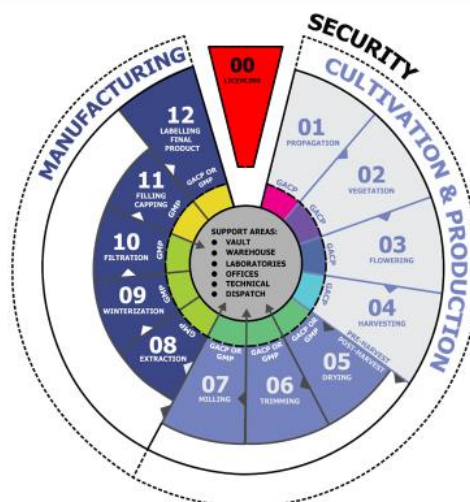
German Pharmacopoeia (GP)

13. Minimum Requirements for Antibiotic Products of Japan
14. Czech Pharmacopoeia
15. **European Pharmacopoeia (EP)**
16. French Pharmacopoeia
17. Swiss Pharmacopoeia
18. ~~Pharmacopoeia~~
19. ~~Pharmacopoeia~~
20. Royal Spanish Pharmacopoeia
21. **United States Pharmacopoeia (USP)**
22. ~~State Pharmacopoeia of the Union of Soviet Socialist Republics (Soviet Pharmacopoeia)~~
23. ~~Yugoslav Pharmacopoeia~~

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Where does
GACP and GMP
fit into the
process?



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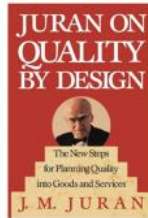
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3 – Regulatory Considerations Quality By Design

Juran – Automobile industry 50 years ago

1. Specification(s)
2. Quality and Commercial (pollen)
3. Source of Variation
4. Assess the Impact
5. Mitigate the Risk
6. By Good Design
7. Control Strategy

- Procedural Controls – PQS



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Source(s) of Variation

TGO Test	Propagation	Vegetation	Flowering	Harvesting	Trimming	Drying	Milling
Aflatoxins	High	High	High	Medium	Low	Low	Low
Foreign matter	Medium	Medium	Medium	High	High	High	High
Heavy metals	High	High	Low	None	None	None	Low
Potency	High	High	High	Medium	None	Low	None
Ochratoxin A	High	High	High	Medium	Low	None	None
Pesticides	High	High	High	None	None	None	None
Total Ash	High	High	High	None	None	None	None
Moisture	None	None	None	None	None	High	None
Micro	High	High	High	High	High	High	High

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Source(s) of Variation

TGO Test	Extraction	Winterization	Filtration	Filling & Capping	Labelling Final Product
Aflatoxins	None	None	None	None	None
Foreign matter	High	Medium	Medium	Low	None
Heavy metals	None	None	None	None	None
Potency	Medium	Medium	Low	None	None
Ochratoxin A	None	None	None	None	None
Pesticides	None	None	None	None	None
Total Ash	None	None	None	None	None
Moisture	None	None	None	None	None
Micro	Medium	Medium	Medium	Low	None

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3 – Regulatory Considerations

Bound to a site because of capex spend and regulations

1. State Poisons, ODC and TGA all require fixed physical addresses
2. Security, Vault, Head House, Packaging are significant investments
3. Drying or freezing **immediately** after harvest is critical



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4 - Site Selection

Outdoor has special considerations

- Usual factors – labour, transport, markets, playschool, discrete, flat etc
- Pollen, rain fall, humidity, temperature, dust, hail, pests
- Irrigation water source and soil
 - **Heavy metals** – Cd levels in fertilisers
 - **Pesticides** – AMPA residue
 - **Pathogens** – Fusarium, Botrytis, Phytophthora, **Tobacco Mosaic Virus**



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5 - Licenses / Permits from local authorities (and some you have never heard of)

- Identify land - Soil sampling and analysis (macro and micro nutrients, pesticides)
- Buy land, transfer water licenses
- ODC licences for Cultivation, Manufacturing, R&D
- Planning authority
 - Council, EPA, DELWP, CMA, Heritage, Bushfire
- Water authority changes
- ODC's 14J's too many to count
- WorkSafe approvals (construction site)
- CFA insist on a 150kL fire water tank, re-filled in 4 hours
- 3 ODC licences
- State poison license
- ODC site inspection
- **Binding Buyer Contracts**
- Cultivation and import permits
- And then there is water.....



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6 – Cultivation

Risk mitigation

Grew hemp

- Cope with heat? 48°C
- Nutrients – amended and non amended
- Pests – still not sure
- Soil pathogens

Mistakes

- “Lost” time at the start of the project
- Did not put in a cover crop
- Comprehensive hemp tests
- Incredibly expensive



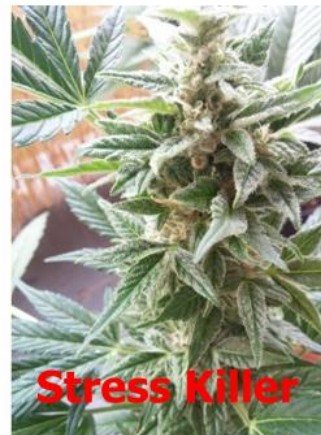
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6 – Cultivation

What keeps us up at night?

- No buyers, i.e. oversupply
 - We scaled up too fast
 - Weather - Hail / Rain / Flood
 - Australia pests – no pesticides
 - Pathogens – no fungicides
-
- 100% alcohol and drug testing **every day**
 - Unbelievable stress – Our first strain....



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6 – Cultivation

We have thousands of questions?

- Acceptable heavy metal limits in soil
- Acceptable pesticide residues in soil
- No till, cover crops
- Developing Australian strains (hot / dry)
- Optimise nutrients
- White / Black / Permeable Plastic
- Developing labour saving technologies

Academy / Collaboration



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7 - TGA license

This is a medicine.....



Target May 2020

- Software
 - PQS
 - Validation
 - 3 Batches
- Hardware
 - Facility built
 - Extraction equipment
 - Packing (bulk flower)

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Thank you

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Regulatory Knowledge, Practically Applied

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EVALUATION OF NEW GENERATION DEGUMMING METHODS ON HEMP

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ABSTRACT

Hemp is viewed by many as being an environmentally friendly source of cellulose fibre. As a bast fibre hemp must first be degummed to separate the fibre from the bark of the plant. Frequently new separation processes are proposed however it is hard to determine if they provide an improvement over traditional methods. In this paper seven new degumming protocols were compared with traditional alkali treatment using the same fibre, equipment and evaluation methods. The new methods evaluated were modified alkali, alkali-oxidising, Fenton and deep eutectic solvents treatment. Samples were opened using a Shirley trash analyser and evaluation was done using fibre yield, optical microscopy, optical fibre diameter analysis and colour. Of the new methods only modified alkali treatment was effective in separating fibres to a level similar to traditional alkali separation. This was confirmed by higher mean fibre diameters, colour and yield after degumming of the new methods. Further work would be required to optimise separation of any of the methods with the deep eutectic solvents showing the most promise.

Keywords: hemp degumming; alkali; oxidant; Fenton treatment; deep eutectic solvents

INTRODUCTION

As the world becomes more environmentally conscious, bast fibres have achieved great attention in textile industry because of excellent mechanical properties, biocompatibility and renewability [1]. Hemp, as a fast-growing, annual herbaceous plant has been recognized as an emerging fibre and material source, particularly in the face of concerns about the environment [2]. However, hemp fibres need to be degummed before they can be processed into value-added products [3]. The non-cellulose components in hemp fibres, including lignin, pectin and hemicellulose, contribute to surface roughness and stiffness. Traditional alkali treatment requires a large chemical oxygen demand value, resulting in high commercial cost and effluent pollution [5, 6]. Research has focused on seeking an effective and environmental-friendly method for hemp degumming.

Modified alkali (M-A), alkali-oxidising (A-O), Fenton (Fen) and deep eutectic solvents (DES) treatments have been proposed as alternatives for bast fibre degumming. These methods have been widely used in fields related to plant transformation [7, 8], waste-water disposal [9] and metal processing applications [10]. The application of hemp fibre degumming using these methods is still in its infancy. Direct comparisons are missing so it is important to determine if these new methods could provide a benefit.

Compared with the traditional alkali boiling treatment, M-A treatment presented a simplified experimental process with less chemicals [11]. Only sulphuric acid (H_2SO_4) and sodium hydroxide (NaOH) were engaged in the experiment, while sodium silicate (Na_2SiO_3), sodium sulphite (Na_2SO_3), sodium polyphosphate ($Na_5P_3O_{10}$) and urea were additionally required in the traditional way. Priority treatment with acid could help to dissolve acid soluble substances, which may contribute to more comprehensive gum extraction with the subsequent NaOH degumming.

The A-O degumming method is an improvement on a pure oxidising treatment. As a strong oxidant, hydrogen peroxide (H_2O_2) has great capacity of producing hydroxyl free radicals, which are specialized in unlinking the intermolecular forces among glues [12, 13]. The presence of hydrogen peroxide should improve the degumming process. The rapid and fierce reaction may also destroy the cellulose components. In order to control the reaction process, NaOH was introduced before H_2O_2 oxidising as sustained-release alkali source to slow down the oxidation reaction speed [14, 15].

The Fenton reaction was named after the chemist H. J. H. Fenton in 1894 when he proposed that ferrous salts could catalyse H_2O_2 to oxidize tartaric acid [9]. The utilization of Fenton reagent also involves oxidising, which includes both oxidant and ferrous ion [16, 17]. The hydroxyl radical form a strong oxidant that is the main force of non-cellulose degradation during hemp separation. The function of ferrous ion is to catalyse hydrogen peroxide to produce hydroxyl radical for lignin removing [18, 19]. The ferrous ions might be exhausted and present in volume at the site of lignin in preference to the cellulose hence the catalysed damage occurs more in non-cellulosic area improving separation. In this case, the more absorbing of ferrous ion will give assistance with more effective degumming.

Compared with other degumming chemicals, DES are relatively new to the bast fibre degumming industry and were first reported in 2001 [20]. DES can be composed of a hydrogen bond donor (urea, renewable carboxylic acids or renewable polyols) and a hydrogen bond acceptor (choline chloride, betaine (*aka* trimethylglycine), *et al*) [10]. As a substitution of ionic liquids (ILs), DES have many advantages such as low cost, easy-preparation, biocompatible and a low ecological footprint. The formation of DES requires only 20% of the ILs cost. When extracting fibres with DES, the cellulose part is less likely to be damaged while the lignin is targeted [21, 22]. The strong degumming capacity of DES derives from the destruction of recalcitrant structure bridging by hydrogen bonds, Van der Waals forces or other intermolecular force among the lignocellulosic biomass [23, 24].

The aim of this work was to evaluate the degumming efficiency of new novel methods proposed in the previous work of seven researchers. Utilising the same fibre, equipment and evaluation methods allowed for direct comparison of the suitability of each method. The surface morphology and diameter were investigated to evaluate the degumming effectiveness. Colour differences were also measured to assess suitability for yellowness reduction.

EXPERIMENTAL DETAILS

Material

Harvested hemp stems were kindly gifted by CSIRO and decorticated manually. Raw samples were stored under the ambient conditions (20-30°C and <50% humidity) for more than one week and dried at 40°C for 24 h in an oven before degumming. The main chemicals used in this study were H_2SO_4 , NaOH, H_2O_2 , $FeSO_4 \cdot 7H_2O$, ChCl, betaine, urea and mannitol, which were purchased from Sigma-Aldrich Pty. Ltd. All chemicals used in the treatments were analytical pure and used without further purification. All the experiments were conducted in triplicates in this study. Deionized water was used to prepare all the solutions.

Modified alkali treatment (M-A) [11]

Raw hemp fibres were soaked in 0.2 mol/L H₂SO₄ for 48 hours at room temperature with a 10:1 liquor ratio. The samples were rinsed with water in a beaker five times with a 200:1 liquor ratio before being treated with 1.5 mol/L NaOH at 98°C for 2 hours with a 10:1 liquor ratio. Finally dilute with distilled water in a beaker to a neutralization status with pH of 7. The as prepared samples were dried at 100°C for 3 hours for further characterization.

Alkali-oxidant treatment (A-O) [14]

Alkali-oxidation degumming reaction was carried out with the following steps: Raw hemp fibres were soaked in water and the pH was adjusted to 11 using the 0.1 mol/L NaOH at 85°C in a water bath with a 10:1 liquor ratio. 8.8 mol/L H₂O₂ was then added in the reactor and mixed well with the solution with a 2:1 liquor ratio in the same water bath. The oxidising process would last for 1 hour and finally fibres were rinsed five times with water in a beaker in a 200:1 liquor ratio and then dried at 100°C for 3 hours.

Fenton treatment (Fen) [16]

Raw hemp fibres were soaked in 0.04 mol/L FeSO₄·7H₂O solution with a 250:1 liquor ratio for 1 hour at room temperature. Then gently wrung out the moisture on the fibres to keep them wet and transferred to 0.88 mol/L H₂O₂ solution with a 250:1 liquor ratio for 1 hour at room temperature. After rinsing five times with water in a beaker in a 200:1 liquor ratio, the fibres were dried at 100°C for 3 hours.

DES treatment [25]

Recipes of the four DES treatment are shown in Table 1. Firstly, a hydrogen bond acceptor and hydrogen bond donor were mixed at a same molar ratio of 1:2 and heated at 80°C in an oil bath for 1 h to form a transparent solution. Secondly the dry hemp samples were immersed in the DES in the length of 10 cm and placed in an oven at 110°C for 1 hour. All trials were conducted at a 20:1 liquor ratio. Finally, samples were washed five times in a beaker with a 200:1 liquor ratio and dried at 100°C for 3 hours before storage.

Table 1. Recipes of the four DES treatment

Sample ID	Hydrogen bond acceptors	Hydrogen bond donors	Molar ratio
Ch-Ur	ChCl	urea	1:2
Ch-Ma	ChCl	mannitol	1:2
Be-Ur	betaine	urea	1:2
Be-Ma	betaine	mannitol	1:2

Traditional alkali treatment (T-A)

The two-step boiling method was employed as the control group. For the first step, the peeled hemp fibre was boiled in 0.25 mol/L NaOH solution for 1 hour at 98°C in a 100:1 liquor ratio. Second step was to put the soda treated hemp in mixed aqueous solution with a 100:1 liquor ratio, which included 0.25 mol/L NaOH, 0.26 mol/L H₂O₂, 0.25 mol/L Na₂SiO₃, 0.16 mol/L Na₂SO₃, 0.88 mol/L urea, and 0.08 mol/L Na₅P₃O₁₀ boiling for an hour. Finally, samples were washed five times with water in a beaker in a 200:1 liquor ratio and then dried at 100°C for 3 hours.

Sample IDs for each treatment are listed in Table 2.

Table 2. Sample ID information

Sample treatment	Sample ID	Sample treatment	Sample ID
Traditional alkali treatment	T-A	ChCl & urea	Ch-Ur
Modified alkali treatment	M-A	ChCl & mannitol	Ch-Ma
Alkali-oxidant treatment	A-O	betaine & urea	Be-Ur
Fenton treatment	Fen	betaine & mannitol	Be-Ma

Degumming evaluation

1. The fibre cross-sectional size was measured with an OFDA2000BT (BSC Electronics, Australia). Samples were first opened with one pass through a Shirley analyser MK2 (SDL Atlas, UK). Opened fibres were cut into 2mm snippets and spread on a 30mm square glass slide for measurement. Each trial was measured 5 times.

2. Yield of degumming was calculated using the formula below;

$$\text{Yield} = w/W \times 100\%$$

where w is the dry weight of fibres after degumming and W is the dry weight of raw hemp fibres before degumming.

3. Colour differences were characterized using a Spectraflash SF600 (Datacolor, USA), using a 30 mm diameter aperture, D65 light source and capturing full reflectance data from 400 to 700 nm. Five tests were conducted for each trial, with the unopened sample rotated through 90 degrees after each measurement, and then averaged by the Datacolor software. The yellowness E313 were recorded.

4. The morphology of hemp fibres treated with different degumming processes were characterized with an optical microscope (Keyence Microscope, Japan). Three pieces from each degumming process were randomly selected and straightened on glass slides to be clearly observed and imaged at 100 magnification.

RESULTS AND DISCUSSION**The effect of different degumming methods on fibre separation and gum removal**

Figures 1 and 2 shows the diameter distribution and percentage mass change of the treated hemp respectively, which together may be used as an indication of the fibre separation and level of removal of non-cellulose materials from the original sample.

The grey area covers the range of the mean diameter of the T-A hemp (20 µm). The narrow area of the grey bar indicated a lower coefficient of variation of diameter compared with other trials. The M-A method was the most effective of the new methods with mean hemp diameter of 24 µm whereas the other methods had a higher mean of 30 µm. The percentage mass change of T-A also showed highest amount of gum removal, and the M-A sample was close in mass change. This further proved that M-A might be suitable for the substitution of T-A method.

Fen and A-O hemp had similar mean fibre diameter (49 µm) but differ greatly in percentage mass change (28 % for Fen and 14% for A-O). The huge mass change by Fen treatment could be caused by the damage to the cellulose part instead of gum. Fibres were still stuck together even though there had been mass loss shown by larger mean fibre diameters. Further work needs to be done for the identification of the residue from Fen treatment.

The four DES treatments all represented wide variation of fibre diameter. The Ch-Ur and Be-Ur hemp were slightly lower in mean diameter with 45.32 µm and 42.79 µm respectively. Only the Ch-Ur

sample had relevant high percentage mass change at 16.7 %. It could be proposed that Ch-Ur treatment followed by slightly alkali corrosiveness may contribute to smaller hemp mean fibre diameter, which represents better fibre separation.

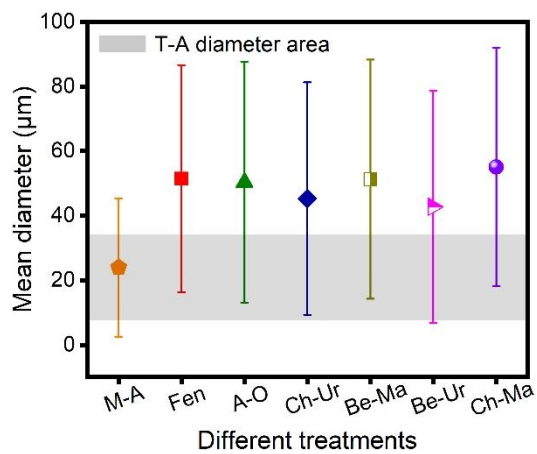


Fig 1. Diameter distribution of treatments

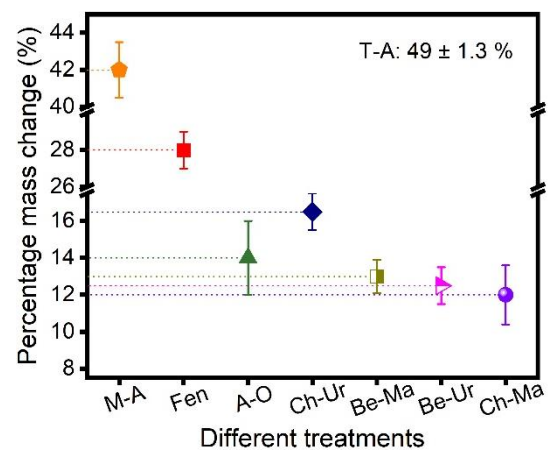


Fig 2. Degumming efficiency of treatments

Colour change analysis from different treatments

The E313 Yellowness Index values for samples treatments are given in Figure 3. Raw hemp had a yellowness value of 43.59, whereas the T-A hemp was 29.32. Using these as references, the M-A and A-O treatments produced whiter samples; lower yellowness values, than the T-A hemp. The Fen method had little change in colour at 45.83 compared with the raw hemp. All DES treated samples were yellower, so further oxidation treatments might be warranted to improve this aspect.

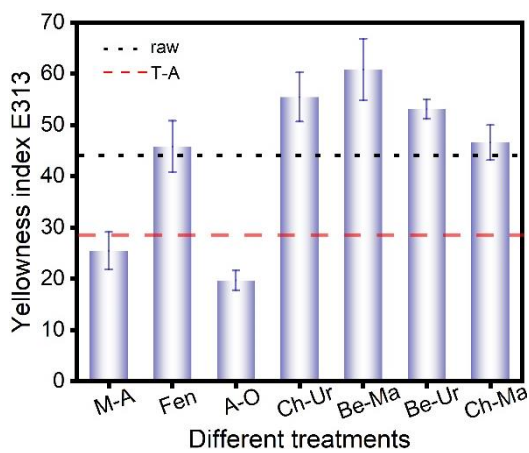


Fig 3. Yellowness of treatments

Surface morphology differences of treated hemp

Microscope morphologies were obtained from each hemp treatment right after chemical degumming process without physical tearing. The macrophotographs in Figure 4 show the visual form and colour of each treatment after degumming.

The raw hemp contained continuous fibre bundles, which were coherent and lined up at one side of the bast. There were almost no individual fibres in the microscopic examination. On the contrary, after T-A treatment, hemp became fragile and ruptured into short fibres. The fibres in the image were quite open and whiter in appearance. Even though T-A has a great degumming effect, over-degumming may lead to lower strength and short length.

Hemp from M-A and A-O also had less yellowness compared with the raw sample, but M-A was better than A-O in fibre extraction observed on this micro-scale, which was consistent with the percentage mass change. Fen and DES treatments added the yellowness of hemp visually, and the Ch-Ur treated hemp fibres were more separated.

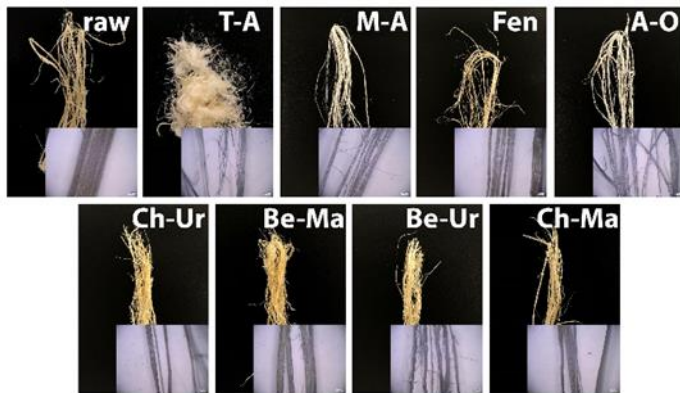


Fig 4. Surface morphology of hemp from different treatments.

CONCLUSION

In this paper, seven new degumming methods on hemp were evaluated using the same fibre and equipment. The results indicate that the new methods were not as effective as the T-A treatment, which still holds the best degumming efficiency in terms of fibre separation and diameter. Noting however that the T-A fibres may have been over-degummed and broken into shorter filaments. The M-A method might substitute for the T-A method with only a little difference in degumming capacity at 42%, meanwhile this treatment also had a brighter colour and small mean fibre diameter. However, the M-A treatment still has a large chemical demand making it not as environmentally friendly as other alternatives. Fen treatment is the next best choice followed by A-O treatment. Keeping the green environment theme, DES treatments could be the optimum new methods, especially the Ch-Ur method. There is still tremendous scope in improving the degumming ability of this treatment. Combinations with changes in final alkali concentration and washing may supply the gap in further research.

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Session 7B – Fibre Value

TECHNOLOGY AND INNOVATION CREATE AN ECOLOGICAL VITALITY: AN INTRODUCTION TO NEW HEMP MATERIALS

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	02	雅戈尔汉麻新型纺织材料 Youngor new hemp textile materials
	03	汉麻综合开发利用的探索 Exploration of hemp's comprehensive utilization and development

 **中国历史上的汉麻**
Hemp in Chinese history


汉麻是中国最早的作物之一，历史文献和考古证明，中国是最早种植和使用汉麻的地区，距今已有6000年以上的历史。古代中国将汉麻作为一种多用途植物栽培，古代文献《夏小正》《诗经》《尚书》《齐民要术》《神农本草经》《本草纲目》等多部古代专著均有记述，表明古代中国很早就掌握了汉麻种植、纤维制作织物、食用药用以及造纸用的技术。直到公元10世纪其他高质量谷物大面积种植之前，汉麻籽一直是中国饮食中的主要来源，而北宋棉花引入中国之前，汉麻纺织品一直师古代中国人主要的衣着原料。


Hemp was one of the first planting corps in China. According to historical literature and archaeological proof, China was the first country to plant and use hems that could be dated back to 6000 yeas ago. Ancient China planted hems as multi-purpose plants, which can be found in many ancient literature like: Xia Xiaozheng, The Classic of Poetry (also known as Shi Jing), The Book of Documents (also known as Shang Shu), Qinmin Yaoshu, Shennong Ben Cao Jing, Compendium of Materia Medica (also known as Ben Cao Gang Mu), indicating Ancient China experienced with hemp plantation, using fiber to make fabric, medicines and papermaking technology. Hemp has been a main source of foods in China before the extensive planation of other high-quality corps in the 10th century, and hemp has been a main material of making clothes until imports of cotton in Northern Song Dynasty.

⁶ Guojun Zhang's visit to the 2nd AIHC was cancelled due to the outbreak of the Coronavirus. His presentation was given by Mr Han Jiang, an associate based in Australia



中国历史上的汉麻

Hemp in Chinese history

公元前16世纪中国最古老的农业专著《夏小正》中已经指出汉麻是一种主要农作物；《诗经》中讨论了纤维用和油用汉麻的种植，记载了汉麻雌雄性别，比欧洲植物性别方面的记载早1500年。

It has been listed in the oldest agricultural literature Xia Xiaozheng in the 16th century BC that hemp was the main crop. Shi Jing has discussed the plantation of hemp for both fiber and oil use and it has recorded the sexuality of hemp, which was 1500 years earlier than the first record of sexuality of hemp in Europe.

中国古代医学典籍《神农本草经》（公元前2000年）首次载明了汉麻的医学用途，明确了麻籽无毒，籽外包叶有毒。公元2世纪中国古代名医华佗成功将汉麻籽和酒制作的麻沸散用于外科手术麻醉药。

An ancient Chinese medical book Shennong Ben Cao Jing has stated the medical use of hemp in 2000 B.C., in which confirmed that hemp seeds are non-poisonous and the bract is poisonous. In the 2th century, an ancient Chinese doctor used hemp seeds and alcohol to make Chinese anesthesia drugs (known as Ma Fei San) as a surgical anesthesia.



中国历史上的汉麻

Hemp in Chinese history

《齐民要术》（公元4世纪）记载了汉麻的种植收获、田间管理等要点，论述了种植对汉麻质量的影响，并推荐小豆与汉麻轮作，并作为汉麻的绿肥。成为的绿肥和轮作概念的最早记载。

Qimin Yaoshu (in the 4th century) has recorded the grow and harvest, and field management of hemp; it also discussed the influence of plantation on hemp quality and it recommended the crop rotation of beans and hemp to be used as green manure of hemp. This has been seen as the first record of green manure and crop rotation.

《本草纲目》中详细记载了麻叶、花、籽、皮的各种医药用途，包括风病麻木、刀伤血瘀、瘰疬生疮、便秘、消渴、发落不生及记忆力衰退等。李时珍更从中华传统医学的角度评价了其保健价值：“麻籽补中益气，久服康健不老，神仙。”

Compendium of Materia Medical (also known as Ben Cao Gang Mu) has recorded the medical uses of hemp leaves, flowers, seeds and peels, which included numbness caused by wind, stab wounds, blood stasis, scabies, constipation, thirst, loss of hair, and memory loss. Li Shizhen has evaluated its health value from the view of Chinese traditional medicine: 'Hemp seeds can supply the centre and boost the energy. If take it in a long term, it can keep you healthy, stay young and feel immortal.'

 **中国历史上的汉麻**
Hemp in Chinese history



01

宁波余姚河姆渡遗址(距今约6000年), 出土了麻绳、双股麻线以及最原始的纺纱工具纺轮。
Hemudu historic site in Yuyao, Ningbo (around 6000 years ago) has unearthed twine, double twine and the most original spinning tool - spinning wheel.

02

大麻灞桥纸(距今约2100年), 西安出土。是世界上最早的植物纤维纸。
Cannabis Ba Bridge paper (around 2100 years ago), unearthed in Xi'an, is the earliest paper based on plant fiber in the world.

03


福建武夷山船棺(距今约3200年)出土的麻布片。
Hemp cloth unearthed from a boat coffin in Wuyi Mountain, Fujian (around 3200 years ago)

 **中国历史上的汉麻**
Hemp in Chinese history



中国西汉时期, 麻纺精品与丝织精品沿着“丝绸之路”进入中东、地中海、欧洲, 继而走向世界。直至宋代, 我国与海外的交往更加频繁, 麻纺织品已成为重要的国际贸易物资, 为了区别从印度等地引种的黄麻, 外商将汉麻纺织品称为“Hemp”, 这一词后成为国际上工业用大麻的名称。

In the Western Han Dynasty of China, good quality hemp spinning and silk products entered the Middle East, the Mediterranean and Europe through the 'Silk Road', and went globally. Until the Song Dynasty, because of the increasing trade between China and overseas countries, Hemp textiles have become a significant international trading material. Foreign businessman used the word 'hemp' to differentiate the jute imported from India and other places, which later became the name of marijuana for industrial use internationally.

 **雅戈尔汉麻新型纺织材料**
New textile materials of Youngor hemp

雅戈尔集团是中国纺织服装行业龙头企业, 创立四十年来, 发展成为以品牌发展为核心, 多元并进、专业化发展的综合性国际化企业集团, 拥有员工5万余人, 各品牌商业网点2600余家。除纺织服装外, 雅戈尔集团业务涉及房地产开发、金融投资、健康旅游产业, 2018年总资产达939亿。

Youngor Group is a leading company in the textile and apparel industry in China. Since its establishment 40 years ago, it has developed as a comprehensive international enterprise focusing on brand development, diversification and professional development. Youngor Group has more than 50,000 employees and more than 2,600 commercial outlets of all its brands. Apart from textile and apparel, Youngor Groups business involves real estate, financial investment, health and tourism, with a total asset of 93.9 billion in 2018.



雅戈尔汉麻新型纺织材料
New textile materials of Youngor hemp



雅戈尔集团自2003年开始，开展了汉麻基础及产业化综合应用研究。建成具备国际领先水平的汉麻纤维生产线及汉麻纺纱基地，汉麻纺织新材料全产业链技术处于国际领先地位。迄今为止雅戈尔汉麻涉及纺织服装、家纺家居建材、生物制药领域，是中国首家具备高新技术起点，自主知识产权的汉麻产业化规模化企业。

雅戈尔汉麻的宗旨是依靠科技创新，焕发古老汉麻天然生态活力，依托技术进步，奉献出新型材料，助力时尚及健康产业。



Since 2003, Youngor Group has launched a comprehensive applied research on hemp foundation and industrialization. It has built hemp production lines and hemp spinning base with an internationally advanced techniques, which lead to an establishment of its leading position in new hemp material whole industry chain internationally. Until now, Youngor Group hemp is involved in the fields of textiles and apparel, home textile and home construction materials, and biopharmaceuticals. Youngor Group became an industrialized and regularized enterprise with a high-tech starting point and independent intellectual property rights.

The aim of Youngor hemp is to depend on technological innovation to rejuvenate the natural ecological vitality of ancient hemp, and to rely on technological development to contribute new materials to help fashion and health industry.

雅戈尔汉麻新型纺织材料
New textile materials of Youngor hemp

- 吸湿导湿、快干、透气
Moisture absorption, moisture guiding, fast dry, breathable
- 天然的抗菌防霉、防螨
Natural antibacterial, mildew and mite proof
- 防臭独特的消音吸波、异味吸附、抗紫外线
Deodorizing, unique noise reduction, microwave absorbing, odor absorption and uvioresistant
- 柔软舒适 用途广泛
Soft and comfortable, wide range of uses

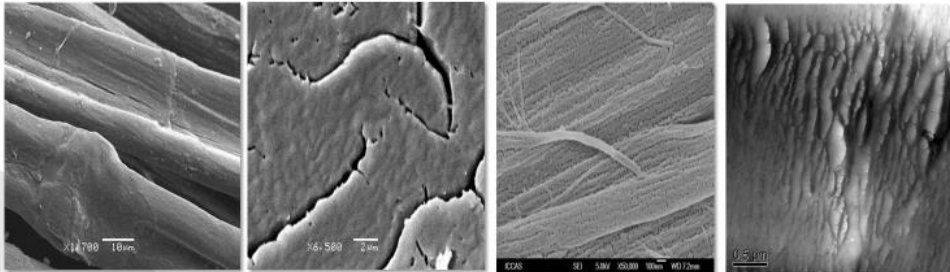


功能与特性

Function and characteristics

雅戈尔汉麻新型纺织材料
New textile materials of Youngor hemp

汉麻纤维吸湿快干、透气性强，服装贴身穿着有自动离身的效果
Hemp fiber absorbs moisture and dries quickly, and has a strong air permeability.
When the cloth is fit, it will not stick to the body and next to the skin.



汉麻纤维电镜照片
Photos of hemp fiber under electron microscope

功能与特性

Function and characteristics

汉麻织物与棉织物干燥试验
Hemp fabric and cotton fabric drying test

织物/Fabric	吸湿速率/mg·min ⁻¹ Moisture absorption	放湿速率/mg·min ⁻¹ Moisture Dissipation
汉麻/China Hemp	2.18	4.40
棉/Cotton	1.33	2.37

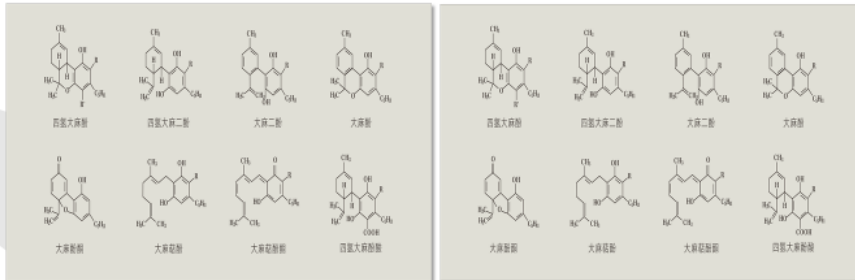
几种平纹织物的湿黏贴力
Wet stick force of different varieties of plain weave fabrics

品种variety	汉麻China Hemp	苕麻Ramie	亚麻Flax	细绒棉Cotton
黏贴力Stick Force /cN	1.63	2.34	2.41	11.45

功能与特性
Function and characteristics

天然的抗菌防霉、防螨防臭
Natural antibacterial, mildew-proof, anti-mite
and deodorant

抗菌性 (AATCC30-2004) 黑曲霉	20°C、7天	没有生长, 0覆盖率
防螨虫性能		67.07%

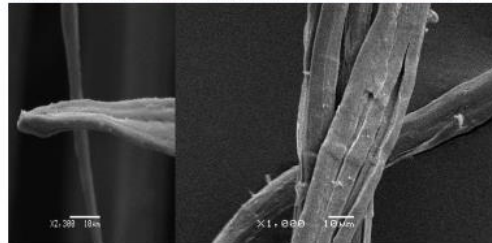


功能与特性
Function and characteristics

汉麻纤维是一种束纤维，单纤维细度仅为苕麻的1/3，接近棉纤维，且末端部呈钝角形，因此汉麻面料手感极为柔软，穿着无刺痒感。
Hemp fiber is a sort of bundle fiber with a single fiber fineness is only 1/3 of that of ramie, which is close to cotton fiber and the end of it is obtuse. Therefore, the hemp fiber feels very soft and has no scratchiness.

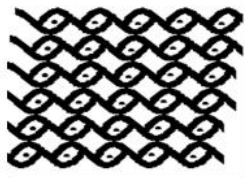


苕麻纤维末端
Ramie fiber ends

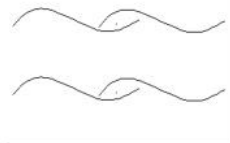


汉麻纤维纵向及末端
Hemp fiber longitudinal and ends

功能与特性
Function and characteristics



粗、硬(木质素含量8 - 10%)



细、软(木质素含量0.2 - 0.3%)



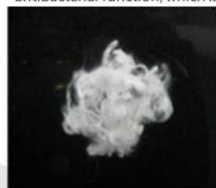
汉麻纤维的细度虽然接近棉花，但单纤较短且木质素含量高，因此过去主要用来生产麻绳、麻袋等粗麻产品。
Although the fineness of hemp fiber is close to cotton, the single fiber is short and the lignin content is high. Therefore, the hemp fiber was used to produce hemp products like hemp rope and hemp sack.

通过技术攻关研制成功了具有自主知识产权工艺设备，使粗硬的汉麻韧皮变为像棉花一样细软的纺织纤维。
Through technological research and development, we have successfully developed a process unit with independent intellectual-property rights, which makes the rough hemp bast into a soft textile fiber like cotton.

功能与特性

Function and characteristics

汉麻杆生物量占植株量地70%，传统上做废料处理，既浪费又污染。我们将其废物利用，制成具有抗菌功能地粘胶纤维等纺织材料，低碳环保又拓宽了汉麻地用途。
The hemp stalk biomass accounts for 70% of the plantation amount. It was used for waste disposal, which is wasteful and polluting. We could make good use of waste materials to make textile materials such as viscose fiber with antibacterial function, which is low-carbon and environmentally friendly, and can expand the use of hemp land.



汉麻粘胶纤维
Hemp viscose fiber

汉麻粘胶指标名称	指标
干强 cN/dtex	2.53
湿强 cN/dtex	1.36
抑菌值	5.3
杀菌值	1.4

注：抑菌值大于2.2表示有抑菌效果，杀菌值大于0表示有杀菌效果

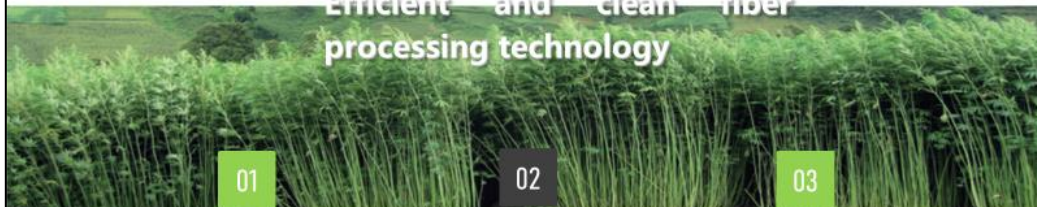


汉麻杆芯粉做为涂层添加剂，透气抗老化效果显著。
Hemp rod core powder is used as a coating additive, and the breathable anti-aging effect is significant.

功能与特性

Function and characteristics

高效清洁化纤维加工技术
Efficient and clean fiber processing technology



01

四位一体联合脱胶工艺
Four-in-one joint degumming process

02

高效渗透柔软工艺
Efficient penetration softening process

03

牵切精梳分理工艺
Stretch-breaking, combing and dividing process

纺织材料工艺技术特点

Technological characteristics of textile materials

四位一体联合脱胶技术
Four-in-one joint degumming process



纺织材料工艺技术特点

Technological characteristics of textile materials

新工艺节约用水46.5%，节约用电13.9%
The new process can save 46.5% of water and 13.9% of electricity

综合污水COD由传统工艺的4500~5500下降到1197，色度由4500-6500下降到1550，实现了脱胶生产的均匀高效、减排低耗、清洁环保。

The comprehensive wastewater COD decreased from 4500~5500 (traditional process) to 1197, and the chroma decreased from 4500~6500 to 1550, which achieved a uniform and efficient, low emissions, clean and environmental protected degumming production.



高效渗透柔软工艺
Efficient penetration softening process

通过连续湿态、干态机械和高温饱和蒸汽潮态渗透等软麻工艺研究，研发了带状柔软处理、机械软麻、快速渗透养生等精干麻加工新工艺制成率提高20.7%、分裂度提高36.4%，断裂强度提升12.6%，综合指标国际领先，实现了高效机械加工和低耗清洁生产。

Through the research of continuous wet, dry mechanical and high temperature saturated steam and tidal infiltration process, we have developed a new way for processing fine hemp like strip-shaped softening, mechanical soft hemp, and rapid penetration health and other hemp processes, which increased by 20.7%, the degree of split increased by 36.4%, fracture strength increased by 12.6%. And we achieved a leading comprehensive indicators internationally and realized efficient machining and low consumption clean production.

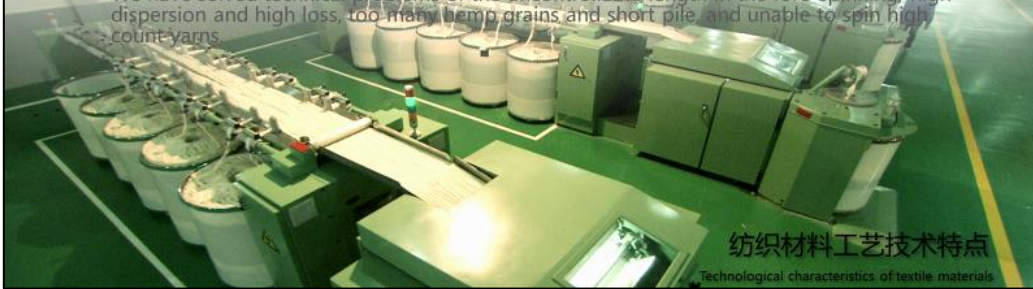


纺织材料工艺技术特点

Technological characteristics of textile materials

牵切精梳分理工艺
Stretch-breaking, combing and dividing process

- 建成了国际上第一条年产5000吨的汉麻麻条和棉型纤维专业生产线
- We have established the first international hemp linen and cotton fiber production line with an annual output of 5000 tons.
- 解决了传统前纺工艺长度不可控、离散和损耗大、麻粒和短绒多、无法纺制高支纱的技术难题
- We have solved technical problems of the uncontrollable length in the fore-spinning, high dispersion and high loss, too many hemp grains and short pile, and unable to spin high count yarns.



纺织材料工艺技术特点
Technological characteristics of textile materials

汉麻纺纱关键技术
Key technology of hemp spinning

01

麻式紧密赛络纺技术
Hemp compact siro spinning technology

新型纺纱技术，目前主要应用于纯棉、粘胶等纯纺和混纺纱。由于汉麻纤维特性，该技术很难应用于汉麻纤维纺纱。

A new spinning technology is mainly applied to pure and blended yarns such as cotton and viscose. Due to the characteristics of hemp fiber, this technology is difficult to apply to hemp fiber spinning.

02

双清双梳纺纱工艺技术
Double-clear and double-spinning technology

针对汉麻与棉、化纤等纤维物理化学和机械性能的差异，研发设计了双清双梳前纺工艺，即经清花、梳棉、精梳的熟与经清花、梳棉的汉麻纤维多混并，再经过清花和梳棉制成混条多。这种精准化的前纺工艺提高了半制品品质，为高支高比例汉麻麻条纺纱奠定了基石。

Aiming at the differences in physical and chemical and mechanical properties of hemp, cotton, chemical fiber and other fibers, a double-clear double-spinning pre-spinning process has been developed, that is, hemp, combed cotton, combed cotton, and hemp, combed cotton. The fiber sliver is mixed and then made into a sliver through cleaning and carding. This precise front spinning process improves the quality of the semi-finished product and lays the foundation for the high count and high proportion hemp blended yarn.

03

潮态纺纱技术
Humidity spinning technology

潮态纺纱技术有效解决了传统纺纱过程中纤维断裂、成纱率低、成本高的问题。

Humidity spinning technology is a new type of spinning technology developed based on the characteristics of hemp fiber, which can effectively solve the problems of poor yarn quality, low yarn count and high cost.

黑板条干(分)

80

麻粒(个)

7

百米重量, CV%

1.8

强力, CN

494

断强CV值, %

15.1

清洁化柔软抗皱染整及成衣整理技术
Clean and soft anti-wrinkle dyeing
and garments finishing technology

01

清洁化柔软抗皱染整技术
Clean and soft anti-wrinkle
dyeing technology

02

清洁化高品质成衣后整理技术
Clean high-quality
garments finishing
technology

纺织材料工艺技术特点

Technological characteristics of textile materials



清洁化柔软抗皱染整技术
Clean and soft anti-wrinkle dyeing technology

汉麻纱线丝光和针织面料丝光的“双丝光+液氨处理”抗皱新工艺，大幅降低织物表面毛羽数量和缩水率，增强了光泽性、染色渗透性及均匀性，提高了色牢度、抗皱性、弹性和柔软性。
The new mercerization technology of "double mercerization + liquid ammonia treatment" for silk yarn mercerization and knitted fabric mercerization has greatly reduced the number of hairiness and shrinkage rate on the fabric surface, enhanced the gloss, dyeing permeability and uniformity, and improved the color fastness, wrinkle resistance, elasticity and softness.

清洁化高品质成衣后整理技术
Clean high quality garment finishing technology

面料精细化和高档化的突破，大幅提高了面料的附加值，使汉麻面料也可以应用到内衣和婴儿服装领域。
The breakthrough of fabric refinement and high grade greatly increased the added value of fabric, so that hemp fabric can also be applied to underwear and baby clothing.

精准动态耐久压烫 (DP) 抗皱新工艺
A new anti-wrinkle technology for precise humidity - state durable press ironing (DP)
成衣汽蒸 (VP) 消除甲醛新工艺
A new process for eliminating formaldehyde by steam (VP) of garments

解决麻类面料易起皱、易变形，无法作为高档服装使用的缺陷。
Solve hemp fabric easy to be wrinkled, easily deformed, unable to use as high-end clothing.



高级汉麻面料



汉麻纺织新材料生产基地，位于湖北省嘉鱼县，占地面积478亩，现在已经形成年产汉麻纤维5000吨，纱线6000吨的生产能力，拥有生产纯麻、麻棉、麻/棉/宾霸、麻/绢丝、麻/羊绒、麻/棉/莫代尔等多种高端纱线的生产能力，纯纺纱可纺60Nm，麻棉纱最高可纺80S，具备供应国际高端奢侈品服装用面料的高品质纱线生产技术，更开发出多品种的汉麻面料，满足高档商务、运动休闲以及家居家纺类产品的需要，产品远销欧洲、日韩。
Han linen textile new materials production base, located in Jiayu county, Hubei province, covers an area of 478 mu, has now formed an annual output of 5000 tons, Han hemp yarn 6000 tons of production capacity, with production of pure linen, cotton, linen/cotton/bin, rebar, hemp/spun silk, linen, wool, linen/cotton/modal yarn production capacity and other high-end, pure yarn spinning 60 nm, linen cotton yarn spinning highest 80 s, with the supply of international high-end clothing with fabric high quality yarn production technology, to develop more varieties of Han linen fabrics, meet the high-end business, sports leisure and the need of home textile products, Products are exported to Europe, Japan and Korea.

雅戈尔汉麻新型纺织材料 New textile materials of Youngor hemp



雅戈尔汉麻已获国家发明专利26项，新申请4项；
实用新型专利43项，美国专利授权1项。
Youngor hemp has won 26 national invention patents and 4 new applications;
43 utility model patents, 1 US utility patents granted

企业荣誉

Corporate honor



汉麻综合开发利用的探索 Exploration of comprehensive development and utilization of hemp

创立华夏汉麻产业科学研究院，与黑龙江省科学院、中科大生命与健康研究院、军科院系统工程研究院等科研院所战略合作。研究院集中智力和资本优势，形成高水平研发机构的共同体，统筹汉麻产业创新资源，构建跨学科、前瞻性产业技术创新网络，形成汉麻从育种种植，到产业共性关键性技术的研发的策源地，从而促进和提升汉麻产业技术发展水平。

We established Huaxia hemp industry scientific research institute, and cooperated strategically with Heilongjiang Academy of Science, Research Institute of Life and Health of University of Science and Technology of China, Research Institute of System Engineering of The Academy of Military Science of the Chinese People's Liberation Army. The institute focuses on intellectual and capital advantages, forms a community of high-level research and development institutions, coordinates the innovation resources of the hemp industry, builds an interdisciplinary, forward-looking industrial technology innovation network, and forms the research and development of hemp from breeding and planting to key technologies for industrial commonality Policy source, so as to promote and upgrade the technological development level of the hemp industry.





Session 7B – Fibre Value


DECORTICATION OF HEMP WITHOUT RETTING: THE HOLY GRAIL OF PROFITABILITY

Charles Kovess


CEO & International Marketing Director
Textile & Composite Industries Pty Ltd, VIC

Secretary
Australian Industrial Hemp Alliance

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This Presentation is made in honour of Adrian Francis K. Clarke, the founder of TCI and the inventor of the world's best decorticator, a decorticator that does not need retting of hemp. Adrian died on 15 October 2015. He dedicated the last part of his life to solving the major problem of the hemp industry: how to decorticate without retting.





The most expensive step in using hemp was the process of separating the hemp stalk into its component parts of FIBRE and HURD; this process is known as 'DECORTICATION'.

Textile & Composite Industries Pty Ltd, driven by its philosophy of helping farmers to become more profitable, independent, environmentally green, and sustainable, has developed a DECORTICATING MACHINE over the past 26 years that eliminates these expensive processing costs.



THE OPPORTUNITIES IN THE HEMP INDUSTRY

There are highly-profitable opportunities for:

- Farmers
- Investors
- Designers of machinery, industrial products and systems
- Manufacturers of textiles and composites
- Food and cosmetics manufacturers
- Retailers
- Agricultural machinery suppliers
- Agricultural support services.



PROFITABILITY OF HEMP GROWING KEY INDICATIVE NUMBERS FOR ONE HECTARE

Seed cost \$10 per kg for 50 kgs per ha	\$ 500
Other growing costs up to harvest	\$ 1200-1500
TOTAL COSTS	\$ 1700-2000
Harvesting & processing costs	\$ 4000
Products for sale	
Fibre (3 tonnes @ \$2500 per tonne)	\$ 7500
Hurd (7 tonnes @ \$1000 per tonne)	\$ 7000
Seed (1 tonne @ \$3000 per tonne)	\$ 3000
TOTAL VALUE OF PRODUCTS	\$17,500



These are ideal fibre hemp crops.
 These crops are 3-4 metres tall and were grown in 90-100 days.
 They yield 3 tonnes of fibre, and 7 tonnes of Hurd, on average, per hectare.





This is the D8 Decorticator that overcomes the problem of retting.





This is the D8 Decorticator in 2012



This is the D8 Decorticator in 2016.





This is the D8 Decorticator in 2018.



Hemp fibre and hurd is now significantly more cost effective to produce WITHOUT RETTING by using TCI's D8 Decorticator. It now provides a very real substitute for existing products in the market.

Raw hemp fibre



Degummed hemp fibre for textile use



The secondary product that is produced is the Hurd. Hurd can be used to make hempcrete, paper, cellulose plastics, cellulosic materials, fuel ethanol, building products and building walls.





A Hemp Hurd and binder wall.
This wall gives maximum insulation and yet it breathes.
It is also fire resistant.
Houses made from hempcrete are ideal for fire-prone areas.



Hemp composites are light and strong, the ideal replacement for fibreglass and some carbon fibre
Shipping Pallets and caravans and even car bodies can be made from unretted hemp fibre



Successful competition against other products and successful global hemp industry growth requires Five Strategic Initiatives.



1. Generate Market Demand for Hemp rather than Farmer Push.

Identify well-funded and successful businesses that have already publicly committed to reduce their negative environmental impact and EDUCATE THEM about the potential for unretted hemp to be the way that they can solve their environmental challenges



2. Embrace an abundance philosophy and not one of scarcity.

Hemp can radically improve the lives of 70% of the world's population who today cannot afford to buy a new cotton shirt. Future sustainable economic growth will come from this 70%, not the existing 30% of consumers.

Additionally, as standards of living rise and consumption per capita increases, industrial hemp will be desperately needed as the prime source of new raw materials on our planet.



3. Avoid commoditisation of hemp products.

Do not fall into this trap. Avoid the current fate of oil producers, iron ore producers, sugar cane producers: in their cases, it is the traders who make the bulk of the profits, not the producers or growers.

Do not give away this magnificent raw material at a cheap price.



4. Harness the skills, experience and relationships in local communities to identify the hemp products that should be produced, and then supply the hungry markets that want these products both locally and globally



5. Educate politicians and enlist their support to succeed against the backlash of those established businesses who are opposed to hemp because of the impacts on their own businesses.



AIHA is promoting organic and biodynamic production, and has established an 'Organics in Transition' subcommittee

Hemp is naturally antibiotic and cuts UV rays.

Hemp will enable regional industries and economies to flourish.



Industrial hemp, WITHOUT RETTING, can make an immediate, inspiring, nurturing, positive, sustaining and life-giving difference to the planet.

The more D8 Decorticators that are used globally, the better our planet will become!

Your job is to share the ideas, insights and possibilities that you have generated during this Conference, to create a surge in economic activity, jobs and skills development.

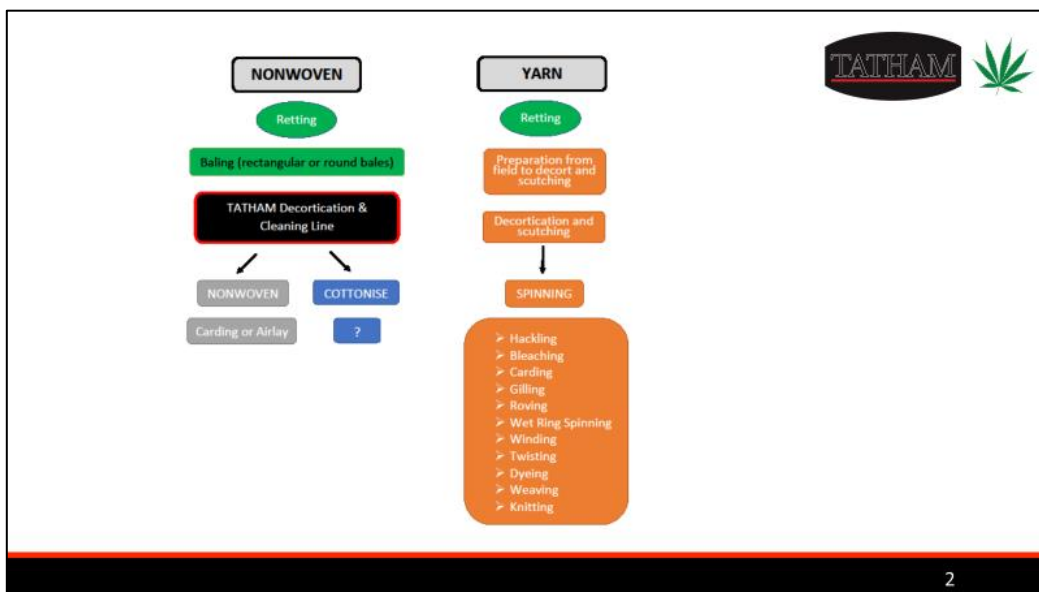
Session 7B – Fibre Value

HEMP DECORTICATION AND CLEANING WITH AN EMPHASIS ON PROCESSING FIBRE FOR NON-WOVEN PRODUCTS

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Field to Fibre

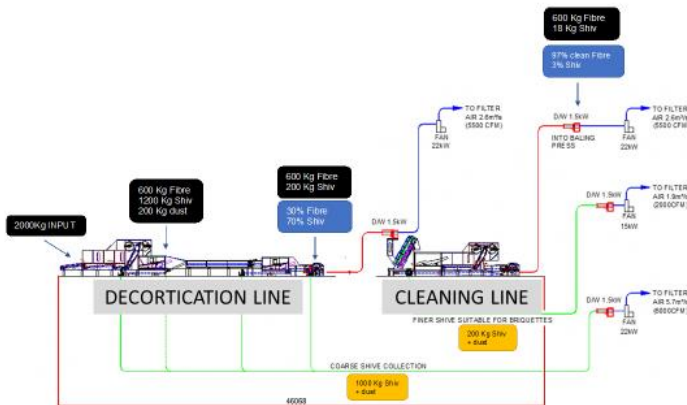


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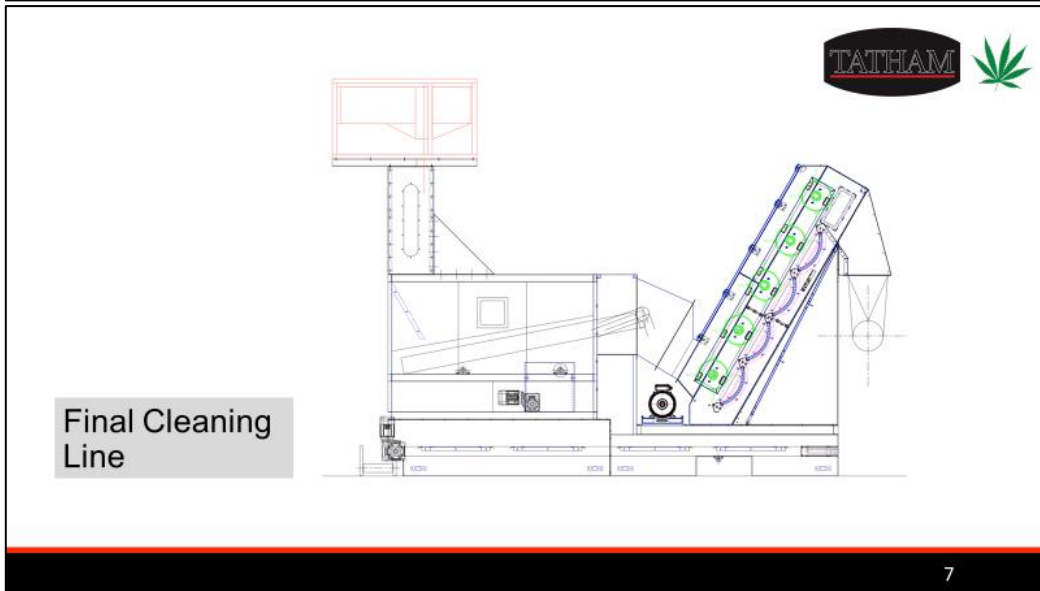
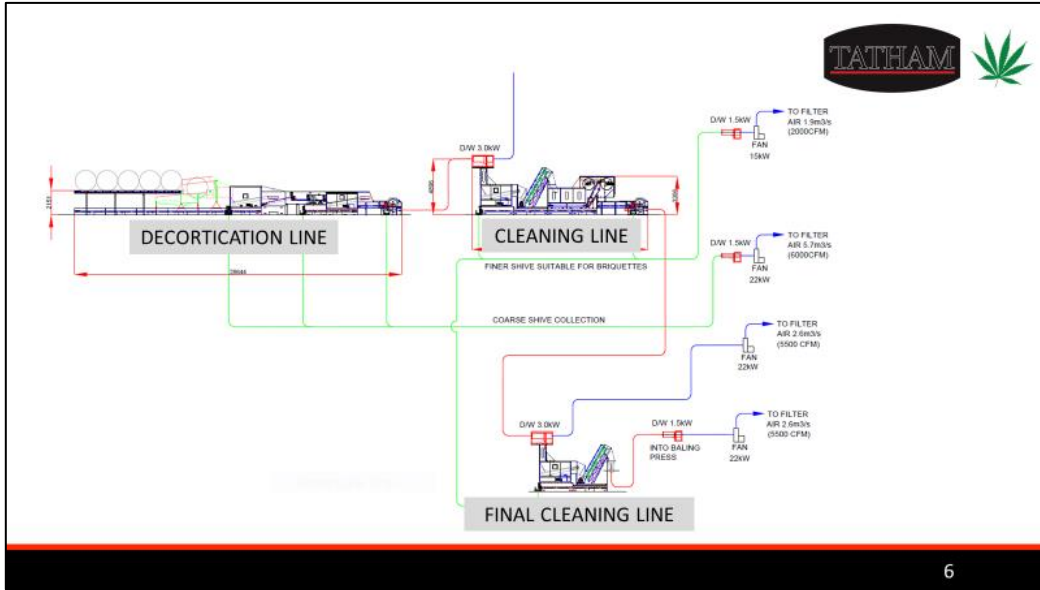
Retting Hemp





4



5







HEMP
DECORTICATION
& CLEANING

FIELD TO FIBRE

FIBRE	SHIV
Nonwoven	Hempcrete
Automotive	Building
Home Textiles	Animal Bedding
Apparel	Briquette
Bio Composites	Mulch Compost
Insulation	Paper

www.tatham-uk.com



9

Session 7B – Fibre Value


**TECHNOLOGY FOR WHOLE CROP UTILIZATION
DOUBLE CUT COMBINE**

Mark Reinders


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3 main revenue streams




Hemp STALK



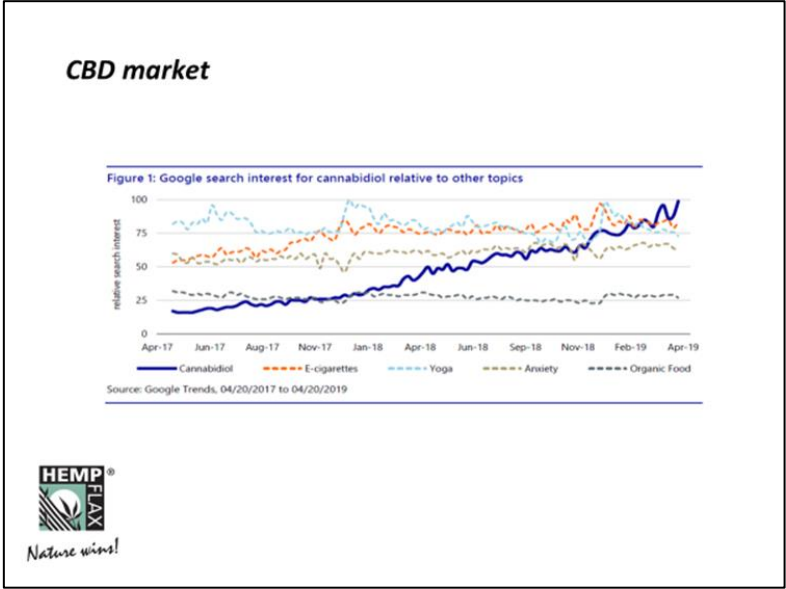
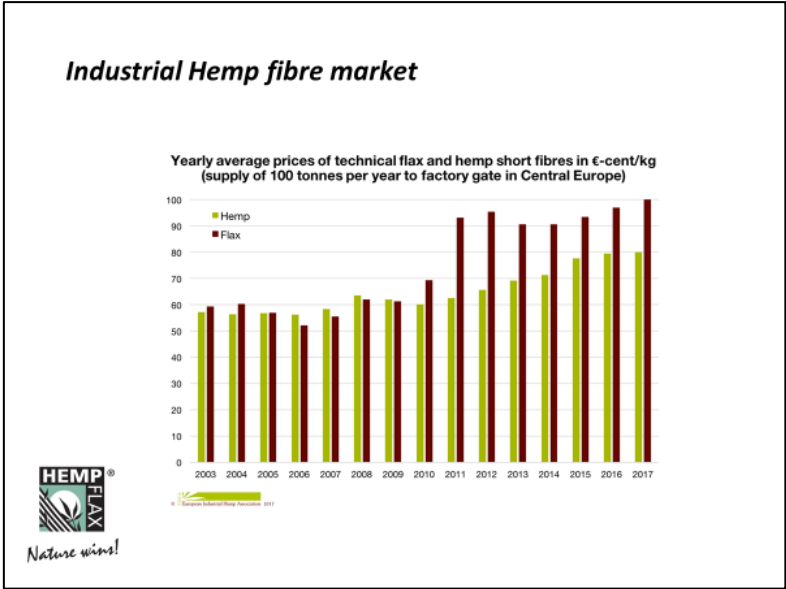
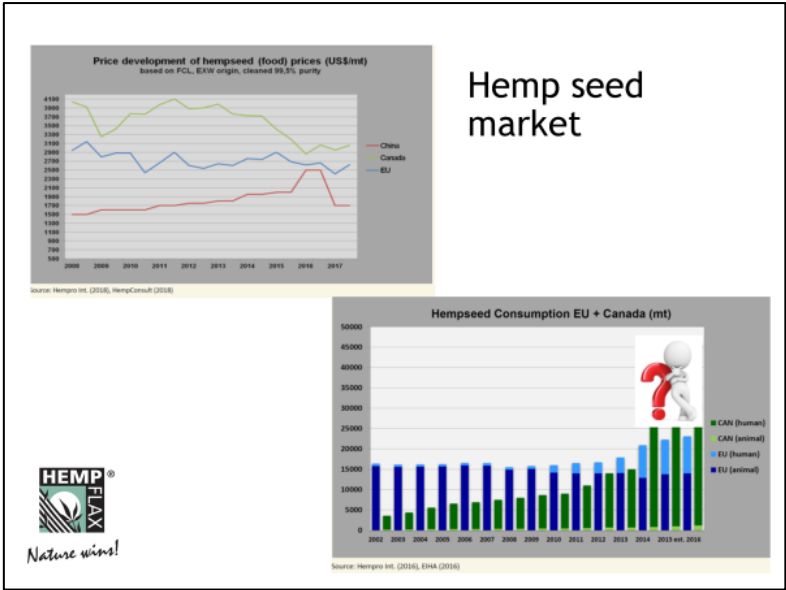
Hemp SEED



Hemp LEAF



Nature wins!



CBD market

Figure 5: Hype Cycle for Emerging Technologies – A Useful Tool for Evaluating CBD



Source: Gartner, Rabobank, 2019



Nature wins!

CBD market



Source: Hemp Business Journal



Nature wins!

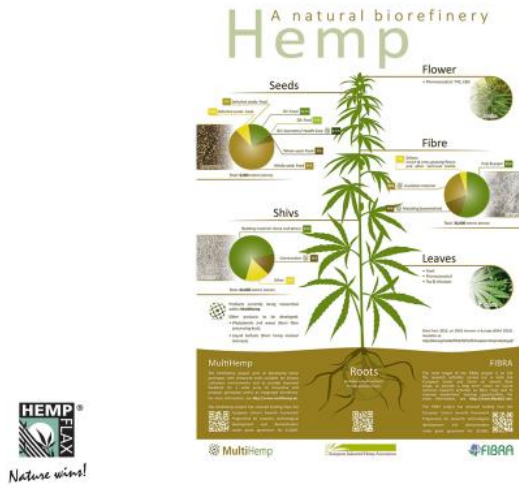
General conclusions

- ▶ Industrial hemp products are developing and are a good fit to the biobased circular economy
- ▶ Hempseed demand is increasing
- ▶ CBD markets will increase and professionalize
- ▶ More supply will put pressure on pricing
- ▶ More need for total crop valuation approach
- ▶ Only possible with appropriate infrastructure in place
- ▶ Need for harvesting technology with total crop approach



Nature wins!

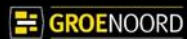
The answer: TOTAL CROP VALUATION!



The right machine for total crop valuation

See John Deere Double Cut (DC) 4510 hemp harvester at www.groenordbv.nl

WWW.GROENORDBV.NL



Advantages of DC Combine - Crop

- ▶ Swath of stems is not too big due to 4,5 working width → optimal drying
- ▶ Optimal dried stems will increase quality of fiber
- ▶ No seeds in the leaves, increases quality of leaves and CBD
- ▶ Possibility using leave chart/trailer at the back of combine from 2020



Advantages of DC Combine - Machine

- ▶ Combine can be used in other crops also, more efficiency per machine and optimal use of investment

Canola	Winterwheat	Hemp	Sunflower	Corn
June	July	August	September	October
				November

- ▶ Rebuilding combine takes only 1 day
- ▶ World Wide John Deere support
- ▶ Machine consists out of 96% original John Deere Parts
- ▶ Tested and improved by HempFlax, no 'teething problems'
- ▶ John Deere W series combines maintains market value



Session 8 – Consumers, carbon, regulation and R&D directions

TRENDSIGHTS ANALYSIS – SENSORY & INDULGENCE: CANNABIS

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A natural ingredient - broad range of therapeutic properties

"SENSORY & INDULGENCE"

Consumers' desire to try new and unusual ingredients, fragrances, formulas, and textures enables companies to offer CBD- or cannabis-infused products.

"MULTIFUNCTIONAL PRODUCTS"

Consumers are increasingly looking for additional benefits and functions in the products they buy.

What? Defining the trend

The recent legalization of cannabis for recreational use in various countries around the globe has seen cannabis-infused products (containing either the psychoactive or non-psychoactive components) become popular among consumers. For example, the non-psychoactive element, CBD, is claimed to have therapeutic properties and skincare benefits.

Who? Consumer targets

- CBD can allegedly help with reducing pain, arthritis symptoms, anxiety, depression, and epilepsy symptoms.
- Novelty-seekers may also be interested in trying out cannabis-infused products.

Industry's Potential?

- The global cannabis industry is estimated to reach \$2.2bn by 2020¹.
- The UK cannabis market is expected to be worth \$7m in 2019.
- The number of UK CBD consumers rose from 125,000 in 2016 to 250,000 in 2018.

"Many innovative and custom-designed products are reaching the market daily. They're made for all kinds of eventualities: for calming down, for energy, for focus and stamina, for pets, for winding down after the school run. CBD is the iconic supplement of our times and it's flying off the shelves."

Guy Coxall, chair of the UK Cannabis Trades Association

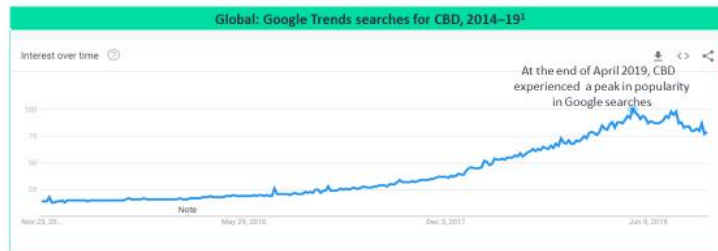
Source: [1] The Independent, January 2019. Image from Shutterstock.

GlobalData 2

Watch Out: Cannabis is a trending ingredient..

Interest in CBD grew significantly between 2014 and 2019

- Recent surge in Google searches for CBD-related products
- Legalization and successful medical case studies driving interest.
- FMCG companies assessing opportunity to sell CBD products



Source: [1] Google Trends, July 2019; [2] The Guardian, October 2018

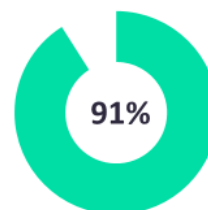
Consumers' interest - increased desire for cannabis



The desire to experiment is driving brands to offer cannabis products



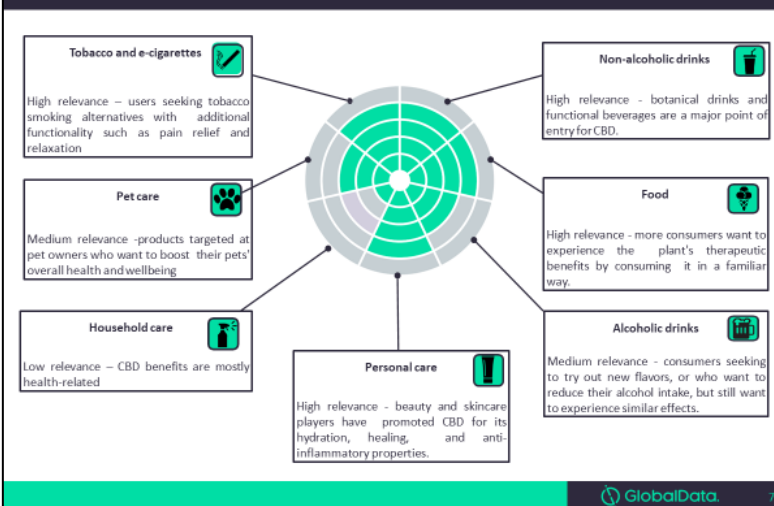
Anxiety-reducing credentials can make consumers try out cannabis-based products



Source: GlobalData global consumer survey

Key Innovations related to Cannabis to look at..

The relevance of the Cannabis application varies by sector



Beverages sector

Cannabidiol is showing early potential in **beverages**, an industry that has traditionally been quick to capitalize on new types of functionality

Product Name	Origin	Description
J.J. Kurberg hemp vodka	Estonia, France, and Germany	With the infusion of <i>Cannabis sativa</i> , this vodka does not have a trace of marijuana's active ingredients but retains the typical cannabis aroma. At 40% ABV and produced with organic hemp this vodka is claimed to be a handmade sipping schnapps (spirit)
Green Times High Flyer organic session IPA	UK	Under a brand promoted as "beers with a real difference," this organic CBD, cannabinoids, and terpenes infused beer is noted to contain less than 0.2% THC, resulting in an easy-drinking IPA that boasts a powerful hop hit with refreshing citrus aftertaste.*
Bumblezest CBD tonic water	UK	This tonic water is an uncommon combination of CBD, ginger, cinnamon, and lemon juice for an unusual sensory experience. It is claimed to be low in calories and sugar, and to have all-natural flavors and ingredients.

Food industry and dietary supplements sector

Cannabis-based foods can attract consumers who want to try cannabis products for their alleged benefits, but want to consume them in a familiar way

Not Pot dietary supplements – US



The jars contain polar bear-shaped gummies, and each bear contains 10 milligrams of organic full-spectrum hemp-derived CBD. The supplements are intended to reduce stress, anxiety, and pain, increase relaxation, and improve mood.

The Marshmallowist cannabis grapefruit and pink peppercorn marshmallows – UK



These marshmallows are claimed as "crafted from organic cannabidiol (CBD), the non-psychoactive extract of Cannabis." The CBD oil selected for the variety is claimed to provide "exceptionally high bioavailability and therapeutic effect."

Défoncé chocolate – US



Défoncé Chocolatier has tried to put anxious consumers at ease by determining the "right" dosage and offering clear instructions and dosing recommendation on the package. Each 100g chocolate bar has 18 pyramids, totaling 180mg of THC (with a 10mg THC dosage).

Source: GlobalData's Product Launch Analytics

GlobalData

9

Innovation - Ben & Jerry's launching a CBD-infused ice-cream

On May 30, 2019, **ice cream manufacturer** Ben & Jerry's announced via a "CBD Statement" that the company is open to offering CBD-infused ice cream as soon as the substance is FDA-approved



Source: GlobalData's Product Launch Analytics

GlobalData

10

CBD has also taken over the beauty industry

Cannabidiol is a recent buzzword in **beauty and grooming** industry

Babaria face cream – Spain



This is a face cream with cannabis seed oil, moringa, and vitamin E that claims to suit sensitive skin. This "vegan", "nourishing", as well as anti-aging" product can attract consumers' attention by using cannabis as its star ingredient.

Josie Maran Skin Dope Organic Glow Oil – US



This product is described as "age-defending oil powered by Argan Oil and hemp seed oil for strong, resilient, glowing skin that bounces back. The product may attract curious shoppers who believe in the health-related properties of cannabis addition in skincare items.

Wu-Tang x Milk Makeup lip color – US



This lipstick contains "antioxidant-rich" lotus water, cherry blossom, and ginseng, as well as hemp extract. According to the brand, the launch is "paying homage to deep Wu wisdom" and it "provides you, the Wu Warrior, with makeup to help set your intentions and master your identity."

Source: GlobalData's Product Launch Analytics

GlobalData

11

Category Innovation - toiletries and hygiene products

A more holistic perception of health is driving the proliferation of **hygiene** products that promote wellbeing

Yaooh organic hemp seed oil shower gel – UK



This shower gel is noted to feature hemp seed oil in the formulation, while its Summer Breeze variety is stated to also contain floral fragrances to create an "invigorating and refreshing" product.

Tetesept Anti-Stress – Germany



This bath product provides a gentle counterbalance to stress with its uncommon combination of hemp and passionflower attracting particularly those curious about the effects of hemp on their body and mood.

Joanna Botanicals for Home cannabis seed body scrub – Poland



This cannabis oil is claimed to be rich in linoleic acid as well as palmitic and gamma-linolenic acids, proteins, amino acids, minerals, and vitamins. The extract offers an "anti-inflammatory, regenerating and antiseptic" action.

Source: GlobalData's Product Launch Analytics

GlobalData

12

OTC healthcare companies investment

Access to and awareness of CBD and cannabis-derived **healthcare** determines a surge in usage

MedTerra CBD Monthly Wellness – US



This product, called CBD Monthly Wellness, is the first product consisting of CBD-based pills for period cramps. It contains 99.6% pure CBD. Other ingredients include: chaste berry tree, dong quai, caffeine, MCT oil, and bovine gelatin.

Endo Drops hemp oil – US



This oil is promoted as cannabinoid-rich to support homeostasis. According to the brand, cannabinoid-rich hemp oil tinctures are the most popular and most economical way to ingest ingredients such as this orally.

Care By Design medicinal cannabis pain cream – US



This "all-natural, non-psychoactive" topical CBD cream is used to relieve muscle and joint pain. It uses full-spectrum CBD and a blend of other essential oils.

Source: GlobalData's Product Launch Analytics

GlobalData

13

CBD and hemp products are making its presence felt in the pet care & vaping products too

Cannabis is showing potential in the **pet care** sector and also gaining traction in the **alternative smoke** industry

Green Gorilla hemp and olive freeze-dried dog treats – US



These treats are made using a CBD lamb recipe, promoted as an "ultra-wellness" option for dogs. According to the brand, the organic recipe contains hemp extract and supports overall wellness of hips and joints, maintains a sense of calm, and improves brain function.

PhytoMaxx PCR hemp oil for pets – US



This product contains a blend of phytonutrients extracted from organically grown cannabis hemp from Colorado and is tagged as having 0% THC. It is suitable for cats and dogs.

Pure Hemp Botanicals vape drops – US



These CBD vape drops are suitable for e-cigarette devices or other atomizers used for vaping. The product can be bought from the company's official website, where consumers can also check the lab results for their product¹.

Source: GlobalData's Product Launch Analytics

GlobalData

14

Consumer Trends to watch-out..

Consumers are willing to experiment with new and emerging ingredients that claim to enhance wellness

CBD has emerged as a health and wellness product

Popularity


- Numerous beneficial claims, like a general sense of wellbeing, propagated through media.

Curious Consumer

- Consumers have begun to try CBD-infused products, attracted by allegations such as pain relief, reduction in inflammation.

Millennials

- Millennials and Generation X form 90%¹ of experimenters.



65% of global consumers are always or often influenced by how the product/service impact their health and wellbeing when choosing it².

Consumers seek natural ingredients in their purchases

Consumers are willing to try various "natural" remedies to treat ailments

Free From Artificial


- The revolution against anything chemical or artificial is ongoing, causing many consumers to trust more natural products to aid with various illnesses.

Natural Label

- 49% of global consumers proactively seek food products that contain only natural ingredients, attracted by "natural labels".

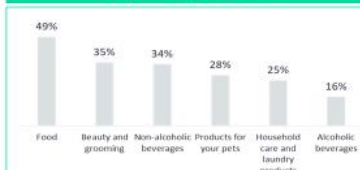
Nature infused

- Offering companies an opportunity to sell cannabis-based products containing only "natural" ingredients, targeting people who would rather treat various ailments without using any medicine.



32% of consumers globally often or sometimes like to experiment or try new healthcare products and non-prescription medicines

Global: consumers who proactively seek products that contain only natural ingredients, 2019



Category	Percentage
Food	49%
Beauty and grooming	35%
Non-alcoholic beverages	34%
Products for your pets	28%
Household care and laundry products	25%
Alcoholic beverages	16%

Legality of cannabis ..

Underdeveloped regulatory framework for cannabis

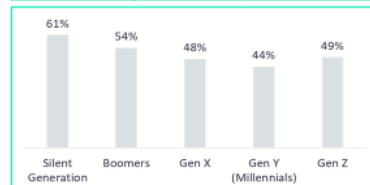
The legality of cannabis is hazy, and can vary from one place to another

- The only two countries in the world where the cultivation, possession, purchase, and consumption of cannabis-based products have been formally legalized are Canada and Uruguay.
- The legal medical use of cannabis is more widespread, but access to treatment is limited. Ireland is one of the most recent countries to allow access to cannabis for medical reasons. The Irish health minister signed a legislation on June 26, 2019, allowing for the Medical Cannabis Access Programme to operate on a pilot scheme for five years.
- These legal hurdles affect companies selling CBD-infused products too, even though CBD is not psychoactive and "does not appear to have abuse potential or cause harm," according to the World Health Organization (WHO) Expert Committee on Drug Dependence.
- However, the FDA still prohibits firms from adding CBD and THC to supplements, drinks, beverages, or oils, and making any medical claims about them⁷. In fact, on July 22, 2019, the FDA issued a warning letter to Curaleaf, a US medical and wellness cannabis operator, for selling unapproved CBD products with "unsubstantiated" health claims⁸.

Source: [1] Eyewitness News, 2018; [2] Radio Free Europe, July 2018; [3] The Journal, June 2019; [4] The Sun, June 2019; [5] WHO, December 2017; [6] Home Office Circular, November 2018; [7] CNBC, May 2019; [8] CNN Health, July 2019; [9] CNBC, May 2019

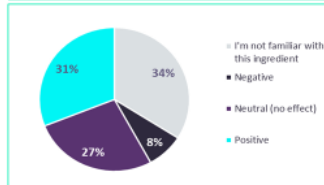
Can negative perceptions of the plant cloud its ability to be positioned as healthy?

Global: consumers who think cannabis/marijuana has a negative impact on their health, 2019



Consumer attitudes toward cannabis are mostly negative irrespective of age, although younger generations are more positive about it

Global: "Do you think hemp protein will have a positive or negative impact on your health?", 2019



34% of global consumers are unaware of the benefits of hemp protein

[1] GlobalData Q3 2019 global consumer survey; [2] Healthline, August 2018

GlobalData at a glance

4,000 of the world's largest companies **make better and more timely decisions** thanks to our **unique data, expert analysis and innovative solutions delivered through a single platform**

Our Solutions

GlobalData provides a range of ways that clients can access our data & insights to meet their individual business needs:

- Intelligence Center
- Consulting Services
- Reports

Our Industry Coverage

Our services cover **five primary industries**:

- Consumer
- Retail
- Technology
- Healthcare
- Financial Services

Our Value Proposition

We empower clients to **decode the uncertain future** they face by providing:

- Unique data
- Expert analysis
- Innovative solutions
- One platform

Our Expertise

- Market Insights
 - Market Forecasts
 - Competitive Intelligence
 - Consumer Insights
- Innovation & New Product Development
- Strategic Planning
- Marketing
- Channel and Sales Management

Our clients:

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Session 8 – Consumers, carbon, regulation and R&D directions

TECHNO-ECONOMIC STUDY OF WHOLE HEMP PLANT BIOREFINERY FOR APPLICATIONS IN THE BUILT-ENVIRONMENT, FOOD INDUSTRY AND ENERGY SECTORS

Sina Rezvani^{1*}, Christopher Kennedy¹ and David Shields²

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ABSTRACT

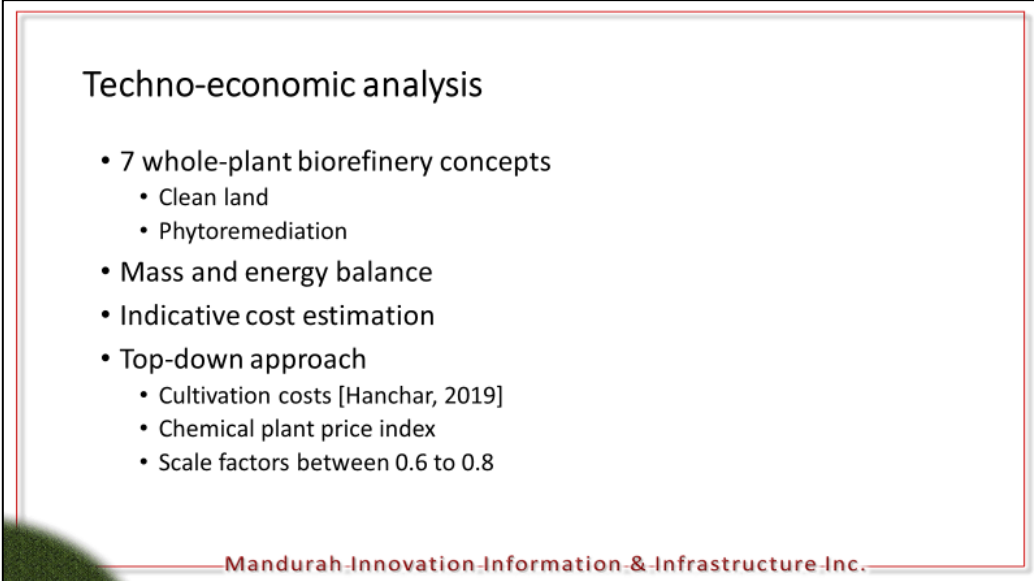
This study analyses the techno-economic characteristics of hemp cultivation and uses in several different scenarios. The goal of the study is to show options conducive to optimising the economic viability of hemp cultivation in both clean and contaminated land. The harvest will be accordingly categorised in a multi-application resource plan.

The first scenario highlights the economic characteristics of crops cultivated on uncontaminated land for production of hemp seed, fibre and hurd as the main products with the remaining part of the crop used for cattle feed. We also consider the added value of CO₂ farming during the cultivation and post-harvest stages. The second case study includes the production of food-grade oil from hemp seed and cattle feed from the remaining oil cake as high protein supplements. Added value is generated through the extraction of terpenes from plant leaves and flowers for the utilisation in the chemical industry. As a further variation, a third scenario considers the use of hurd for energy generation and the production of fishmeal from the oil cake. Fishmeal has a considerably higher

wholesale price compared to cattle feed cancelling out the lower marketing price of hurd as a source of energy. The remaining case studies deal with crops cultivated on contaminated lands.

Hemp crops have showed a phytoremediation ability to remove pollutants and heavy metals from contaminated soil and disperse them gradually within the plant body. Harvests from contaminated lands are excluded from any food-grade products. On this ground, this fourth scenario utilises the hemp seed for biodiesel production. The oilcake along with leaves and flowers will enter an anaerobic digestion process for biogas production. The fibres and hurd can be used either as raw materials in the textile, pulp and chemical industry or energy source in the combustion or gasification process. We also consider the whole plant utilisation as an energy source. An interesting option is the use of direct chemical liquefaction of the whole-plant in a hydrogen-pressurised reactor at an elevated temperature up to 420°C in the presence of catalysts to produce transportation fuel. The hemp oil can partially substitute solvents required for the liquefaction process. The use of direct chemical liquefaction has been demonstrated for various plants. The characteristics and application areas of liquid, gaseous and solid product from hemp liquefaction however needs to be validated in future studies.

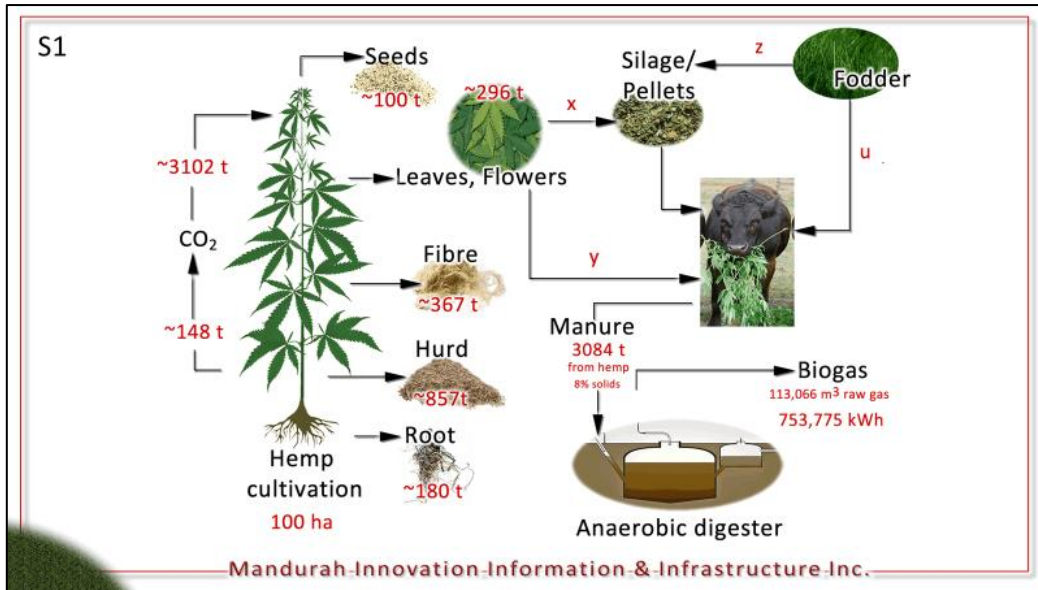
Keywords: Techno-economic assessment; biorefinery of hemp; food-grade products; energy source; raw materials



Techno-economic analysis

- 7 whole-plant biorefinery concepts
 - Clean land
 - Phytoremediation
- Mass and energy balance
- Indicative cost estimation
- Top-down approach
 - Cultivation costs [Hanchar, 2019]
 - Chemical plant price index
 - Scale factors between 0.6 to 0.8

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Fixed operating cost

Operation	Capital costs		Series of payments
Cost of cultivation	600,000 A\$		61,778 A\$/yr
Cost of decortication	200,000 A\$		20,593 A\$/yr
Seed fiber separation	150,000 A\$		15,444 A\$/yr
Processing green parts	50,000 A\$		5,148 A\$/yr
Contingencies	302,248 A\$		31,120 A\$/yr
Anaerobic digestion Cost	400,000 A\$		41,185 A\$/ye
Total costs			175,268 A\$/yr

Uniform series present value
Interest rate of 6%
15 years payback time

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Variable operating costs

Variable operating costs	A\$/100-ha.yr
Cultivation	114,221
Decortication	42,258
Anaerobic digestion	29,397
Misc. operations	55,763
Total operating costs	241,638

- Cultivation cost: Fertilisers, seeds, land charges, equipment, fuel, lube, operating capital, and labour
- We assume ground water use or water from mining operations
 - Water expenses can be crucial.

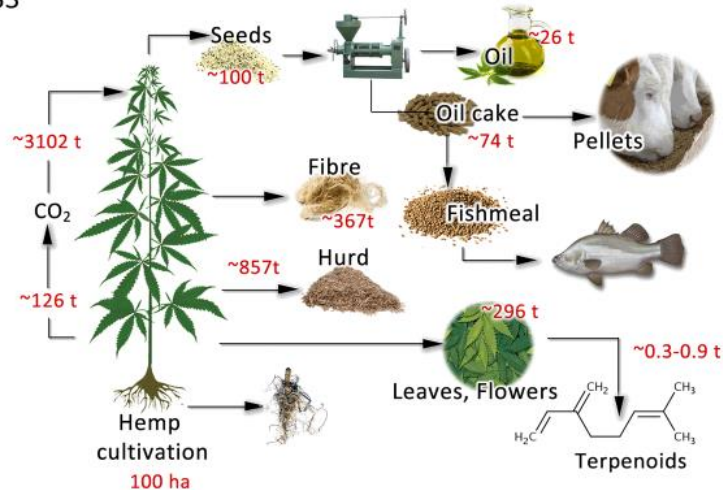
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Revenue

Product	Production	Price	Subtotal A\$/ 100 ha
Fibre	367.20 t	800 A\$/t	293,760
Hurd	856.80 t	350 A\$/t	299,880
Seed	100.01 t	2000 A\$/t	200,016
Leaves	296.03 t	0 A\$/t	0
Roots	180.00 t	0 A\$/t	0
Biogas	753,775.00 kWh	0.14 A\$/kWh	105,529
CO2 trading	2,953.94 t/a	15 A\$/t	44,309
Max.			943,494

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S2 and S3



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Oil extraction

- Oil extraction: Dox-hivex technology (scaled down)
- Fixed operating costs of oil extraction: A\$68k/year payback time 10 years
 - 1 month operation per year for the proposed 100 ha cultivation
 - Throughput up to 5t/day
- One month full operation at 720 man hours: A\$25,200/month
- Energy cost for oil extraction: A\$7.8k/month
- Total operating costs for oil extraction: **A\$50k** for one month operation
- Revenue from oil: **A\$79k** for oil and up to **A\$30k** for oilcake

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S2: Fibre, hurd, oil and animal feed

- Fixed operating costs; **A\$143k/year**
 - Contingencies A\$31k/year
- Var. operating costs: **A\$259k/year**
- Total expenditure: **A\$ 402k/year**

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Revenue S2

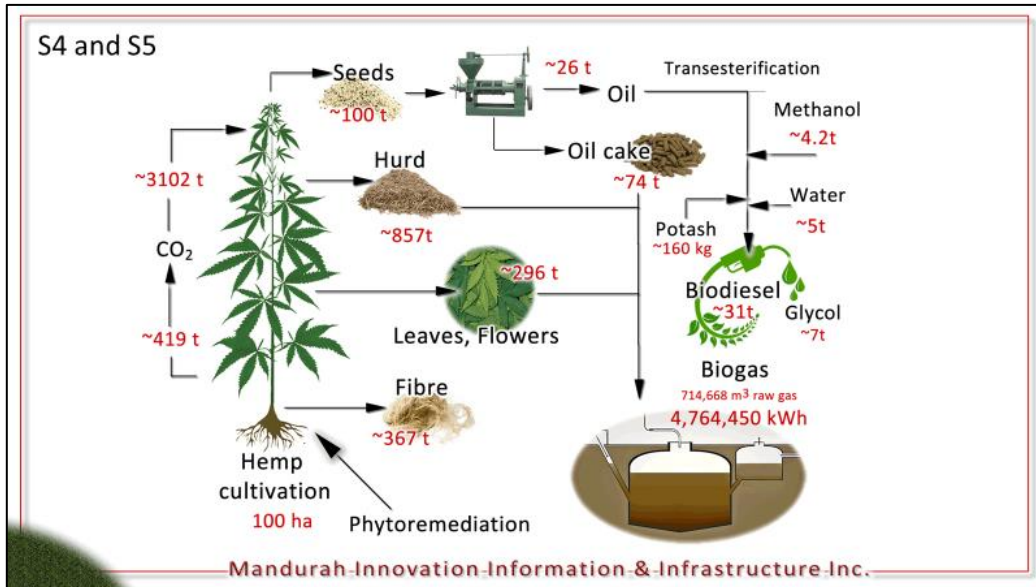
Product	Production t/a	Unit price A\$/t	A\$/100 ha
Fiber	367	800	293,760
Hurd	857	350	299,880
Oil from seeds	26	3,000	78,756
Cattle feed	74	400	29,502
Leaves	296	500	148,014
Roots	180	0	0
CO ₂ trading	2,973	15	44,598
Max.			894,511

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S3: Fibre, hurd, oil and fishmeal

- Fishmeal production costs according to FAO technical paper 142
 - A fixed cost of over **A\$9k/month** operation of 74t
 - Operating costs of over **A\$19K/month**
 - Specific fish meal price: **A\$1.2k**
 - Income from fishmeal production: **A\$89k** (processed in a month)
- Total expenditure: **A\$441k/year**
 - Fixed operating cost: A\$157k/year
 - Variable operating cost: A\$284k/year
- Total income < **A\$953k/year** (max if yield according to assumption)

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S4: Case with an integrated large AD plant

Product	Production	unit price	A\$/100ha
Fiber	367.20t	800A\$/t	293,760
Hurd	856.80t	0A\$/t	0
Oil from seeds	34.65t	0A\$/t	0
Biodiesel	30.84t	1200A\$/t	37,009
Glycerol	7.09t	200A\$/t	1,419
Oil cake	65.36t	0A\$/t	0
Leaves	296.03t	0A\$/t	0
Roots	180.00t	0A\$/t	0
Biogas	4,764,449.96kWh	0.14A\$/kWh	667,023
CO ₂ trading	2,683.49t/a	15A\$/t	40,252
Max.			1,039,463

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S5: Hurd sold separately

Product	Production	Unit price	A\$/100ha
Fibre	367.20	t 800 A\$/t	293,760
Hurd	856.80	t 350 A\$/t	299,880
Oil from seeds	34.65	t 0 A\$/t	0
Biodiesel	30.84	t 1200 A\$/t	37,009
Oil cake	65.36	t 0 A\$/t	0
Leaves	296.03	t 0 A\$/t	0
Roots	180.00	t 0 A\$/t	0
Biogas	1413409.96	kWh 0.14 A\$/kWh	197,877
CO ₂ trading	2,683.49	t/a 15 A\$/t	40,252
Max.			868,779

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Overall economics of S4 and S5

- S4: **A\$862k/year** (max)
 - Fixed: A\$416k/year
 - Variable: A\$446k/year
- S5: **A\$651k/year** (max)
 - Fixed: A\$391k/year
 - Variable: A\$259k/year

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Hemp as a fuel source

- No need for expensive CCS
- Technologies
 - Combustion
 - Gasification
 - Pyrolysis
 - Anaerobic digestion
 - Ethanol production
 - Terpenoids as jet fuel
 - Indirect liquefaction
 - Hydrothermal liquefaction
 - Direct Liquefaction

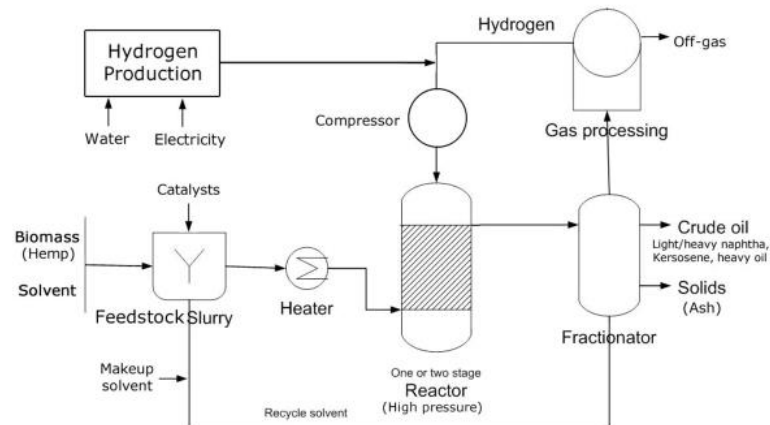
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Economics of energy generation from hemp

- Combustion
 - 5MW Circulating Fluidised Bed Combustion
 - Biomass used in a month full operation
 - Income from electricity production **A\$520k/month**
 - Operating costs: **A\$384k/month**
- Gasification
 - 280kW
 - Capacity factor of 75%
 - Income: **A\$485k/year**
 - Operating costs: **A\$ 580k/year**

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Liquid fuel production



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Economics of hemp liquefaction

- Payback time: 25 years
- Fuel output: 13,000 barrels/month
 - Breakeven fuel selling price: A\$77/bl
 - Use of other fuel sources for the rest of the year
- Small system with 12,000 barrels/year
 - Breakeven fuel selling price: A\$114 per bl

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Session 8 – Consumers, carbon, regulation and R&D directions

INDUSTRIAL HEMP AND CARBON MARKETS

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ABSTRACT

Addressing climate change is crucial to the survival of humanity and the Australian government has incentivised climate change mitigation through the Climate Solutions Fund (CSF). The CSF allows participants to accrue carbon credits by participating in an approved methodology, and there are many methodologies available to Australian agriculture sector. Australian industrial hemp production is an emerging agricultural industry that may have the potential to participate in the CSF. This presentation will provide an overview of the CSF and provide examples of currently approved methodologies. It will then provide an assessment of the climate mitigation potential of using hempcrete to replace brick veneer walls and discuss these results in the context of a potential CSF methodology for the hemp industry. Insights into the process that the Department of Environment and Energy follows in developing methodologies will also be provided.

Climate Solutions Funds

- Previously (or still?) the Emissions Reduction Fund
- Proponents contracted to supply agreed number of carbon credits at an agreed price
- Minimum abatement of 2 000 t CO₂-e required to participate
- Reverse auction
- Proponents must participate in an approved methodology

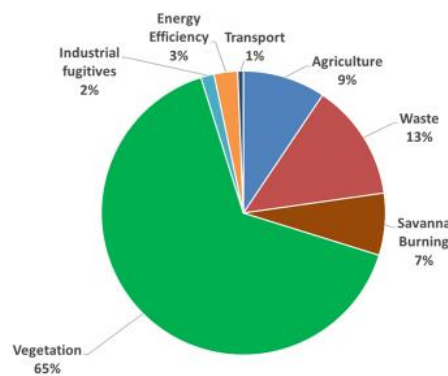


Examples of approved methodologies

- Two broad groups; sequestration and avoided emissions
- Sequestration
 - Soil organic carbon
 - Forestry and re-vegetation
- Avoided emissions
 - Methane destruction from dairy/piggeries
 - High efficiency industrial equipment
 - Energy efficient commercial buildings



Contracted abatement

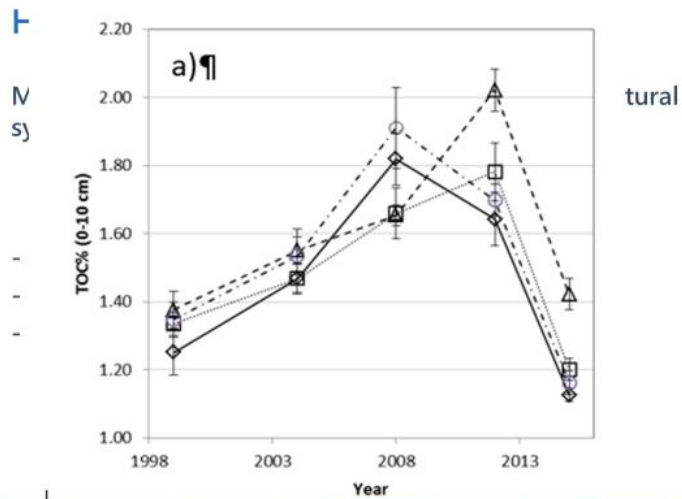


Hemp and existing methodologies

Measurement of soil carbon sequestration in agricultural systems



- Costly
- Uncertain
- Labile = easily lost



House with hempcrete walls



= 9 432 kg CO₂-e



= 2 145 kg CO₂-e

- cradle-to-wall
- ISO 14044
- UNFCCC Kyoto compliant



= -7 287 kg CO₂-e mitigation for every hempcrete house that replaces brick house

Hempcrete ERF methodology

- **Additionality**
- **Sources of abatement**
 - Avoided emissions due to reduced masonry inputs
 - Avoided emissions due to lower energy requirements of building (?)
 - C stored in hempcrete (unlikely)
- **Methodology proponent**
 - Builders using hempcrete or hempcrete "manufacturers"
- **Qualification (2 000 t abatement)**
 - 285 4 bedroom houses
- **Returns on abatement**
 - Last bids were \$14.17 t CO₂-e (2019 auction)
 - @ \$14.17 = ~ \$100 per house (assuming no discount for uncertainty)
 - Potential for secondary markets

The vagaries of ERF methodology development

- Development all in-house by dept.
- Large quantum of low-cost abatement
- Squeaky wheel gets the oil
 - Co-ordinated approach to lobbying
 - Industry "champions"
- It's not what you know.....
- Not a case of "build it and they will come"
 - High likelihood of participation (in the mind of dept.)
 - Not a mechanism to develop an industry
- **Current limitations**
 - Production capacity
 - Processing capacity
 - Market access

What are the consequences?

- Limited amount of agricultural land
- Replacing products with hemp requires land
- Displaces existing agricultural production
- More agricultural land created (deforestation)

Hemp agronomy

Grown in Macquarie valley NSW

Hurd yield = 10000 kg ha⁻¹

Fibre yield = 2000 kg ha⁻¹

Seed yield = nil

N application rate = 111 kg ha⁻¹ (as MAP and urea)

Irrigation = 5 ML ha⁻¹

Minimal herbicide applications – 1 fallow, 1 in-crop

Nil fungicide/insecticide applications

Session 8 – Consumers, carbon, regulation and R&D directions

DAY ZERO WATER. ARE YOU READY?

Chris Wootton

CEO

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What is Water Stewardship?



Water stewardship is the use of water that is socially and culturally equitable, environmentally sustainable and economically beneficial, achieved through a stakeholder inclusive process that involves site and catchment based actions

AWS Global Network



AWS Asia-Pacific



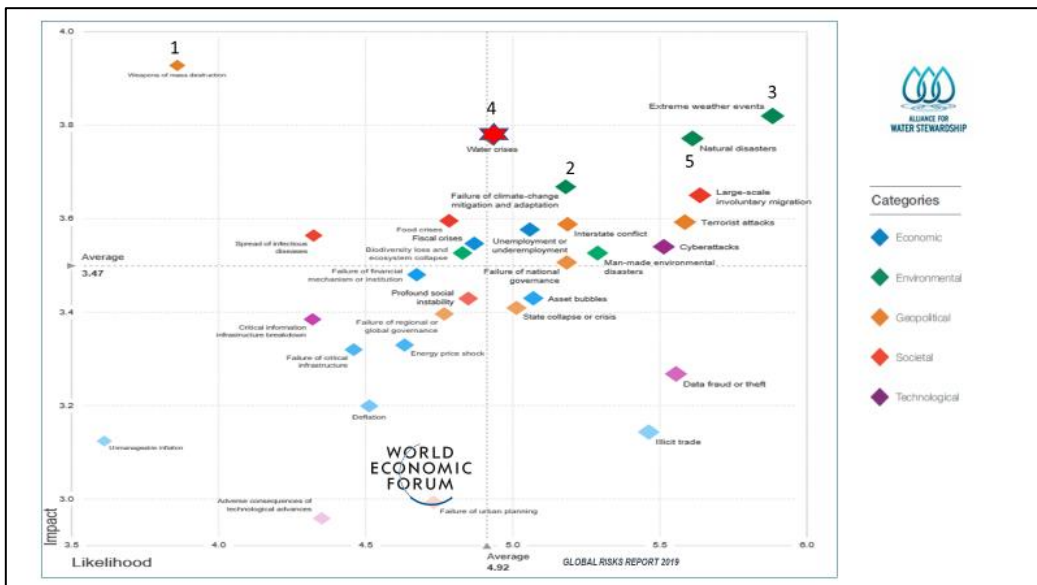
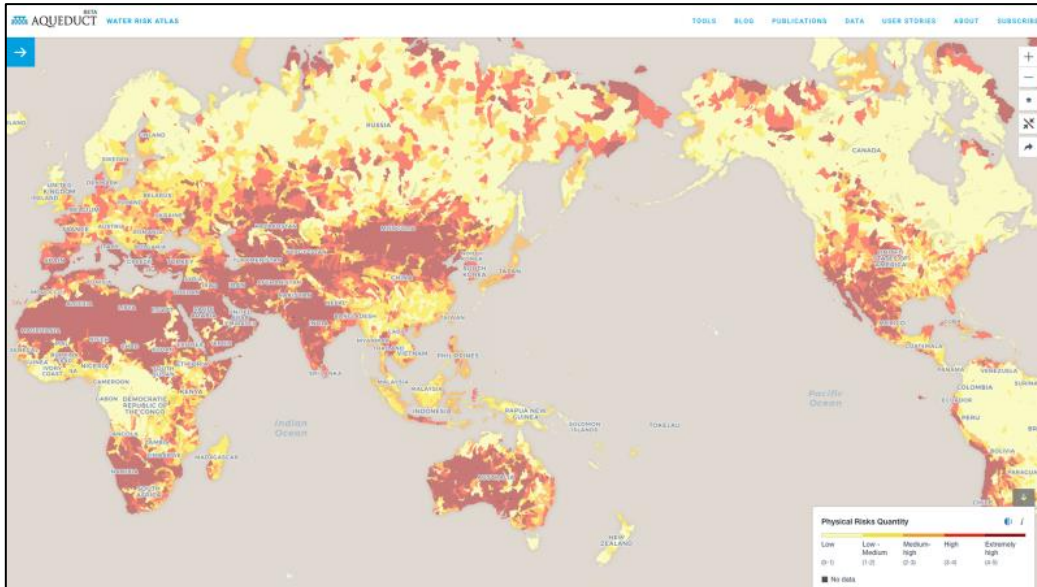
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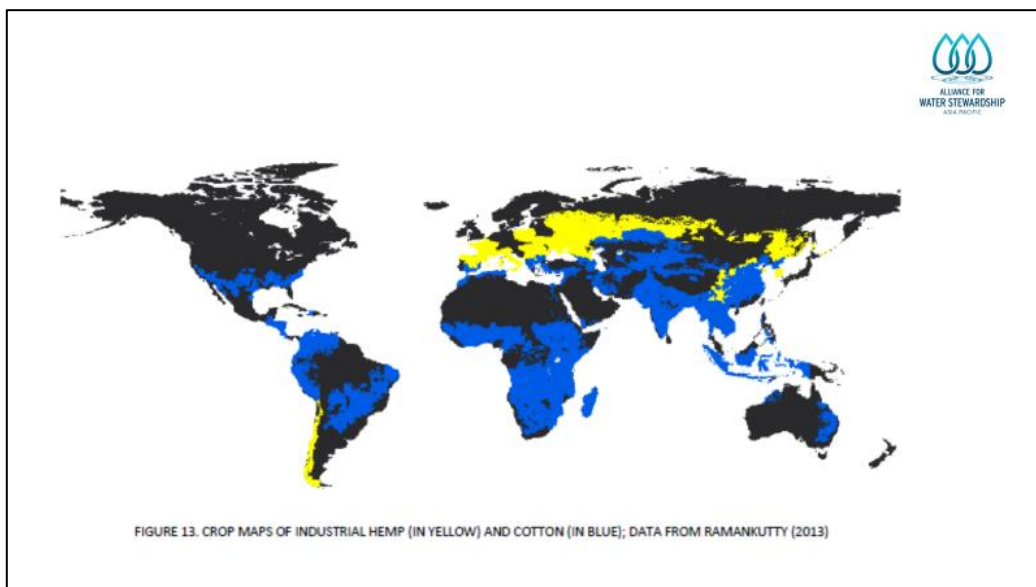
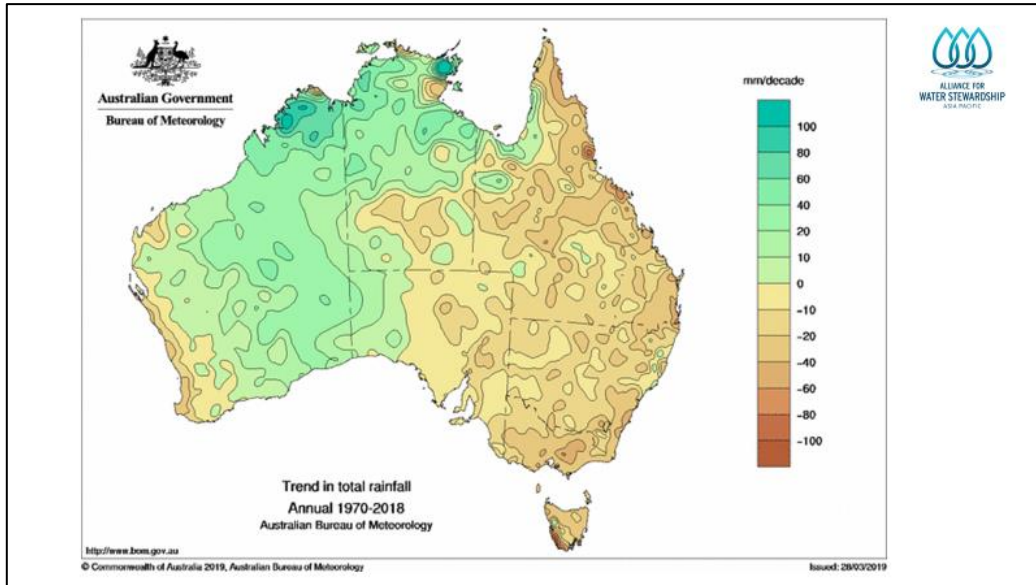
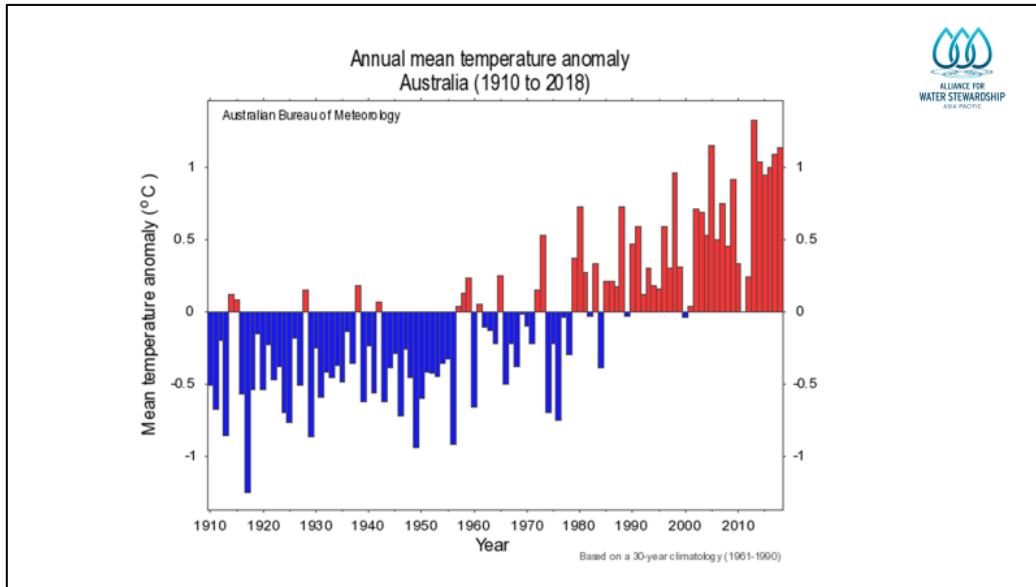
- NFP entity with DGR 1 status.
- A membership-based organisation.
- Delivering programs in Australia, Indonesia & China.
- Responsible for the AWS Standard and training for the Asia-Pacific region.

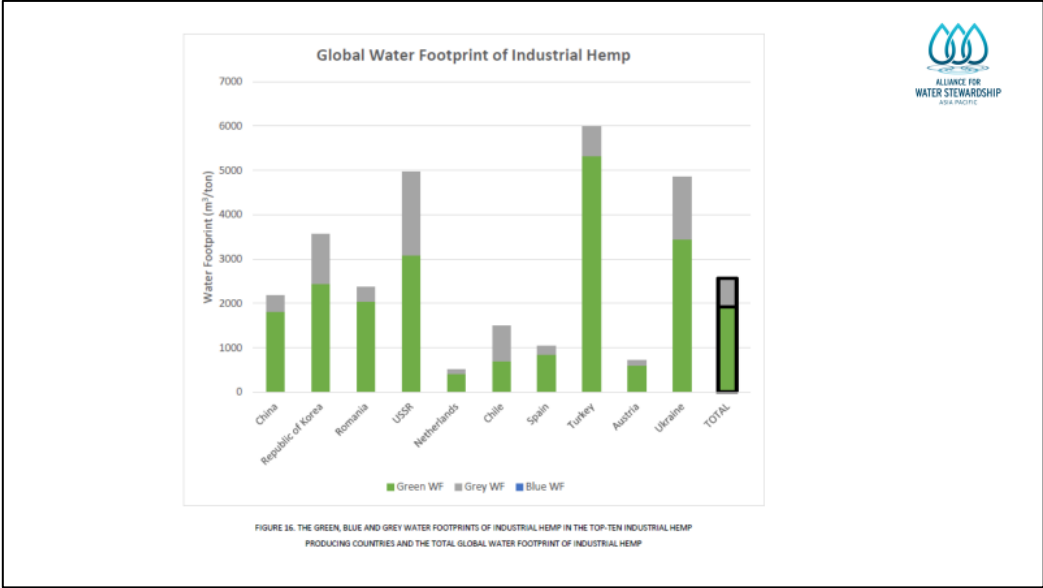
Our Global Members



- **55%** increase in global water use by 2050
- **40%** of the world's population living in areas of severe water stress by 2050
- **78%** of the world's workforce are moderately/heavily dependent on water availability







1. Day Zero Water Readiness Program

From: **To:**

- To assist corporations/businesses to identify their water balance and working with their stakeholders – upstream and downstream to identify their impact, risk and opportunities
- Involves: pre-water use assessment, site visit, stakeholder forum and report outlining their readiness status for Day Zero Water

2. AWS Standard Certification

The Alliance for Water Stewardship is responsible for the **ONLY** global standard for Water Certification (AWS Standard V2.0). It is a **site-based** system for large water users to understand their water use and impacts, and to work collaboratively and transparently for sustainable water management with all stakeholders within a catchment context.

GOOD WATER GOVERNANCE

SUSTAINABLE WATER BALANCE

GOOD WATER QUALITY STATUS

IMPORTANT WATER-RELATED AREAS

SAFE WATER, SANITATION AND HYGIENE FOR ALL (WASH)

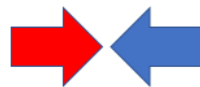
2. AWS Certification



3. Water Off-Set Trading Scheme



Buyers of Water Certificates:
To achieve Net Zero Water – seeking to buy water credits



Sellers of Water Certificates:
Seeking investment to achieve water efficiency savings



Session 8 – Consumers, carbon, regulation and R&D directions

**THE TASMANIAN HEMP INDUSTRY
A LOOK AT THE CHALLENGES AND DEVELOPMENT**

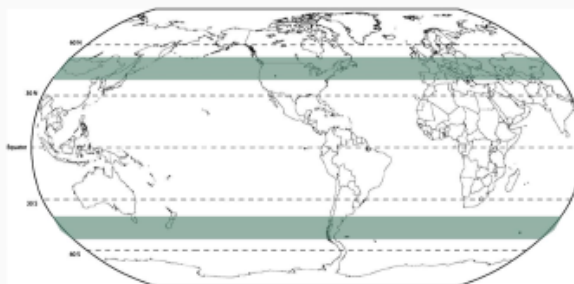
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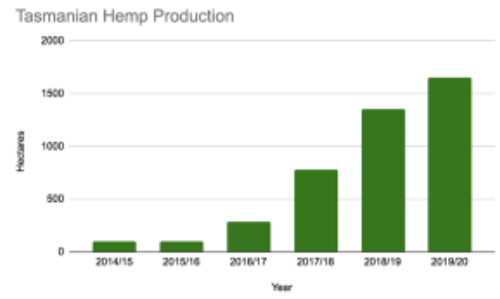
Overview

- Cultivated since hemp was legalised in the 90's
- Similar latitudes to Canada
- Set the legislative model for the rest of the country
- Leading variety trials and agronomic research
- Government has been very supportive of the industry



Production

- Responsible for over 50% of national production
- Increased from 150 ha, 2015 to 1650 ha this season
- Focus is on seeds for food or cosmetics
- Food Standards Changed in 2017



Production

- Yields have increased from 0.5t/ha to an average of 1.2t/ha in 2019
- Top farmers achieved over 2t/ha cleaned and dressed
- At \$3-3.50 farm gate value, gross margins are close to poppies
- Variable costs are approx. \$1600/ha so low risk
- Short grow window, improves soil health / structure
- Post harvest production infrastructure, with experienced operators ensures integrity and quality

The Hemp Association



- ~70 members - majority are growers
- Education through field days
- Lobbying for legislative change
- Foster industry growth and look for opportunities to improve on-farm profits



Controlled Cropping in Tasmania

- Poppy production since 1969, key export for the state over the past few decades
- Responsible for 80% of world legal production at one point
- Peak of 30,000 ha in 2013. Now only 10,000 ha - mostly due to US crackdown due to opioid crisis

Tasmanian poppy farmers are at the centre of the US opioid crisis, but they say they're not to blame

By Jessica Hoare
Updated 13 Oct 2016, 10:56am



PHOTO: David Hill, Farmers Media Ltd. Tasmania's poppy industry. (2017) Source: Project Gateway

Poppies vs Hemp

- Similar production window and system
- Hemp is an ideal alternative, and much more sustainable. Symbolic change.
- Huge disparity between security requirements of hemp for extracts and poppies for extracts
- Poppies are proof, controlled crops can scale successfully



Challenges

- Price pressure from imports and wider Australia
- Tasmania's high value agricultural system means farmers need inflated returns
- Expensive Bass Strait freight means state value-adding critical to industry success
- Inability to utilise whole of plant, management of residues



Challenges into Opportunities

- Residue in field is currently a problem, but is potential to increase on-farm profits
- Only utilising ~10% of total field biomass. Remaining 90% is potential cream. Eg. 3 to 160 hemp houses in Aus in 3 years
- Provenance unique and ideally suited to SE-Asian demand. China health food market \$200B+



Future...

- Power in numbers, we need a unified national strategy if we have any chance to change legislation - make it easy for politicians
- CBD is great but are we too late to the party? What aren't we thinking about?
- NZ referendum, global trends...Should we be discussing for wider legislation to leapfrog? Higher THC limits for broad-acre?
- We should be drawing parallels and lessons from the wine industry where renowned appellations demand premiums



Session 8 – Consumers, carbon, regulation and R&D directions

**FEATURES OF THE NORTHERN TERRITORY HEMP INDUSTRY ACT 2019
AND SUPPORTING REGULATIONS**

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Objectives of the Act:

The DPIR has responsibility to regulate the development and operation of an industrial hemp industry in the Northern Territory

- a licensing system for cultivation, possession, supply, research and processing of industrial hemp;
- prohibitions;
- enforcement provisions;
- offences; and
- administration and miscellaneous arrangements.



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Industrial Hemp uses under this Act

- Fibre e.g. manufacturing for textiles, ropes and lines, paper and building materials, animal bedding, insulation and car mouldings etc.
- Foods e.g. grain, emulsified cake, flour, or pressed oil, and **beer**.
- Other value-added products include health lotions, sunscreens, shampoos, soaps etc.

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Question:

Could we grow Low THC hemp and extract non-psychoactive cannabinoids or terpenes for industrial uses?



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Answer:

Maybe in the future, but not under an NT Hemp Industry Act at this point.



So what will be different than some other Australian jurisdictions in regulatory arrangements?

- An approved varieties list
- 5 year licences
- Consignment notes/waybills for transporting material
- A shared NT Dept. Primary Industry & Resources database with NT Police
- Minimum land area for commercial cropping i.e. 2 hectares
- No feeding of leaf material to stock

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NT DPIR is also represented on an Australian Industrial Hemp Regulators' Network.

Meets biannually (every 6 months), in a different host state.

In existence since February 2018.

- Coordinate regulatory efforts
- Safe, secure and compliant cultivation, transport and production of low-THC cannabis across jurisdictions.
- Promote the sustainable development of low-THC cannabis industry in Australia.



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Industrial Hemp relevance to the Northern Territory

- The Territory has some geospatial and climatic advantages that could be exploited.
- May be possible to supply viable seed for crop propagation in southern Australian farming regions.
- Open-air pollinated crop, distances between blocks of varieties are important to prevent cross-pollination and therefore contamination of lines (i.e. 10 km).
- Irrigated hemp crops with uninterrupted sunlight, will grow faster in the warm dry season of the Top End - two seed crops per season might be possible.
- Would need to be an **irrigated** cropping system.
- Much more research is required to understand numerous aspects agro-ecological suitability of cultivars and their performance.



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DPIR has consulted widely with both private and public stakeholders outside the NTG:

- Mr Greg Owens, former Chief Executive Officer, NT Farmers' Association (NTFA).
- Mr Paul Burke, Chief Executive Officer, NTFA.
- The NT Board of Regional Development Australia.
- Mr Philip Warner, Ecolife Science Research Foundation, Queensland;
- Mr Omid Rasnari, EcoFibre Ltd, Queensland;
- Professor Graham King, Southern Cross University;
- Mr Paul Benhaim, Hemp Foods Australia, New South Wales;
- Mr John Hall, The Hydroponics Company Ltd and Agri Fibre Industries Pty Ltd, Bundaberg, Queensland;
- Mr Robert Edkins, Food Fibre and Land International Group Pty Ltd, Western Australia.
- Mr Christopher Golding, Ms Donna Johnston and Mr Eric Davis, officers of the NSW Food Authority (NSWFA);
- Ms Deidre Wilson, Mr Peter Boyle, and Ms Caroline Atkinson, officers of the Tasmanian Department of Primary Industries, Water and Environment (DPIWE);
- Mr Patrick Phillips, Mr Andrew Sanger and Mr Philip Blackmore, NSW Department of Primary Industries.
- Mr Michael McManus, Manager Rural Chemical Operations, and Mr Mark Peters, Principal Policy Officer, both of Primary Industries and Regions South Australia (PIRSA).
- Mr Michael Davies, Western Australian Department of Primary Industry and Regional Development.
- Mr Jamie Milne and Mr Michael Benham, Department of Agriculture and Fisheries Queensland.

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Session 8 – Consumers, carbon, regulation and R&D directions

AUSTRALIAN INDUSTRIAL HEMP REGULATORS NETWORK UPDATE

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Why do we have industrial hemp legislation

- The cultivation of *Cannabis sativa* is illegal across Australia under the relevant drugs and poisons legislation.
- Industrial Hemp legislation has been implemented across jurisdictions to enable industry to develop and provide protections for licensees growing, harvesting and processing low-THC hemp.



Australian Industrial Hemp Regulators Network

Who are we?

- Representatives from each state and territory
- Responsible for administration of hemp legislation across Australia



A bit about the AIHRN

- Met first in Geelong 2018
- Held our 5th meeting on Tuesday in Perth
 - Current Chair – Jamie Milne (Qld)
 - Current Secretariat – Warren Hunt (NT)
- Provides a forum for Australian jurisdictions to meet and discuss:
 - emerging issues
 - advancement in technologies and applicability to regulation
 - differences in legislation
 - opportunities to provide harmonisation

National hemp industry

- **Northern Territory** recently passed their Industrial Hemp Bill and are in the final phase of developing Regulations to enable the Hemp Act to go live.
- **New South Wales** have amalgamated the administration of hemp into a broader regulation and compliance group.
- **Victoria** will introduce a Bill to parliament to amend THC level to 0.5% and 1% to be consistent with other jurisdictions, likely to be finalised later in 2020.

Hemp industry in Australia (19/20)	WA	Qld	NSW	TAS	Vic	SA	NT	AUS
Total licensees	87	33	109	104	63	17	0	413
Licensees cultivating	35	11	-	64	6	5	0	121
Total hectares sown	282	131	-	1,650	200	110	0	2,373
Varieties sown	22	9	-	25	4	12	0	-

Current actions from the 2020 meeting

- Ongoing commitment to seek a meeting with the Office of Drug Control
- We are investigating an approach by industry to better harmonise the movement of cannabis material across jurisdictional boundaries
- Investigating current interactions between hemp regulators and law enforcement agencies
- Investigating the benefit of developing an Australian National Standard for the sampling of industrial hemp crops (building on previous work)

NOTES

NOTES



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by Stuart Gordon

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