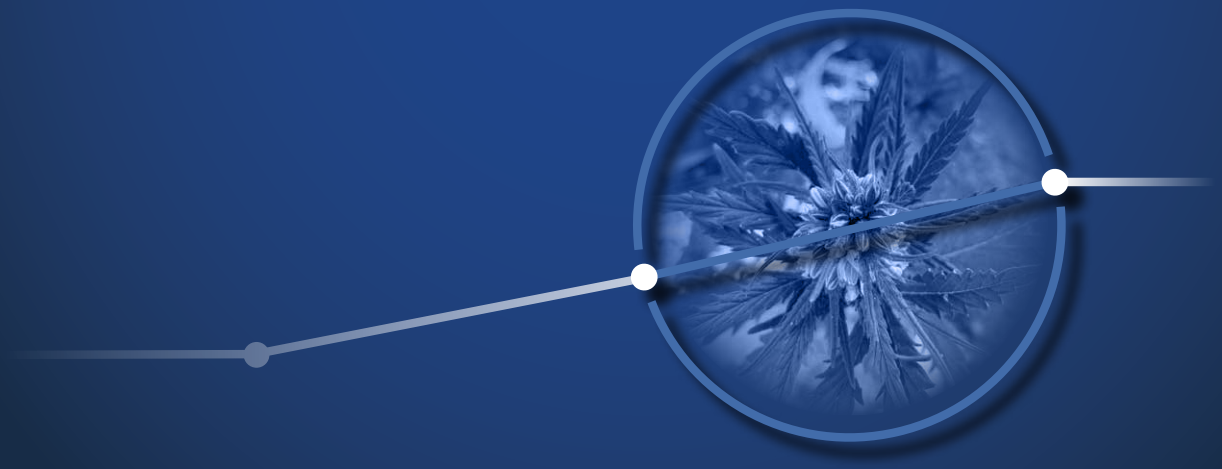
Department of
Primary Industries and Regional Development

GOVERNMENT OF WESTERN AUSTRALIA

Yawoorroong Miriuwung Gajerrong Yirrgeb Noong Dawang Aboriginal Corporation

Evaluation of commercial development opportunities for industrial hemp in the Ord River Irrigation Area Western Australia



AgKnowledge®
CONNECTING AGRICULTURE

MARCH 2020

P: 08 9291 8111
E: cookes@iinet.net.au

Industrial Hemp in the ORIA project

Yawoorroong Miriuwung Gajerrong Yirrgeb Noong Dawang Aboriginal Corporation (**MG Corporation**) is seeking to build economic development outcomes through agribusiness development to deliver viable commercial opportunities to sustain and grow the financial resources, and generate employment opportunities for MG people.

A renewed interest in WA to produce **Industrial Hemp** (IH) for seed/grain and fibre has led MG Corporation to investigate if hemp could be integrated into an appropriate scaled, viable and sustainable economic business opportunity in the suite of their proposed activities in the Kimberley.

Agribusiness consultancy **Ag*knowledge*®** was tasked to evaluate the commercial development of industrial hemp in the **Ord River Irrigation Area** (ORIA). The priority was to compile information and create a decision support matrix to guide MG Corporation in considering the feasibility of participating in establishing a long term, viable and sustainable IH industry.

This Ag*knowledge* evaluation report provides the background information to determine:

- Potential hemp products and analyse the market conditions for those products.
- Hemp production opportunities and constraints, recognising the unique challenges of the ORIA.
- If there is sufficient advantage to establish and sustain an IH industry in the ORIA.
- Does IH offer a commercial opportunity for MG in the Kimberley.
- For potential opportunities identified, articulate the assumptions, and likely capital investment, scale, interactions with current crops, complementary development or partnerships that may be required to realise those opportunities for IH in the ORIA.

The consultants completed a desktop study of the current information in the rapidly growing IH industry and capitalised on the recent work by the WA HempGro Cooperative, the Bi-annual Hemp Conference held in Fremantle in February 2020, development of Strategy Matrix industry feasibility studies in the South West, DPIRD variety research trials in 2008 and 2018 at the Frank Wise Institute, and importantly the rapid production growth on the eastern seaboard, coupled with the development of processing facilities and product development investment.

Ag*knowledge* was able to interview key players involved in the development work to date and captured the current thinking at the Fremantle conference.

Industrial Hemp production in Australia is a new industry and there are some excellent examples to follow for understanding the critical pathways for development. Recent examples in Western Australia include Chia and Canola.

PROJECT DELIVERABLE 1: Preliminary re GO:NO GO for ORIA IH

Based on the evaluation of the commercial development of industrial hemp in the Ord River Irrigation Area (ORIA), Ag*knowledge* recommends that MG Corporation <u>does not proceed</u> with further investment in Industrial Hemp until at least three years of field trials have been completed with suitable seed, further industry development and collaboration across northern Australia is underway.

CONTENTS

Executive Summary

Industrial hemp is a cannabis plant species (*Cannabis sativa*) which has a range of uses for the fibre, food, and oil that can be produced including textiles, biofuel, paper, animal bedding, building materials, plastics, cosmetics and food. Hemp seeds and oil contain protein, vitamins, minerals and polyunsaturated fatty acids, particularly omega-3 fatty acids. Hemp oil is extracted from the seed, and has been used for cosmetics, paints, printing inks, solvents and animal feed.

Since the legalising of hemp for food in Australia in November 2017, the profile and interest in industrial hemp has increased within Western Australia's agriculture sector.

Despite its long history, the industrial hemp industry is still very small (120,000ha of crop area globally) and it is constrained by a lack of critical mass in research and technology development, which has characterised the development of other major crops. Hemp's seed and biomass value will likely become more important into the future for the seed's excellent nutritional properties and for sustainable building and industrial textile materials.

Globally there is information available to help grow, process and market hemp products, and while the industry development pathways of countries such as Canada provide relevant learnings, local growing, processing, manufacturing and market conditions in the ORIA are significantly different. At a local level there is limited information and applying the international experience to the ORIA setting has risks.

The primary risk is the current lack of certified industrial hemp cultivars specifically selected and bred for ORIA conditions. Initial trials in the Ord (2008 and 2018) accessed un-certified hemp seed of cultivars bred for northern hemisphere conditions or for east coast environments. Results from DPIRD trials shows that this is leading to poor results in terms of germination, growth rates and yield.

The DPIRD trials in the ORIA to date have shown some positives in that the crop will grow under flood irrigation in formed beds and has little difficulty dealing with the soil types, and when given the opportunity is a vigorous growing plant quick to maturity and not requiring significant treatment for weeds, pests and disease. However, the constraints at this level are finding the right cultivar to grow in the topical conditions, and adapting to the soil temperature which needs to be under 37°C.

Efficient production systems will be essential for the long-term development of a successful industry. Basing industry development on suitable varieties will, therefore be essential.

In the ORIA there are two key parameters for crop production; competition for suitable irrigated land availability with other crops, and having a clear market focus on the intended market and the per hectare cost of production.

Following the exit of the sugar industry from ORIA due to economic conditions, a large portion of the irrigated area was taken up with Sandalwood and represents around 30% of the Ord Stage 1 area. Other crops have been tried and recently a push toward perennial tree crops in mangoes, bananas, and citrus have been moderately successful.

Hemp Trials Frank Wise Institute 2018 - Warmington

The Ord Co-operative has been a strong driver in the success of continued crop development and in the past three years the work in securing a long-term contract for corn exported to South Korea has become a boon for its Members.

The development of Goomig Ord Stage 2 and Mambajim Farm has enabled some opportunities to develop new crop systems and trials of cotton have proved reasonably successful. The significant change to the operating environment in ORIA is the influx of commercial cotton operators seeking alternative land and water supply to the limited Murray Darling Basin drought driven water restrictions. These 'new' growers come with experience in cotton production, and are seeking to develop the industry across northern Australia.

The lessons learnt from a concerted push to develop the Chia industry demonstrate that sorting the key agronomic factors required research, investment and tenacity. Despite commitment from growers, the development of a strong value chain to end of market and consumer awareness, the final success or failure was determined by the global market pricing. In the Chia example a yield of 1.5t/ha required a grower breakeven price around $2,000/t before transport to processing facilities. When the global competition lowered the price to sub $1,500/t the crop become unviable.

MG Corporation has access to two locations in the Goomig development – Lots 15 and 16 comprising some 640ha with water access. A recent joint venture with Cubbie Ag has opened the door for MG Corporation to commence their future in irrigated cropping. 2020 will see Cubbie Ag plant Lot 15 with cotton, with the expectation that a successful crop will provide a return to all parties.

Developing a new industry or crop is not for the feint hearted and certainly not for participants who are first time into an industry. MG Corporation are not crop 'pioneers' and so the innovation and development must be left to research science and investors who can exploit conditions and opportunity to manage the risk of failure, or reap the rewards of success.

One of the key points for investment in hemp is the attractive proposition of increasing employment. The development and technology in primary industries globally has led to a significant decline in the requirement for on farm employees. The scope for new employees is in service provision in R&D, marketing or engineering, or alternatively in the downstream post farm gate processing.

One of the biggest requirements for IH at this early stage of its economic viability is the will to make this happen - this is one of the major hurdles for IH as this is a long term project which will involve a number of steps to be successful. At each stage there needs to be an understanding of research and development as well as good sound business practice to make this industry viable in the ORIA.

The economic analysis (gross margin - page 30) indicates that to grow and harvest IH in the irrigated system of the ORIA, the return is marginal and on first glance not a proposition for MG Corporation or their partners. However, there are many more products which can be derived from the IH crop, which lends itself to a range of value adding which will improve the economic bottom line of this crop and also develop downstream markets, so only looking at IH through a single product focus will not create a long term industry in the ORIA.

To achieve the value from IH, the options for value chain processing must be considered. The processing of fibre is not a consideration at this stage as the cost of equipment and distance to transport a relatively lightweight commodity is quite prohibitive. Hemp hurd is the inner core of the hemp stalk and excels with absorbent and thermal properties, and is an ingredient in hemp concrete and building products. Transportable and lower cost processing equipment is under development and within a few years, this style of processing will become available.

Hemp seed can be processed now and has a market position for processed grain and oil products. The dilemma is that Kununurra is some 3000kms from a processing facility. The immediate post-harvest treatment means that hemp must be dried down to less than 10% moisture within a few hours, and that it requires cold storage from then until it is processed. These facilities are available in Kununurra and need to be factored into the cost of processing.

Despite the interest in commercial development of industrial hemp in the ORIA, Ag*knowledge* recommends that MG Corporation does not proceed with further investment in Industrial Hemp until at least three years of field trials have been completed with suitable seed, further industry development and collaboration across northern Australia is underway.

Key Findings

Industry development
IH is an industry in its early stages of development and has yet to achieve any meaningful collaborative behaviours across the country. There are significant developments in the northern hemisphere but this has yet to be demonstrated as a mainstream crop in Australia.

The current development work for the ORIA is based on a 'south-north' arrangement within the State, however to ensure a far greater development the collaboration 'east-west' needs to be considered.

Value chain
IH products require high levels of post-harvest management and investment in technology for processing into a useable commodity. The end market is rapidly developing products for use and is currently using *sustainability and healthy* attributes for marketing.

Marginal return limits grower interest
The interest in developing an IH industry in ORIA is one of the major hurdles as this is a long term project which will involve a number of steps to be successful. At each stage there needs to be an understanding of research and development as well as good sound business practice to make this industry viable in the north of WA. ORIA growers are very definite around a benchmark value of $3,000/ha gross income to consider planting a crop. At a seed yield of less than 1t/ha and a current price of $3,000/t, IH is a marginal crop decision.

ORIA Hemp agronomy
Hemp is primarily dioecious, which means the pollen-bearing parts are found in one plant and the seed-bearing flowers on another. In a dioecious crop, the number of female plants is 10 per cent to 50 per cent higher than the number of male plants. This may have influence on the grain yield achievable. Hemp yield (grain or fibre) varies with variety, plant population, soil conditions, timing of harvest and annual climatic conditions. The average grain yield in Canada is 850 kg/ha and the highest recorded yield was 2,242 kg/ha.

The differences in growth rate and development between male and female plants are large. The male plants tend to flower and senesce earlier. For a fibre crop, this variation may limit yields, reduce the efficiency of resource use and may result in variable quality.

Seed choice for growing needs
There are some tropical hotspots such as Hawaii and Puerto Rico that are conducting research into tropical varieties of IH seed, however many of them have been sidelined into the medicinal cannabis space thereby leaving this avenue to develop good, strong, consistent Industrial hemp seed varieties for new markets. A search for sound tropical seed is an imperative for future success.

Northern WA has no facilities for Physical Containment Level 2 plant facilities which would be required for rapid transfer of preferred tropical varieties.

There can be up to 100 days difference between flowering of some varieties of IH seed. The dioecious seeds tend to be longer growing times with a larger biomass whereas the monoecious varieties are more regular growth, less biomass and shorter seasons. IH is also very heat sensitive.

Research into growing IH in a tropical climate

Soil Temperature

The soil temperature for hemp to grow in Europe is above 10°C whereas the soil temperature in Kununurra rarely drops below 25°C. DPIRD believes, after their IH trials, it is the soil temperature drop during May/June that will open up a window for growing IH with seeds presently available. Over time, it is hoped that seeds adapted to tropical heat will develop and so the window for sowing may extend.

Temperature

Hemp grows in temperate, subtropical and tropical climates. It generally prefers a mild climate (optimum temperatures for growth are 15–27°C), a moderately humid atmosphere and rainfall of at least 600–700mm year.

The high ORIA temperatures will mean that harvesting and drying needs to be done quickly. The seed and leaf matter in the harvester heat up considerably if left to sit and this will affect the oil quality and germination rate of the seed collected. In the processing plant there will need to be a cool room to store seed at all stages of production. Any value add should be contracted to a seed processing facility in the Perth region.

Hemp is extremely sensitive to flooding, water logging and soil compaction, therefore poorly drained or badly structured soils are not recommended, as excess surface water and heavy rains (during the wet season) can result in damage to the hemp crop. In addition, access to fields for harvesting and in-field postharvest operations may be hindered by thunderstorm activities in February and March.

Daylight requirements

Hemp has a high light requirement during its growing period. The cultivars grown in Europe are usually of French origin and have a critical photo-period of between 14 and 15.5 hours. In temperate regions, industrial hemp can only be grown in the summer months. For fibre production in the tropics, hemp crops need to be grown over the summer months to capture the longer day lengths which enable it to produce high stem dry weights.

Hemp is a short-day plant, which affects crop production. The plant requires a set number of successive short days for flower initiation. Flowering is important for grain production. Once the flowering starts, the efficiency with which intercepted radiation is converted to dry matter drops rapidly. A particular variety tends to flower at the same calendar date no matter when it is planted. However, the time of planting might influence the grain yield production (t/ha). New varieties are becoming available that are not photo-period sensitive.

Developing skill sets to grow good crops of IH

IH is not as easy to grow well and consistently as first thought. During the research phase of the trials it would be valuable to gather as many of the agricultural skill sets to grow the crop. As yet, there is not enough margin in IH to out-source the sowing and harvesting of the crop, so it will need to be done in house to be financially viable.

Developing skills set to use hemp locally

Building with hemp, weaving with hemp, natural medicinal medicines are some of the great many uses for IH and learning the trades to utilise and value add to IH is a must to create a sustainable industry.

Opportunities and Challenges for Industrial Hemp in the ORIA

In the assessment of the Industrial Hemp industry in Australia and in particular the Ord River Irrigation Area there were many factors identified in the literature as well as the industry consultation that can be considered as opportunities and challenges:

Opportunities

- Growth opportunities for the agriculture and horticulture industry
- New products and markets open up in the future
- Irrigation resources available in ORIA
- The crop is useful as a soil ameliorant, with its long tap root capable of breaking up subsoil
- Improve sustainability, hemp uses less inputs
- Potential as a break crop in rotation with existing crops
- Versatile plant with both seed and fibre production capability
- Environmentally friendly
- Utilising the entire plant - bast, hurd, seed
- Collaboration and cooperation with growers and processors and manufacturers
- Aggregation of growers into dedicated supply chain
- Crop production utilising current machinery
- Fibre products can be used in local industry and construction.

Challenges

- Lack of specific cultivars for tropical hemp production available.
- Not a lot is known about its agronomic performance in the ORIA region and the cultivation challenges growers may face
- There are few herbicides currently registered for use on industrial hemp in Australia (but growing)
- Lack of cultivars bred for ORIA conditions - specific high-performance genetics available
- Current production based on uncertified seed sources
- Limited grower skill and experience with hemp agronomy
- Limited data on the role of hemp in rotations with existing crops
- Per hectare returns are undetermined but likely require value to be created in the value chain
- Currently no processing facilities for hemp in WA
- Currently limited hemp supply chain in WA with clear end products and developed markets
- Consistency of yield, supply, and quality due to retting process
- The lack of modern economic processing technologies seem to be the greatest obstacles for hemp fibre producers under the changing conditions of international raw material markets
- Complexity of the process to separate the bast fibre from the hurd
- Due to its bulky nature, raw fibre can't be moved more than about 100 km before the economics begin to decline. The alternative is to have primary processing close to the farm, with secondary and tertiary processing at a greater distance, or even mobile processing facilities
- Finding new markets for products as it is new to Australian industry
- Scale required at farm and processing facility level
- Needs further research around oil instability (oxidises quickly)
- Australia late to the market compared with competition.

Assessment of success factors to develop a new Industrial Hemp Industry in the ORIA

Ag*knowledge* has compiled an assessment of the key 'success' factors required to move a new industry from the innovators to mainstream production and what this could look like in 5 years. This assessment recognises the intricacies of the Industrial Hemp industry but also consideration of the specific positioning, the excellent capacity and record of the ORIA growers and their knowledge of industry development and the ORIA.

(Note: chart uses traffic lights of red for blockage and green for go to rank elements of the industry.)

ACTIVITY	SUCCESS FACTORS FOR THE FUTURE OF INDUSTRIAL HEMP IN THE ORIA	FUTURE STATUS	COMMENTS
Marketing/ Competition	• Market awareness and demand	🟡	National industry development
	• Distribution of market share	🔴	Isolation will curtail participation
	• Alternative products	🟢	Many replacement opportunities
	• Alternative suppliers	🔴	Supply from temperate zones
	• Competitive edge	🟡	Local positioning & replacement
	• Ease of access to market	🔴	Transport and cool chain costs
	• Market share possibilities	🟡	Out of season or seed bulk up
	• Future of the market	🟡	Slow build-up of market
Production / Technology	• Ability to sustain supply	🔴	Competition with crop options
	• Quality improvements	🟡	Overcome suitable seed
	• Research and development	🟢	First rate capacity
	• Production levels	🔴	Economics need to stack up
	• Efficient production	🟡	ORIA growers' efficiency
	• Agreed quality systems in place	🟡	QA standards are SOP
	• Environmental issues	🟡	Benefits re carbon, break crop
Financial / Economic Factors	• Value adding	🟢	Excellent opportunities with crop
	• Level of sales	🔴	Long way from reality
	• Profitability - lower risk and bankable	🔴	Break even gross margin in ORIA
	• Cost of distribution	🔴	High cost cold chain and storage
	• Environmentally sustainable	🟢	All points to sound contribution
Infrastructure	• Transportability of the product	🟡	Once stabalised, relatively good
	• Buying systems	🟡	Should be a market in place
	• Processing and storage capabilities	🔴	Limited options
	• Formalisation of the industry sector	🟢	National industry development
	• Vertical integration of hemp	🟢	Strong options
	• Spin off industries	🟢	Strong options with product
Management / Strategy	• Knowledge in the industry	🟢	Will have grown exponentially
	• Training and development	🟢	Investment by industry
	• Employment prospects	🟡	Post farm gate, value chain
	• Skill and commitment of operators	🟡	Professional growers to hobbyists

Recommendations

1. Based on the evaluation of the commercial development of industrial hemp in the Ord River Irrigation Area (ORIA), Ag*knowledge* recommends that MG Corporation does not proceed with further investment in Industrial Hemp until at least 3 years of field trials have been completed with suitable seed, further industry development and collaboration across northern Australia.
2. ORIA hemp production will not progress without suitable certified tropical seed which may need to be sourced from Asia or the sub continent. The priority is to identify the best adapted varieties for the local environment, DPIRD and ORIA Growers to source suitable seed genetics from Ecofibre, Hawaii, China, or India. A range of grain varieties needs to be evaluated in field trials during the dry season, and fibre varieties during the wet season at Kununurra. Ecofibre Industries Ltd owns 248 accessions of germplasm collected from over 25 countries. They have developed commercial hemp cultivars specifically for latitudes less than 42°.
3. It will be necessary to acquire a better understanding of the impact different cultural practices (time of planting, plant population, fertiliser, irrigation, etc.) have on THC levels in the plant to avoid those that may increase levels. MG Corporation support the long term investment in field trials with DPIRD and possibly with Northern Australia Crop Research Alliance (NACRA), and potential funding support from CRC Northern Australia, GRDC and Agrifutures.
4. Identifying cross North Australia border growing and sharing of information. An industry body dealing with the Tropical IH in Australia which is very different from the dry land industry of southern mainland Australia. There could be synergy in emerging industries in the region.
5. The ORIA has no tropical plant research facilities in the form of a Physical Containment Level 2 facility. This infrastructure would be beneficial for many future crop opportunities across northern Australia. It is recommended that acquisition of such a facility be investigated.
6. In preparation for future crop opportunities some post-harvest facilities for small seed crops such as driers, small seed cleaners and cool rooms could be investigated. An audit of current facilities and their capabilities are warranted.
7. MG Corporation to capitalise on their joint venture with Cubbie Ag and build a program of farm tours (Lots 15/16) to share the story with different age groups. Tailor these for MG Boards, staff, Dawang Council, Elders, youths 13-18 and kids 8-12.
8. MG Corporation could use this time to be a part of the primary industry community of the ORIA, but in particular investigate the indigenous Branding and Intellectual Property opportunities around the production of food and fibre either on MG land or MG partnerships. (Reference *Our Culture: Our Future* - Report on Australian Indigenous Cultural and Intellectual Property Rights by Terri Janke, Principal Consultant, Michael Frankel & Company)
9. MG Corporation could take a long term view of engagement with primary industries by targeting current secondary school scholarship holders and introduce them to future tertiary studies in agricultural and land management sciences. Encourage partners to engage and provide scholarships, cadetships with a goal that in 10 years, MG Corporation has qualified people to take on management.
10. There are some opportunities for MG Corporation to partner with builders and manufacturers of hemp building products in the south west to develop appropriate skills should the hemp products become available in the Kimberley.
11. Identification of markets locally which may not yet exist due to no product but which IH could address. Cattle feed cake, animal bedding, nursery matting for hydroponics or soil erosion are a few which could be of interest.

Industrial Hemp in Western Australia

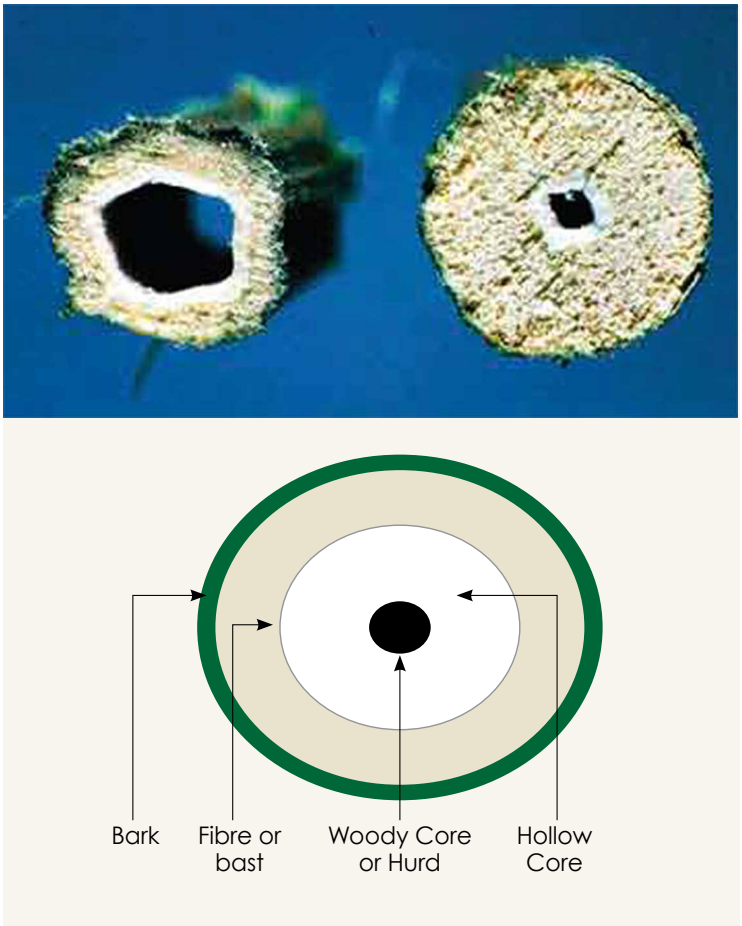
What is Industrial Hemp?

Industrial Hemp (IH) is the variety of Cannabis Sativa plant that has a very low Tetrahydrocannabinol (THC) rate. In Western Australia the legal limit of THC in industrial hemp is <0.5% for sowing and <1% for food grade seed. If the plant is tested to be above this rate then the plant is deemed not industrial hemp and cannot be used in food or fibre production under the Industrial Hemp Act 2004 (2009).

The State Government of Western Australia passed the Industrial Hemp Amendment Bill 2018 to amend the Industrial Hemp Act 2004 to increase the permitted level of THC in industrial hemp to no more than 1% for production. This brings Western Australia into line with other States and Territories, following changes to the FSANZ Code in 2017 to allow the sale of food products derived from hemp seed with a THC content of up to one per cent. These amendments reduce the risk for hemp growers and opens up new opportunities in hemp seed as a food and drink product. IH seed is still legislated at >0.5 THC for sowing.

IH is a fast growing, herbaceous plant with a deep tap root. Depending on variety, it can grow to a height of 4m and produce 10 tonne of biomass per hectare. Some seed varieties are able to produce 1 tonne of seed per hectare.

FIGURE 1: Transverse Section of the stem of a Cannabis Sativa plant (DPI 2008 NSW)



Industrial hemp is normally Dioecious, meaning that it has a male and female plant in its sowing pattern, however due to breeding there are now a vast number of Monoecious varieties, male and female on the same plant, available. They tend to be more day light hour affected and so tend to be short growing varieties for seed production.

Hemp has traditionally been grown in Mediterranean and northern hemisphere climates.

There has been some work done on producing tropical plants in both Queensland and Hawaii.

Cannabis flowers: Dioecious Left: Male plant flower Middle: Female plant flower (J.Lacy DPI 2008 NSW)).

Industrial Hemp vs Marijuana

Industrial hemp and Marijuana are from the same plant species, *Cannabis sativa*. However, there are two distinct subspecies (*Cannabis sativa, Cannabis indica*) with key difference in appearance and the level of the plant's psychoactive inducing component, tetrahydrocannabinol (THC). Typically, hemp contains below 0.3% THC, while cultivars of *Cannabis* grown for medicinal or recreational use can contain anywhere from 2% to over 20%. Marijuana is not suitable for the vast array of IH uses as it is mostly grown in controlled environments indoors and does not go to seed or grow large biomass. It is harvested at flowering.

Hemp varieties of *Cannabis sativa* have been bred specifically for fibre and / or high grain yield. Marijuana is a common term referring to varieties of *Cannabis sativa* bred specifically for their high THC levels.

Industrial Hemp Value Chain

Industrial hemp is a plant said to have 25,000 uses but logically no one company can look to all these uses to create markets.

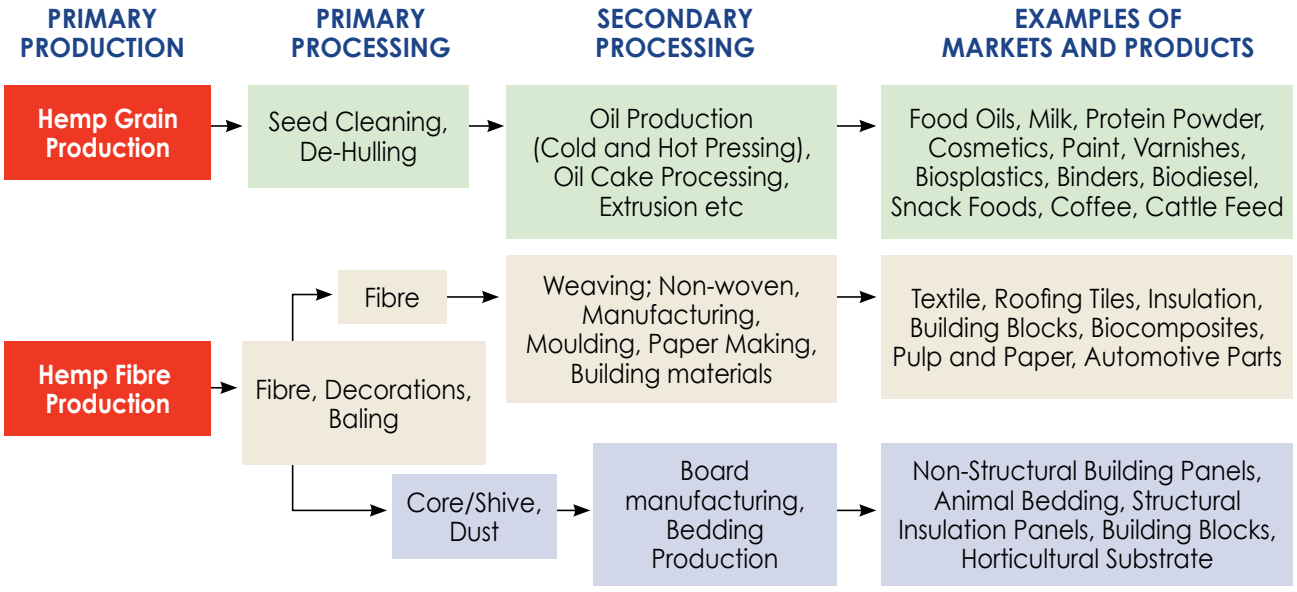
Given the nature of hemp the plant and its ability to produce fibre, grain and oil, and therefore, to produce products with a diverse range of end uses and markets, it is a challenge to capture the possibilities in one diagram. The simplified value chain presented illustrates the complexity of establishing a hemp industry. In Australia, and especially in WA, all supply chain participants will need to work collaboratively to establish a viable hemp industry supply chain to deliver a long-term sustainable sector.

Some of the immediate 'fits' in the local and regional markets could be:

- Shipping clean dried seed to processing plants in Queensland, Southern WA and South Australia.
- Animal bedding
- Horticultural uses –mulch, fibre mats, mushroom compost
- Housing building material

The export market could capitalise on the attraction of good hemp seed oil for cosmetics and the health food markets. As well as becoming a seed exporter of tropical grown seed to Africa/PNG, as there is a shortage of this type of seed worldwide.

Kununurra trial crop 2018 - Warmington.



Industrial Hemp Processing

The processing of Industrial Hemp is divided into two major streams – the primary and the secondary processing of the seed into oil and other products; and the separate primary processing of the straw into fibre and core/hurd. The latter is then able to develop various secondary processing outcomes to turn the fibre and hurd into various high value products.

Hemp Seed
Hemp seed generally goes through the primary processing steps of:

1. Drying, cleaning, dehulling and bagging of seed for direct consumption

2. Drying, cleaning and pressing for oil (cold pressing)

3. Processing and packaging for the by-product 'hemp cake".

Oil and Seed production will need to be done in a timely manner due to the heat of the Kimberley. IH seed has a 35% ratio of oil in the seed, which contains linoleic acid (LA) and linolenic acid (LNA) as its major omega-6 and omega-3 polyunsaturated fatty acids. This high oil content heats up quickly and can spoil.

Unprocessed Seed
Seed kept for re-sowing would need to be cleaned, dried and tested for germination rates and registered for sale into the market. It could also be kept for re-sowing with the aim of developing strong, heat resilient seeds. Tropical industrial hemp seeds are not well established at present as most research is heading into CBD plants.

Hemp seed.

Unprocessed seed.

Hemp Oil
IH seed oil is produced using a cold press and it would be beneficial to start with a small scale – possibly 500kg to 1 tonne machine – to work out the potential heat factor of pressing seed in the tropical climate. This machine could easily be a re-purposed canola machine. There are a few in WA and they are able to be purchased through Ballard Seeds (*www.ballardseeds.com.au*). The oil pressing also produces a secondary product in the form of protein cake which could be pelletised for animal feed. As it has no THC and CBD it does not constitute a risk to the livestock market.

Seed oil presently sells wholesale in Australia for $15litre. To achieve a litre of seed oil there needs to be at least 3.5kg of seed pressed. (See pricing chart – page 17.)

Hemp Stem Processing

The processing of hemp straw has the potential to add considerable value to the straw from the field. The unprocessed hemp straw is largely a waste product, however it can be grazed as animal feed or it can be cultivated back into the soil to improve organic matter content.

Hemp straw is primary processed (by decortication) into three fractions or parts, each having application into different markets and uses. The outside bast (fibre) comprises about 30% of the mass, and with secondary processing is used in automotive, textile, bioplastics, pulp and paper markets. The inside core (sometimes called hurds or shive), represents about 60% of the mass. It is typically used in the green building materials industry, furniture, insulation and animal bedding markets. The residual 15-20% is dust and can be pelletised or used in the biofuels industry, though it is in some cases simply discarded.

The process by which the straw can be transformed to add value involves separating the outside bast fibre from the internal core or hurds. This is typically known as the process of decortication. There are a variety of ways to separate the straw into fibre and core:

Field and hand retting – This was the historical method used to separate the core and the fibre. The straw is cut and left to lie in the field. Wet weather begins this separation process and it can be accelerated through a manual hand retting process. This process is still used in China.

Mechanical decortication – This is the primary and most established method of decortication for hemp straw. At present there is no equipment for practical use available in WA however one company is aiming to have a unit working in winter 2020.

The lack of availability of a proven and cost effective technology for decortication is a major bottleneck for hemp straw processing. There has been considerable research in the last few years and a number of processing systems exist in Canada, USA and well as long standing decortication processing units in Europe.

Hemp fibre decortication facility at Vegreville, AB.

Some of the long established companies are:

1. **CRETES** - Creative Technical Solutions (Belgium *www.cretes.be info@cretes.be*).
2. **Dun Agro Hemp Group** – machinery for field and processing. *https://dutchhempgroup.com info@dunagro.nl* (Their processing mill is scalable, so a 2 t/h processing can be scaled to 8 t/h processing line, without any change in quality. Making it more cost efficient to enter into the market and increase processing capacity in relation to market size.)

TABLE 1: Housing or wall building specification from an Australian company:

SIZE	AMOUNT FROM PRODUCT	SIZE OF WALL	COST OF MATERIAL
1 cubic metre	8.25 batches mixed hurd and lime	4m x 1m x 250mm thick	$420.75 (batch)

Hurd

When put through a decorticator the stem is separated into fibre and hurd from the central core of the plant. This allows the core to be chopped up into small shivs. This can be done a by either a Tub grinder or a more sophisticated decorticator.

The final product is small pieces of core hemp, without fibre, which can be used for housing products.

A simple chopped product which still has the fibre attached can be used for animal bedding.

The fibre pulled off in this processing is usually damaged by the chopping and grinding and so is more useful as non-woven matting, insulation fibre or compressed fibre for bioplastics.

Fibre

There is a large market for nursery products made out of natural fabrics which last but are also biodegradable – hemp matting fits into this criterion very well. This is non-woven fibre which is pressed into a sheet that can be cut into weed mats, blanket to stop erosion, hydroponic water mats.

Terrafibre (*https://terrafibre.ca/*) is an example of a Canadian grower based company which is developing product across a wide spectrum of hemp and other fibre materials.

Fibre for clothing is a very high grade product and would not be viable as a starting industry. If cotton is processed into a woven fibre in the region then there may be a synergy which can work with IH.

Examples of fibre.

Dust

There is a great deal of dust that comes off the processing of IH stalks. There is a current study into the effect of IH dust on workers and the resurgence of byssinosis in the fibre factories.

"Byssinosis is a disease of the lungs. It is caused by breathing in cotton dust or dusts from other vegetable fibres such as flax, hemp, or sisal while at work."

This is an HSE issue which will need to be addressed in the building of the decortication/fibre plant. Having said this, the dust is a valuable commodity in the bioplastic industry for its strength and also is used as a filler for building. Extraction of the dust is recommended as a product as well as for HSE.

However, the extracted dust is also a product. It can be used in the production of cannabidiol (CBD) oil or compounds. It can also be used in cosmetics and soaps.

Future CBD products

CBD is the second most prevalent active ingredient of the enzymes or Cannabidiols in the cannabis plant. There are over 30 different cannabidiols in a plant of which THC is one.

CBD oil is produced from the flower and leaves of the IH plant. It has a very low THC value; hence it remains in the IH space. Oil extraction can occur a number of ways: cold press - which uses no chemicals but produces a very unsophisticated raw product that would need to be processed more to be valuable unless the market is for non-chemical extracted oil: CO_2 extraction and ethanol extraction.

CBD oil is a major market in north America and Europe. At the moment in Australia it is illegal to produce CBD products which have more than 7mg per litre in the product. It is also not allowed to be recorded as being a beneficial or pharmaceutical grade product.

As the markets and farmers in North America collapse under the deluge of businesses who have opened up in this space and have flooded the market with product, Australia is still pondering what to do about it. There is a burgeoning black market in this product thought to be worth roughly $10 million.

Processed hemp prices

PRODUCT	AVAILABLE OS/LOCAL	PRICE $/TONNE	INPUT	PRICE SOURCE
Hemp seed (farm gate)	Local	$3,000	1 tonne	Pers comms
Hemp seed – 10% moisture and 97% clean	Local - Tas/Q	$3,500	1 tonne	Pers comms
Hemp Seed Oil	Local – Tas/Q	$15,500	4 tonne seed	
Hemp Seed cake	Local - Tas/Q	$6,475	Residual	https://www.bulkhempwarehouse.com
		$15,300		Protein powder
Dehulled Seed	Local -Tas/Q	$64,000	2.5 tonne	https://13seeds.com.au
		$17,300		wholesale
Crushed Seed	No	$1,300	1t/residual	
Hemp Tea	OS	$25,000	Residual	
Hemp Dust	OS	$40,000	residual	
Fibre Long	OS China/India	$15,000		https://www.indiamart.com/proddetail/hemp-fibers-2339605330.html
Fibre short/ matted	OS/China Canada	$22,000	residual	https://terrafibre.ca/shop
Bio Diesel			5 tonne biomass – 800 litres	https://hempgazette.com/industrial-hemp/biofuel-hemp-energy
Decorticated stem	Local/OS	$1,700 local $1,600 OS	2 tonne of stem	http://www.hempmasonry.com.au

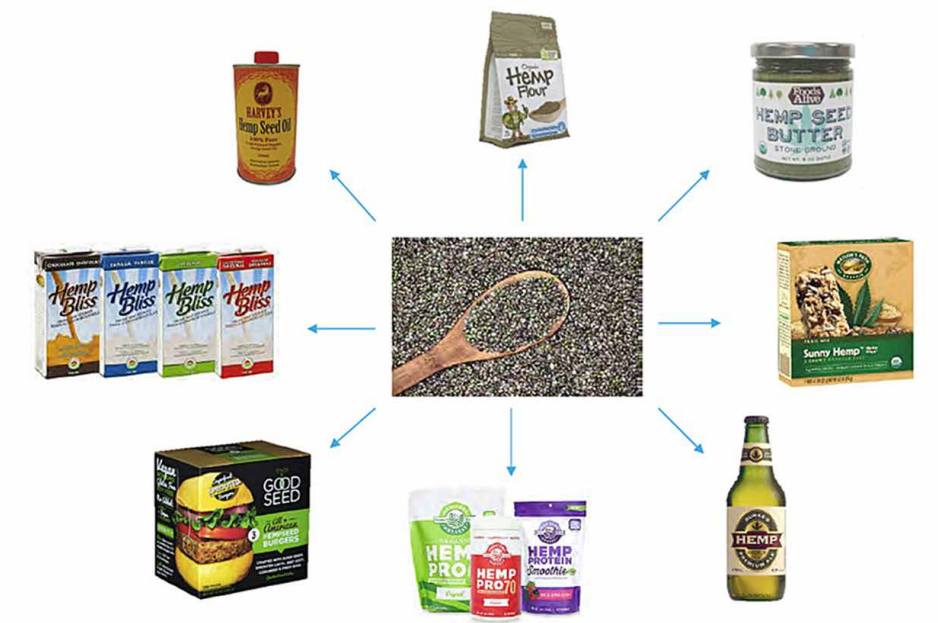
Industrial Hemp Products

Hemp Seed

Hemp seeds are the only edible seeds with gamma-linolenic acid (GLA). The hulled hemp seed or hemp "nut" remains after the removal of its hull. It contains 30 – 35% protein and 35 – 40% essential fatty acids by weight. This superior nutritional profile makes it ideal for a wide range of food applications. Whole hemp seeds are available sterilised, toasted, roasted and fractionalised (cracked) forms, they are rich in protein, vitamins and minerals. They can be cold pressed for oil, or hulled to expose the seed heart.

Whole hemp seeds can be toasted for snack food or ground into flour. Very versatile, hulled hemp seeds can even be processed into milk, cheese, ice cream, margarine and other foods.

Value added opportunities



New Opportunities in New and Emerging Agricultural Industries in Australia
Coriolis December 2017

Hemp Seed Oil

Hemp also produces an oil seed that contains between 25 – 35% oil by weight, which is high in essential fatty acids (EFA). Cold pressed, unrefined hemp oil is light green, with a nutty grassy flavour. It is a superb nutritional supplement for EFA and imparts a desired flavour into dressings, dips and spreads. Refined hemp oil is clear with little flavour or nutrients and has been widely used in body care products, lubricants, paints and industrial uses.

Antimicrobial properties make it an ideal base for soaps, shampoos and detergents. The hemp seed oil that is used for cosmetics and skin care products contains a high amount of polyunsaturated essential fatty acids (linoleic and linolenic acids), which makes it an important ingredient in anti-inflammatory skin care formulations. Intake of both ETAs in sufficient amounts and proper balance is essential for prevention or treatment of a wide range of conditions, including diabetes, cardiovascular disease, menopause, osteoporosis, atopic eczema, psoriasis and acne. Hemp oil industrial uses are in paints, inks, solvents, and binders and in polymer plastics and bio-fuel.

Hemp Fibre

Hemp fibre has been probably been used by humans for more than 20,000 years. Hemp fibres can be spun and woven to a fine, crisp, linen-like fabric and used for apparel textiles, home furnishing textiles and carpeting. Anti-mildew and antimicrobial properties make them very suitable for sails, tarps, twine, ropes, insulating matts/boards and floor coverings.

Primary fibres can be cut to shorter staple lengths to accommodate a variety of spinning systems. Hemp fibre blended with wool, cotton, linen or other fibres, adds strength, durability, absorbency and breathability, making hemp-blended fabrics cool and comfortable to wear and touch.

The automobile industry uses the fibre in its pressed form for manufacturing parts such as door panels and dashboards. Hemp fibres are used in the production of insulation boards and batts for the building industry and are also highly demanded by the textile industries. Like primary fibre, it is biodegradable and possesses anti mildew and antimicrobial properties.

Hemp Hurd

Hemp hurd is the perfect material to replace trees for pressed board, particleboard and core concrete construction moulds. By using a process that applies heat and compression, hemp hurd can be made into strong construction panelling, replacing dry wall and plywood that is fire resistant, with excellent thermal and sound insulating qualities.

When hemp hurd (the woody core of the stem) is mixed with a lime binder and water it creates a bio-composite substitute commonly known as Hempcrete. Hempcrete is lightweight cementitious insulating material weighing about a seventh or an eighth of the weight of concrete. Hempcrete regulates the temperature and humidity of a building; in some cases, completely eliminating the need for heating and cooling systems, resulting in huge energy savings. Hempcrete is carbon negative and the obvious choice for buildings aiming to achieve a low carbon footprint and the highest sustainable building code levels. The Hemp plant absorbs atmospheric CO_2 during the plant growth phase, and again as the material gains strength and matures. (100sq m with 300mm thick walls) will lock up 7.9 tons of CO_2 in the walls. Estimated rate of carbon sequestration is 165Kg CO_2 capture/m2. Therefore, building with Hempcrete reduces atmospheric CO_2.

The core fibre is derived from the sturdy, wood-like hollow stalk of the hemp plant, it is up to twice as absorbent as wood shavings, making it an excellent animal bedding and garden mulch. Its high cellulose content means it can be applied to the manufacturing of plastics or biomass conversion to fuel. The natural absorption capacity of hemp wood is considerably higher than that of conventional materials. Moisture, odours and ammonia are absorbed better and more rapidly. Hemp bedding is ideal for horses' hooves, as it forms a springy, insulating bedding.

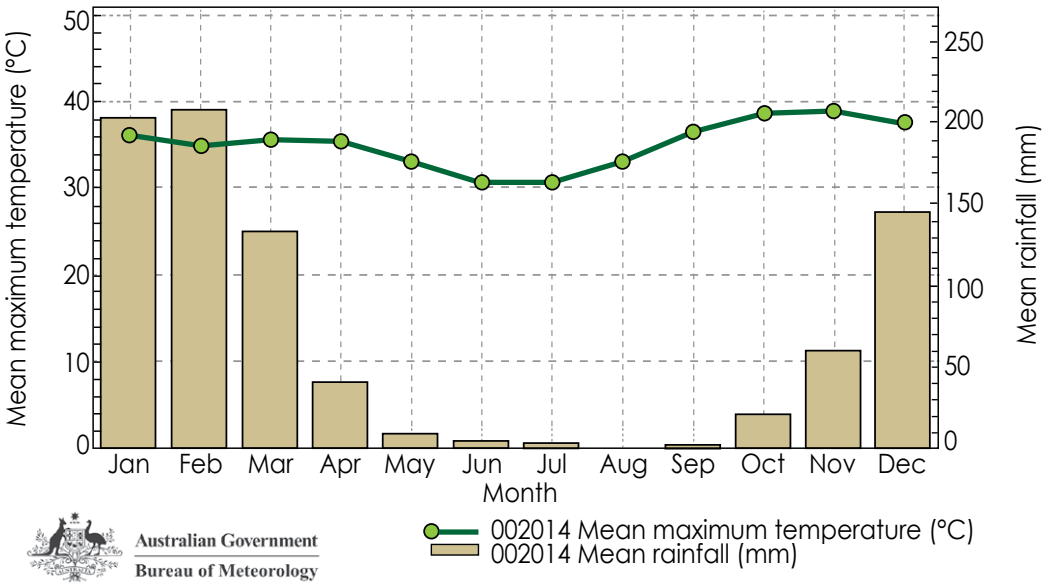
Chanvribat® construction hemp aggregate is a plant-based material made from raw hurds, which – once verified as complying with strict specifications – can be used in the building sector as insulation and construction material.

Industrial Hemp Production

Critical issues for hemp production in the Ord

Hemp grows in temperate, subtropical and tropical climates. It generally prefers a mild climate (optimum temperatures for growth are 15–27°C), a moderately humid atmosphere and rainfall of at least 600–700mm year.

Climate data – Kununurra Research Station



Hemp is extremely sensitive to flooding, water logging and soil compaction, therefore poorly drained or badly structured soils are not recommended, as excess surface water and heavy rains (during the wet season) can result in damage to the hemp crop (Roberta, 2016). This has implications for a fibre crop grown during the wet season. In addition, access to field for harvesting and in-field postharvest operations might be hindered by thunderstorm activities in February and March.

Hemp also has a high light requirement during its growing period. The cultivars grown in Europe are usually of French origin and have a critical photo-period of between 14 and 15.5 hours (Alberta Agriculture and Forestry, 2017). In temperate regions, industrial hemp can only be grown in the summer months. For fibre production in the tropics, hemp crops need to be grown over the summer months to capture the longer day lengths which enable to produce high stem dry weights.

Hemp is a short-day plant, which affects crop production. The plant requires a set number of successive short days for flower initiation. Flowering is important for grain production. Once the flowering starts, the efficiency with which intercepted radiation is converted to dry matter drops rapidly. A particular variety tends to flower at the same calendar date no matter when it is planted. However, the time of planting might influence the grain yield production (t/ha). New varieties are available that are not photo-period sensitive.

Hemp is primarily dioecious, that is, the pollen-bearing parts are found in one plant and the seed-bearing flowers on another. In a dioecious crop, the number of female plants is 10 per cent to 50 per cent higher than the number of male plants. There are a few monoecious cultivars now that have both male and female flowers on the same plant. This may have influence on the grain yield achievable. Hemp yield (grain or fibre) varies with variety, plant population, soil conditions, timing of harvest and annual climatic conditions. The average grain yield in Canada is 850 kg/ha and the highest recorded yield was 2,242 kg/ha (Alberta Agriculture and Forestry, 2017).

The differences in growth rate and development between male and female plants are large. The male plants tend to flower and senesce earlier. For a fibre crop, this variation may limit yields, reduce the efficiency of resource use and may result in variable quality. However, good yields of a quality fibre stem product will be achieved if harvest starts when 50% of male plants are flowering (or when female plants have just started flowering); and hemp cut after this period, i.e., during female flowering will have lignified fibres which are more difficult to cut and process, and may lodge (Jobling T, 2016). In this instance, grain production is not possible from the fibre crop.

Soils and land preparation

Cropping system with IH would need to be monitored when in rotation with Lupins and Chickpeas as all three are known to develop *Sclerotinia*. However, the crop has benefitted from being in a rotation with lupins in other areas of the world. The high nitrogen fix of lupins complements the IH crop and the biomass drop of the IH crop likewise enhances the lupins yield.

The soil would need to be furrowed and mounded for flood irrigation. To break up the clay pan it would be beneficial to add high content of mulches or carbon based soil ameliorations – e.g. biochar.

Flood irrigation is not always recommended for IH but could assist the growing cycle in the heat by breaking up the clay pan when establishing the channels, by having channels close together to allow the crop to shade out the channel and thus keep the soil cooler.

Soils
The ideal soil acidity is between 5.8 and 6.5 pH.

Very rich black mollisols, brown rendzina and brown steppe soils have favourable water balance, good water permeability and an excellent nutrient-accumulation potential.

Hemp may react poorly to residual herbicides in soil, however with time it should be possible to develop a reasonable yield of hemp on soils previously impacted by chemical usage, helping to improve soil health, and supply industrial inputs for building products or paper, rather than as a food crop.

Hemp is a huge user of biomass and so soils strong in residual biomass from previous cropping will encourage strong growth. Due to the tap root system, hemp doesn't grow well in compacted soils and a clay pan may be an issue unless already worked from a previous crop.

Most seeds imported into WA have had temperature restrictions of 12°C to 25°C in the soil. There is one or two which may grow outside this range, so soil temperature needs to be monitored as this may stop growth during the season. Temperature stress will definitely stop growth and set flowering early if it occurs early in the growth pattern.

Hemp tap root.

Literature suggests that:

- best temp is 25°C;
- soil temp should be 10-12°C at sowing
- the optimum (soil) temp is 35°C, the maximum is 45°C
- optimum soil temp for germination are around 18°C.

Optimum soil temperatures are important to ensure rapid germination and growth to out compete weeds. Based on the Kununurra climate data, the only months suitable for planting are June and July, otherwise the soil temperature will be over the critical level of 37°C.

Planting

Planting needs to be in season where the soil is moist but not sodden and compacted and there is a chance of cool and long days. Seeds should initially be chosen for day-length maturity. At the moment there are seeds from China which could match what is required in the Kimberley. There is also a research station in Hawaii which may allow use of their seeds.

Due to the different requirements of some IH seeds there may be an opportunity to grow two different crops at two different sowing times in the Kimberley.

European seed – which will set early and short may be a variety for seed production will need to be planted at the coolest months.

China/Hawaiian seed – which will take longer to grow and set can be sown earlier and in warmer months, will produce a great deal of biomass.

Sowing

Sow Rate:

Fibre crop approximately 80 kg/Ha

Seed crop approximately 5 - 40 kg/Ha

Or 100-250 plants/m^2

Planting at the higher density results in minimal branching, improves the quality bast fibre for textile use, almost complete ground cover and weed suppression. Wider spacing of plants allows for more branching and higher seed yields but can allow weeds to develop.

Sow Method

Regularly spaced plantings assist uniformity of crop qualities. Seed depth 2-5 cm, with uniformity preferred. Deeper for light soils. A normal combine seeder can be used.

Both broadcast and drill sowing have been used successfully, however mounding the soil is preferable for flood irrigation.

Good seedling establishment.

Crop nutrition

Nitrogen is considered the most important nutrient for hemp, which needs adequate, readily available nitrogen throughout the entire vegetative period to achieve high yields. Including leguminous crops in rotation and addition of natural organic fertilizers prior to sowing can provide good required N as the crop does not respond well to additional nitrogen over the growing period. This addition of N can result in reduced fibre quality and quantity. It can also cause the stems to become hard and woody and difficult to harvest. To use a benchmark for the area - Hemp requires less N than rice or cotton but is closer in requirements to Sunflower and Rapeseed.

Hemp requires adequate Calcium and therefore pH should be rectified by liming if acidity limits the availability of any of these nutrients.

Phosphorous and potassium are also quite important relating to elasticity and tensile strength of fibre cells or bundles and fibre quality respectively.

Hemp crops in south western Australia have benefitted from organic mass such as mulches, seaweeds, fly ash, bird and animal manures, lime, that add long term nutrients to soil rather than one season fertiliser.

There is also reported damage to seeds from fertiliser burn and so any nutrition for the crop would need to be added and turned in prior to seeding.

"Hemp removes minimal ingredients permanently from the soil in comparison to wheat, corn, tobacco and such like." P. Blehiem. This can mean that following crops will benefit from hemp growing in an area.

Irrigation requirement

Flooding is the current option in Kununurra and so new ways of looking at moisture requirements are needed. In France, the crop only requires rainfall events of 5 to 10ml each over three crucial times of growing: Seeding, flower set and seed set. The ORIA will have very different requirements.

Seed beds will need to be raised and the crop seeded between each irrigation row. DPIRD have always sown this at four seed rows between each flood channel. This may be an area which could do with some research as smaller mounds and more channels may help keep the soil temperature down. This compacting seeds and channels may also allow the canopy to develop quickly and keep a shade area over the soil.

Weed control

If hemp is able to develop a canopy early due to seed sowing numbers being high, then there is little need for weed control. Most farmers report that using pre-emergent herbicides needs to be done well in advance as any residual on the surface will kill off seedlings.

Hemp has proved to be highly sensitive to the residue of herbicides in the soil, therefore it is advisable to avoid the cultivation after maize if atrazine and simazine are used, or after tomato treated with specific herbicides for Solanaceae.

There is no reason to use a desiccant with hemp – the seeds are harvested at 70% ripen on the flower to stop them shattering. And the stalk is knocked to the ground for either harvesting or biomass.

Hemp crop establishment trials - Kununurra 2018.

TABLE 3: There are some registered herbicides for hemp:

ACTIVE INGREDIENT	SOME TRADE NAMES	PERMIT	NOTES
Fluazifop-P	Fusilade	85061	Post-emergence, kills grass weeds
Glyphosate	Roundup Wipe-out	85061	kills grass and broad leaf weeds
			No selectivity, applied as a desiccant to biomass crops
Pendimethalin	Stomp Panida Max or Grande	85061	Pre-emergence, kills grass and broad leaf weeds
Trifluralin	Trifluralin	85061	Pre-emergence, kills grass and broad leaf weeds
Bromoxynil	Bromicide	81997 87802 86924	post-emergence, kills broad leaf weeds
Clethodim	Sumistatus	81997 87802	Post emergence until flowering, kills grass weeds
Diquat	Reglone	81997 87802 86924	desiccant
Haloxyphop	Verdict	81997 87802 86924	Post emergence, kills grass weeds
Quizalophop	Targabolt	81997 87802	Post emergence, kills grass weeds

Pest and disease control

TABLE 4: There are some registered insecticides for hemp

ACTIVE INGREDIENT	SOME TRADE NAMES	PERMIT	NOTES
Azadirachtin	Azamax	85066	A natural product
Methomyl	Lannate	85066	Withholding restrictions with warnings that it should not be applied if bees are active in the crop
Chlorpyriphos	Lorsban	85066 81997 87802	Withholding restrictions with warnings that it should not be applied if bees are active in the crop
Indoxacarb	Avatar	85066 86924	Withholding restrictions with warnings that it should not be applied if bees are active in the crop
Bacillus thuringiensis	Dipel	85066	Biological product. Treated product is 'not for human consumption', but this product presents no risk to humans
Nucleopolyhedrosis virus	Vivus Max	86924	No risk to humans
Chlorantraniliprole	Altacor Hort Insecticide	86924	No risk to humans
Alpha-Cypermethrin	Astound	81997 87802	Withholding restrictions with warnings that it should not be applied if bees are active in the crop.

Pests

In hemp crops in Australia, many pests have been recorded but most have been easily dealt with using organic and biological controls.

In fibre crops, Heliothis (*Helicoverpa spp.*), Red Shouldered leaf beetles (Monolepta australis), Green Vegie Bug (*Nezaria viridula*), Jassid (*Batracomorphus angustatus*) and Lucerne Flea (*Sminthurus viridis*) have been recorded.

The only one in WA which has affected crops to a worrying extent is the Heliothis grub and that can be controlled by Biological sprays if caught in time.

From a report by B.R. Weeden for RDIC on planting hemp in Tropical Queensland: Fungal attack has caused minor occurrences of plant death in trials in Queensland and New South Wales and has been identified as species of *Sclerotinia* and *Sclerotium*, or White Mould. The infection has been more prevalent in clay soils or where frequent watering occur, creating a wet-dry cycle which encourages the disease. In no cases of fibre crops were these pests or diseases present in large numbers or at economically damaging levels.

Basal stem rot (*Sclerotium rolfsii*), Septoria (*Septoria cannabis*) which was a new record for Australia and Cercospora (Cercospora sp) were identified. There were some plant deaths due to the basal stem rot while the Septoria and Cercospora caused some leaf damage however none of the diseases were at a level which required treatment. Under large scale commercial plantings however these diseases may be of concern, especially in tropical areas. (2)

Root knot nematodes (*Meloidogyne spp.*) and other nematodes have been identified in the root systems of hemp in cropping soils where nematodes are known to be a problem (e.g. sugarcane areas). In some cases, infection with nematodes is thought to be the cause of considerably reduced plant yields. There is presently some work being done on this issue with DPIRD and how IH deals with RRN.

In the southern hemisphere Fungi is hemp's most common type of pathogen. Yellow leaf spot, grey mould, hemp canker, downy mildew, fusarium stem canker and fusarium wilt are the most well-known.

Meloidogne haplii is anematode worth noting, while parasitic plants include dodder and branched broom-rape. Viral organisms such as alfalfa mosaic virus, arabis mosaic virus, cucumber mosaic virus, hemp mosaic virus and hemp streak virus may be infected via insects. Hemp's THC levels usually inhibit most viruses as this raises in the plant to combat pathogens. Work is being done by NSW DPI into cotton and hemp pathogens - valuable contact Karen Kirby: (*karen.kirby@dpi.nsw.gov.au*).

Spider mites and the hemp russet mite are known to attack but this is usually because hemp has been grown out of season.

Birds can be a pest, at the early stages of germination and particularly to seed crops. This is particularly true of the South West of WA where there is a large parrot population. As yet this is occurring only in small farm plots.

Animals such as sheep, cattle and deer have been known to graze on IH.

TABLE 5: Fungicides

ACTIVE INGREDIENT	SOME TRADE NAMES	PERMIT	NOTES
Boscalid	Filan	85055	
Fludioxinil and Metalaxyl-M	Maxim XL	85055	
Metalaxyl-M	Apron	85055	
Thiram	Barmac (Thiram liquid) Barmac (Thiram DG)	85055	liquid and dry formulations
Potassium bicarbonate	Ecocarb	85055	
Mancozeb	Farmoz Mancozeb	85055	

Harvesting

Harvesting for seed.
Grain should be harvested when shattering begins. The rest of the plant will still be green and about 70% of the seed will be mature. The grain water content may be 22-30%. Grain combine harvesters can be used for grain harvest and some have suggested settings similar to those used for grain sorghum. The long stems can challenge combine harvest so some have placed PVC pipe around moving parts to reduce wrapping. Keeping the head at the correct height for the seed head also helps for a clean run.

As with any grain crop, the proper harvesting, processing, transportation, and storage are critical to prevent spoilage and ensure the highest value for the harvested grain. Hemp grain is thin-walled and fragile, requiring care in harvest, storage, and transport.

Seed Storage
Wet or green seed needs to by dried with hours of harvesting, preferably within the first 5 hours, and stored with a moisture level between 9-10%, to preserve viability. Seed also needs to be stored in a cool environment otherwise the 30% oil content of the seed will spoil. This is critical to also maintain seed germination viability.

Harvesting for Fibre/Bast
Fibre plants are not sown for seed and therefore they are harvested prior to flowering. If being used for textiles the plants should be harvested a little earlier – at the first appearance of the indications of bloom on the male stalks. Male stalks are reported to have a stronger fibre and can be hand pulled for the carbon fibre market.

The crop is cut and windrowed. Mechanical harvesting is now common, using specially adapted cutter binders or simpler cutters.

The cut hemp is laid in swathes to dry for up to four days. This was traditionally followed by retting, either water retting (the bundled hemp floats in water) or dew retting (the hemp remains on the ground and is affected by the moisture in dew moisture, and by molds and bacterial action). Modern processes use steam and machinery to separate the fibre, a process known as thermo-mechanical pulping.

When seeding for fibre the end destination is a consideration – the higher the sowing rate the taller, straighter and thinner the plant. For paper fibre the plants are able to be sown less densely as biomass is required rather than long stalk.

The timing of growing for hurd and fibre need to be thought through as the late harvest of the hemp stalk and leaving it to rett may move into the following season plantings. IH varieties will need to be trialled to find out which ones not only grow best in the Kimberley but also for their ability to fit into the rotational system established.

Harvesting seed Warmington.

The plants are cut at 2 to 3 cm above the soil and left on the ground to dry. Traditionally hemp was gathered in stooks and leaned in a 'tipi' like structure to air dry.

Harvesting for Hurd

Hurd can be cut after seed has been harvested using a cutter bar which can be attached to the front of a traditional tractor. It would need to be retted in the field for 4 – 10 weeks. As there is very little literature on the breakdown on hemp in tropical heat, this would need to be learnt on the go. Once the retting has occurred the hemp stalks are windrowed like hay and baled. They can be stored under cover until required for either decortication or chopping for bedding or bio composites.

This is the difference between a seed crop and a biomass crop. The IH variety on the left is French and sown for seed. The one on the right is Chinese and will keep growing long after the French seed is harvested. It will be cut before flowering.

Transport

The Strategy Matrix Report (Feb 2018)) found that the majority of processors do not contract hemp production outside of a 100 km radius of their processing facility. This is due to the cost of transporting baled hemp stalks long distances and the added expense of inspecting each crop.

There are significant costs in relation to transporting hemp considering it has a very low weight per unit of volume. The general rule of thumb from Tasmania is that milling facilities need to be within a 50km radius of the crops growing location. In Europe, one study notes a maximum distance of 40km.

Scale of production required to make the harvesting, transporting and processing of hemp fibre viable was difficult to achieve (in Tasmania), primarily because:

- Significant costs in relation to transporting hemp considering it very low weight per unit of volume. General rule of thumb is that milling facilities need to be within 50km of the crops growing location.
- Processing of hemp for fibre is technically complex and requires significant investment in infrastructure.
- Processing requires large volumes of dry hemp material as bast fibre is recovered at a rate of 35-40 percent of the stem. Evidence suggests a minimum scale is about 2500 ha.
- An estimated cost of a decortication plant is $3.4m.

The issue of growing Hemp in the ORIA at the moment is not the transport to the processing facility, should it be located in the Ord, but the transport of the fibre to any key market is expensive due to the distance and deemed to be prohibitive.

The realistic option for hemp could be to produce seed and manage the post harvest requirements of drying and cool chain management in 1000kg bulka bags (this system was used for the Chia crop).

Hemp positioning with cotton in the ORIA

In the ORIA the cotton industry is under some significant trialling with 2020 seeing around 1,250ha of cotton being planted and now in its third year. The intention is to assess the outcome from this year and significantly increase production in 2021. This year also sees the introduction of four new growers with irrigated cotton experience who are seeking to find additional sources of water and land to make up for reductions due to the east coast drought. These new growers will be heavily focussed on cotton with a full book of knowledge and tools around growing cotton and little experience with IH.

A paper from the Australian Cottongrower magazine Dec 2019 presented an article; A comparative analysis of cotton and hemp production in Australia by Stuart Gordon and Rose Brodrick – CSIRO Agriculture and Food.

Both crops are nominally summer crops, with similarities around growing requirements although industrial hemp is less tolerant to sodic soils than cotton. It is also intolerant of compacted soils particularly at seed germination. Once set, industrial hemp grows quickly, maturing in 70 to 90 days. Flowering occurs in many varieties at the summer solstice no matter the time of sowing. In contrast, cotton produces squares and flowers for about half its growing season, which extends up to 180 days before maturity.

Pests and diseases affecting Australian cotton crops are well documented and managed via pesticides, genetically modified traits and integrated pest management regimes. In contrast, there has been little investigation of pests and diseases affecting industrial hemp in Australia. Slugs, earth mites, cutworms, heliothis moths, Rutherglen bugs and birds have all been observed by local growers as indicative pests of industrial hemp. There is work being done on this by DPI NSW.

A recent survey of a winter crop in northern NSW identified industrial hemp as a possible host for a range of diseases affecting cotton, and in Canada one researcher stated it was advisable to avoid crops in the same rotation with industrial hemp varieties susceptible to pythium and sclerotinia.

In terms of water and nutrition, both cotton and hemp require reasonably significant inputs to achieve good yields. Viewing numbers broadly on a season length basis, i.e., an average of 5.5 ML per hectare over 90 days for industrial hemp versus 7.8 ML per hectare over 180 days for cotton, shows the water requirement for industrial hemp, depending on the location and season, is probably very similar to cotton. The same scenario applies to N and other nutrient requirements.

None of the Australian crop has been harvested for fibre yet, as the post-harvesting processes to extract and properly refine the fibre from the stem do not yet exist in Australia.

Comparison of each crop's products and farm-gate returns

While cotton and IH are different plants, they do share commonalities in the products for which each crop is grown. Both plants produce fibre. Cotton produces both seed and stem (bast) fibres (although the cotton plant stem bast fibre is not exploited) and IH produces a bast fibre which can be used in traditional textiles, non-wovens particularly for industrial end-uses, and composites. Both plants also produce an oily seed that can be used for food for humans and animals.

Table 6 lists average production values for cotton plus yields from the top 20 per cent of cotton producers against recent Australian yields for the equivalent product from hemp. The top seed yield from Canadian IH growers is provided for comparison. There is certainly much scope to improve Australian industrial hemp yields via shared variety testing and optimising agronomic and harvest practices.

TABLE 6: Comparison yields (kg/ha) for cotton and industrial hemp farm-gate products 2017–18

CROP OUTPUT	AUSTRALIA AV YIELD KG/HA 2017–18	CANADA TOP 20% YIELD KG/HA 2017–18
Cotton fibre	2297	2865
Cotton seed*	5742	7163
Hemp fibre**	790–1220	
Hemp seed (grain)***	900–1280	3402
Hemp hurd****	1430–9090	
*Assuming 227 kg/bale and 40 per cent turn out at gin.		
**Theoretical percent fibre from 15-25 per cent of the dried stem mass.		
***Range from 2017–18 SA, NSW, TAS & VIC crops.		
****Range from 2017–18 SA & NSW crops.		

TABLE 7: The current farm-gate prices Australia/Canada

Comparison farm gate value ($/ha) for cotton and industrial hemp farm-gate products 2017–18

CROP OUTPUT	AUSTRALIA AV RETURN $/HA 2017–18	CANADA TOP 20% RETURN$/HA 2017–18
Cotton fibre	4959	6399
Cotton seed	1254	2506^
Hemp fibre?	?	?
Hemp seed (grain)^^	2588-3703	3703
Hemp hurd^^^	420-2700	>9000
^Drought price of $350/t - ^^$2.50-3.50/kg - ^^^$300–1000/t		

Industrial hemp will not replace cotton's traditional place in the textile world but there could be distinct synergies in crop rotation or refugia plantings with cotton, and certainly in the development of industrial and domestic textile and material products.

Hemp Seed Gross Margin

	Yield	1.00	graded tonnes harvested per ha					
INCOME:	**Grade**	**%**	**Tonnes**	**$/unit**			**$ha**	**$/ha**
Hemp Seed	First	80%	0.8	$3,200.00	per tonne		$ 2,560	
	Second	20%	0.2	$ 800.00	per tonne		$ 160	
Commission				Rate	0.0%		$ -	
				TOTAL INCOME:			**$ 2,720**	**$ 2,720**
VARIABLE COSTS								
Machinery Costs (incl R&M)	**Number**	**Units/ha**	**units**	**$/unit**			**Per ha**	
Annual cultivation costs								
Bed perperation	1	1.1	hrs	$ 119.00	per hour		$ 131	
Fertilising	1	0.4	hrs	$ 184.00	per hour		$ 74	
Discing etc	1	1.25	hrs	$ 100.00	per hour		$ 125	
Planting	1	0.5	hrs	$ 75.00	per hour		$ 38	
Boom spray	6	0.1	hrs	$ 120.00	per hour		$ 72	
Labour		3.85	hours	$ 35.00	per hour		$ 135	**$ 574**
Planting								
Seed	1	18	kg	$ 25.00	per kg		$ 450	
Fertiliser								
NPKS	1.00	0.2	tonnes	$ 990.00	per tonne		$ 198	
Agras	0.00	0.32	tonnes	$ 848.00	per tonne		$ -	
Urea	1.00	0.12	tonnes	$ 805.00	per tonne		$ 97	**$ 745**
Chemical costs		**rate l/ha**						
Pre-emergent	1	applics		$ 50.00	per applic		$ 50	
Herbicides	2	applics		$ 25.00	per applic		$ 50	
Insecticides	2	applics		$ 25.00	per applic		$ 50	
Fungicides	1	applics		$ 40.00	per applic		$ 40	**$ 190**
Harvesting								
Contract harvesting		1	harvest	$ 285.00	per ha		$ 285	
Drying/handling charge		1	bulka bags	$ 40.00	per tonne		$ 40	
Contract freight		1	transport	$ 30.00	per ha		$ 30	**$ 355**
Irrigation costs								
Laser levelling	0%	1	per ha	$ 940.00	per ha		$ -	
Fixed charges		1	ha	$ 165.00	per ha		$ 165	
Water		8	Ml	$ 6.00	per Ml		$ 48	
Water management		8	applic	$ 6.00	per applic		$ 48	
Shire rates							$ 32	
Land lease								
Aerial spraying		0	applics	$ 23.00	per ha		$ -	
Scouting costs	1	10	ha/hr	$ 80.00	per hour		$ 8	
Pest control		0.5	hours	$ 35.00	per hour		$ 18	**$ 819**
					TOTAL VARIABLE COSTS		**$ 2682**	
					GROSS MARGIN PER HA		**$ 38**	
			BREAKEVEN YIELD@	$ 3,000	per tonne		**0.9 tonnes**	
			BREAKEVEN PRICE @	1	tonnes/ha		**$ 2,682 per tonne**	

SENSITIVITY ANALYSIS — **Yield t per total ha** — 120%

Average Price $/t	**0.5**	**0.6**	**0.8**	**1.0**	**1.2**	**1.5**
$ 2,500	$1,432	$1,182	$862	$182	$318	$1,068
$ 2,750	$1,307	$1,032	$482	$68	$618	$1,443
$ 3,000	$1,182	$882	$282	**$318**	$918	$1,818
$ 3,250	$1,057	$732	$82	$568	$1,218	$2,193
$ 3,500	$932	$582	$118	$818	$1,518	$2,568

Publications and references

- Growing Hemp for Profit – P. Blehiem/S. Bailey & K. Marosszey
- World Health Organisation (WHO) Cannabidiol (CBD) Pre-review Agenda 5.2 2017
- Industrial Hemp Trials at Kununurra 2008 and 2018 Progress Report – DPIRD Sivapalan and Warmington 2019
- Manjimup Hemp Milling Pre-Feasibility Study Strategy Matrix 2018
- A comparative analysis of cotton and hemp production in Australia – Australian Cottongrower Dec 2019
- Alberta Hemp Cost of Production and Market Assessment Report – Serecon Management Consulting 2012
- Ecofibre's Industrial Hemp Grain Production Guide - 2016
- Ecofibre's Industrial Hemp Fibre Production Guide - 2016
- Industrial hemp – a new crop for NSW Prime Facts 2008
- Industrial Hemp Harvest and Storage - Best Management Practices Alberta Agriculture and Rural Development 2012
- Evaluation of Hemp and Kenaf Varieties in Tropical and Sub-tropical Environments – RIRDC 2007 by B R Weeden 2006.
- Information on Hemp Fibre taken from 2020 Canadian Hemp Trade Alliance. *http://www.hemptrade.ca/eguide/fibre-production/fibre-processing*
- A New Breed of Fibre Mill: Bast Core Hemp Processing - Fibershed 2017
- Scan of new and emerging industries Coriolis – 2017

Consultation

Ag*knowledge* would like to thank Gail Stubber, CEO, WA HempGro Co-op for a significant contribution to the background information in this report.

Others who contributed to a greater understanding of the potential for Industrial Hemp in the ORIA include:

Andrew Beer – Consultant, Kimberley Development Commission

Fritz Bolton – Grower, Oasis Farms, Kununurra

Robert Boshammer – Grower, Oasis Farms, Kununurra

Paul Brimblecombe – CEO, Cubbie Ag

Stephen Brooks – CEO, MG Corporation

Tim Bray – Kimberley Development Commission

David Cross – CEO, Ord Cooperative and Northern Australia Crop Research Alliance

Sam Crouch – Researcher DPIRD, Broome

Lauchlan Grout – Grower, Hemp Farms Australia, QLD

Chris Ham – DPIRD, Broome

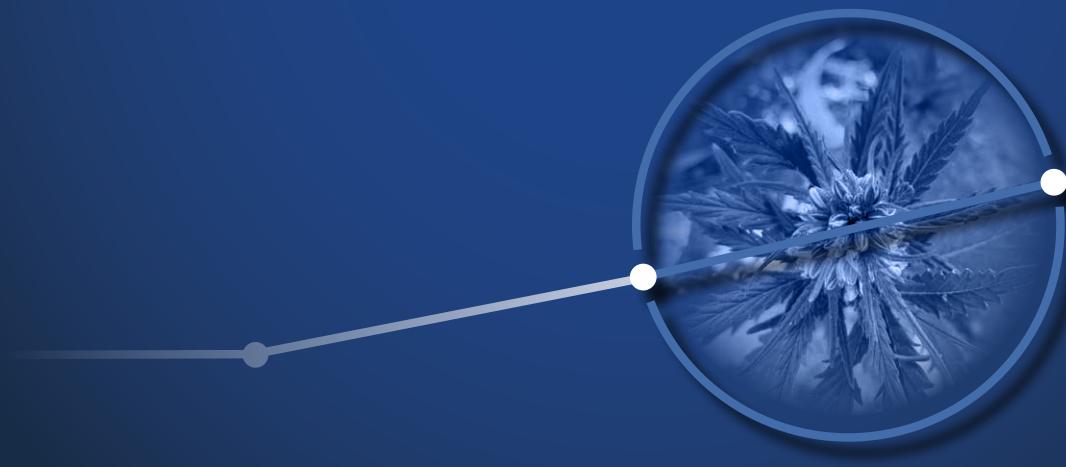
John Muir – Consulting Agronomist, Hemp Farming Systems, NSW

Dominique Reeves – Senior Counsel, MG Corporation

Dr Helen Spafford - Senior Research Scientist DPIRD, Kununurra

Gail Stubber – CEO, WA Hempgro Co-op, Carbunup River

Mark Warmington – Senior Agronomist, DPIRD, Kununurra



AgKnowledge®

CONNECTING AGRICULTURE

P: 08 9291 8111
E: cookes@iinet.net.au