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PROFITABLE & SUSTAINABLE PRIMARY INDUSTRIES www.dpi.nsw.gov.au
JULY 2008 PRIMEFACT 801

Industrial hemp – a new crop for NSW

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Introduction

Industrial hemp (*Cannabis sativa* L), also known as 'Indian hemp', is one of the oldest crops known to man. It has been cultivated since ancient times for its bast (phloem) fibre in the stem, multi-purpose oil in the seeds (achenes) and an intoxicating resin secreted by epidermal glands. It is thought that *C. sativa* was one of the first plants to be cultivated and there is general agreement that the plant species originated in China where the greatest genetic diversity is found.

Tetrahydrocannabinol (THC) is the classified psycho-active (mind-altering) ingredient in *C. sativa* that is produced in specialised glands. The difference between marijuana and industrial hemp is that the THC concentration is significantly lower in industrial hemp than it is in marijuana.

Industrial hemp is a tall, annual herbaceous plant which produces fibre and hurd (woody core) from the stem as well as oil from seed.

Interest in industrial hemp has gained momentum world wide, suggesting that demand for natural fibres will continue to increase. Market segmentation for ethically produced goods and growing demand for biodegradable and natural products has led to a wide range of new industrial hemp products being developed. Interest has increased because of climate change issues and the desire to become more environmentally friendly.

The objective of this Primefact is to provide information on a broad range of topics relating to the industrial hemp industry. Of particular interest are the issues

Figure 1. Early February planted industrial hemp foreground and early December planted industrial hemp background.

Figure 2. Young vegetative industrial hemp crop.

that may affect the development of the industry in New South Wales. Industrial hemp, because of its 'green' image, seems to be almost self-promoting. The challenge is determining which information is factual and which information is of a promotional nature.

There are many myths associated with industrial hemp and for a profitable industry to develop the myths must be separated from the facts. For those interested in producing industrial hemp, four key questions need to be answered:

1. What markets are available for industrial hemp material?

2. Is the profit margin equal to or higher than other crops?
3. How will the crop be harvested?
4. What processing facilities are available?

If these four fundamental questions can not be adequately addressed, then industrial hemp may not be right for your farm business.

From the individual producer's perspective, the old adage '*find your market before you plant your seed*' remains sound advice.

The plant

Industrial hemp (*C. sativa*) is a fast growing, annual herbaceous plant with a deep tap root. It can grow to a height of 5 m, depending on variety and growing conditions. Industrial hemp is a short-day plant (long nights) – the plant requires a set number of successive short days for flower initiation.

It has a slender main stem and when grown at commercial crop densities the stems are almost unbranched. Stem diameter varies from 10 mm to 40 mm.

Figure 3. Basic morphological features.

Cannabis sativa. 1. Flowering branch of male plant. 2. Flowering branch of female plant. 3. Seedling. 4. Leaflet. 5. Cluster of male flowers. 6. Female flower, enclosed by perigonal bract. 7. Mature fruit enclosed in perigonal bract. 8. Seed (achene), showing wide face. 9. Seed, showing narrow face. 10. Stalked secretory gland. 11. Top of sessile secretory gland. 12. Long section of cystolith hair (note calcium carbonate concretion at base).

Figure 4. Cross sections of stems at internodes of a fibre plant (left) and of a narcotic plant (right). Fibre cultivars have stems that are hollower at the internodes, i.e. less wood, since this allows more energy to be directed into the production of bark fibre.

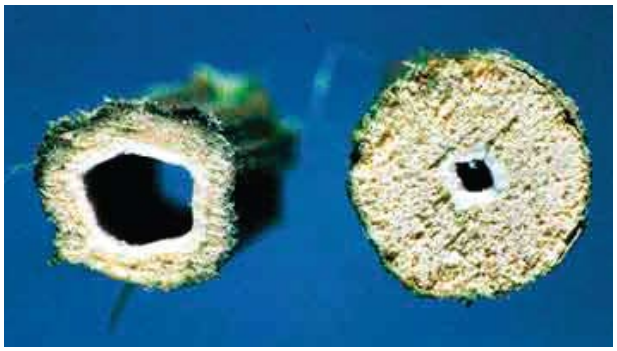
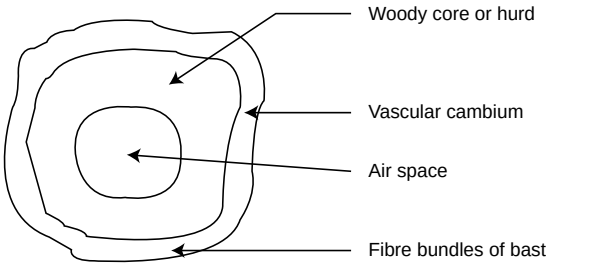


Figure 5. Transverse section of the stem of a *Cannabis sativa* plant.



The stem comprises two parts: the bark or bast, which contains the fibres used for textiles, and the hurd, with much shorter fibres, used in mulch products. The bast fraction represents about one third of the stem, the core about two thirds. The value of these fractions depends on variety, the age of the plant and the position along the length of the stem, as well as growing conditions. See Figure 4.

Industrial hemp is normally dioecious, meaning it has separate male and female plants, but monoecious varieties with male and female parts on the same plant, have been bred. They have, however, been largely unsuccessful as yields of both fibre and oil are compromised.

Economics – growing the crop

To achieve a viable gross margin, the production of industrial hemp in New South Wales will need to be undertaken on a broadacre basis. Hence, the size of industrial hemp farming operations would need to be comparable with other broadacre summer growing crops such as sorghum, sunflower, cotton and soybean. Planting, cultivation and harvesting equipment would need to be of sufficient capacity to handle large-scale operations.

Agronomy

Industrial hemp plants grow well on a fertile, neutral to slightly alkaline, well drained clay loam or silt loam

Figure 6. Photograph of Cannabis sativa. Top, staminate ('male') plant in flower; Bottom, pistillate ('female') plant in flower. Photos: J. Lacy.

soil. Industrial hemp is intolerant to wet, flooded, or waterlogged soil. Seeds should be sown to 4–5 cm depth in non-crusting soils to achieve rapid germination to optimise weed suppressant qualities.

Moisture

To avoid plant stress and obtain viable yields (tonnes dry matter per hectare), adequate moisture during active growth is required. This is particularly important during the first six to eight weeks of crop establishment to ensure maximum early canopy closure and effective suppression of weeds.

Potential industrial hemp growing regions will need to determine the season of active growth (photoperiod requirements of particular varieties) and whether adequate soil moisture is potentially available from rainfall and/or irrigation.

Until germination has occurred (usually 3–5 days after sowing), irrigation is recommended to keep the surface soil moist. Industrial hemp is sensitive to drought conditions and needs an adequate supply of water. Without rainfall the crop may require 3–6 ML of irrigation water per hectare.

Varieties

Currently there are limited varieties suited to NSW growing conditions. However, there are new varieties being developed for both fibre and seed production.

Plant density

Potential growers will need to establish the germination rate for sowing. If germination data is not provided, growers should contact a qualified seeds lab to undertake a germination test. The germination rate must be considered when determining the seed sowing rate and desired plant density. The desired plant density will be different depending on whether a fibre crop or seed crop is to be grown.

The effects of plant densities have been widely researched. Optimum densities are determined by local conditions, varieties used and end-product required (fibre and/or seed). In industrial hemp, the proportion of stem in the biomass (total dry matter produced) and the content of bast fibres normally increases with plant density.

Plant densities ranging from 80 to 400 plants per square metre have been found to have little effect on stem dry matter yield. However, for fibre production, around 250 plants per square metre is desirable, equating to 50–70 kg/ha. This sowing rate is ideal for maximising industrial hemp fibre yield per unit area.

Seed crops can be sown at a far lesser rate, often from 30–70 plants per square metre, or 5–25 kg/ha.

Optimum temperatures

Optimum soil temperatures for germination are around 18°C. Optimum temperatures for growth are 15–27°C. Industrial hemp is relatively easy to cultivate. It is, however intolerant of:

- frost
- inadequate moisture
- very humid conditions giving rise to fungal disease
- excessively cold or hot climatic conditions.

Figure 7. Well designed irrigation layouts minimise the chance of water logging.

Nutrition

The effect of nitrogen supply on yield and quality of industrial fibre hemp is complex. Research conducted with nitrogen application at 80 kg/ha and 200 kg/ha nitrogen demonstrated responses but did not provide a clear indication of optimum levels. Further field work is required to determine optimum levels of nutrient application with respect to:

- expected biomass (kg dry matter per ha), growth and nutrient removal at harvest
- possible nutrient deficiencies
- residual soil nutrient levels.

Like other quick growing summer crops, attention should be given to adequate supply of other essential nutrients like phosphorous, potassium and sulfur.

Weed control

Given adequate nutrition, moisture and sunlight, industrial hemp has the ability to grow very quickly, allowing the plant to be very competitive with weeds. However, if grown for seed production and sown at a low plant density then weed control may be necessary. It is important to note that there are NO herbicides currently registered for use on industrial hemp in NSW or Australia.

Pests and diseases

Industrial hemp has a reputation for being resistant to pests and diseases, although the degree of resistance has been exaggerated: the crop plays host to several insects and fungal pathogens. However, under Australian conditions these have tended not to be too serious to date.

Harvesting

For fibre production, industrial hemp plants are normally cut at the early flowering stage or while pollen is being shed, well before seed set. This is when the stem, bark and fibre yield has reached its maximum. This stage is considered the best as it leads to easier decortication (removal of bark) without any effect on the tensile strength of the bast. A stem diameter of 5–10 mm is considered optimum for fibre production and most industrial hemp billets are chopped to a length of 40–60 cm.

Mechanical harvesting of industrial hemp in Australia is yet to be refined. However, through grower innovation and ingenuity, mechanical harvesting will be developed over time. With the development of mechanised machinery this may do away with retting.

Retting

Retting is a process of decomposition (rotting) and is necessary to separate fibre bundles from the woody core of the stem and outer bark. The result of retting is the sloughing off of the outer parts of the stem and loosening the hurd from the bast fibres. There are a number of retting methods;

1. Paddock retting (dew retting)

Harvested industrial hemp is left lying in a windrow until fungal organisms can complete the retting process. This may take several weeks and can be a risky process due to exposure to the elements. Determining when the stalks have become sufficiently retted requires experience – the fibres should turn golden or greyish in colour and should separate easily from the interior hurd. Stalks should have less than 15% moisture when baled and should be allowed to dry to about 10% in storage out of the weather.
It appears that paddock retting is currently the most cost-effective retting process.

2. Water retting (traditional)

Water retting has been largely abandoned in countries where labour is expensive or where environmental regulations exist. Traditional water retting involves soaking the stalks in ponds or ditches and can lead to high levels of pollution. Such techniques are still to be refined in Australia.

3. Water retting (enzymes)

Enzyme retting replaces traditional water retting and dew retting by using enzymes that degrade the plant cell wall, such as pectinases, hemicellulases and cellulases. Following this process the material may then be able to be fermented into ethanol. This process involves the introduction of an enzyme preparation into suitably sized tanks containing the retting mixture and stem material. Such techniques are yet to be refined in Australia and it still looks as though paddock retting may be the most cost-efficient process.

Products and markets

A comprehensive report on industrial hemp products and markets can be found at www2.dpi.qld.gov.au/hemp/16241.html

Figure 8 outlines the components produced from specific plant parts.

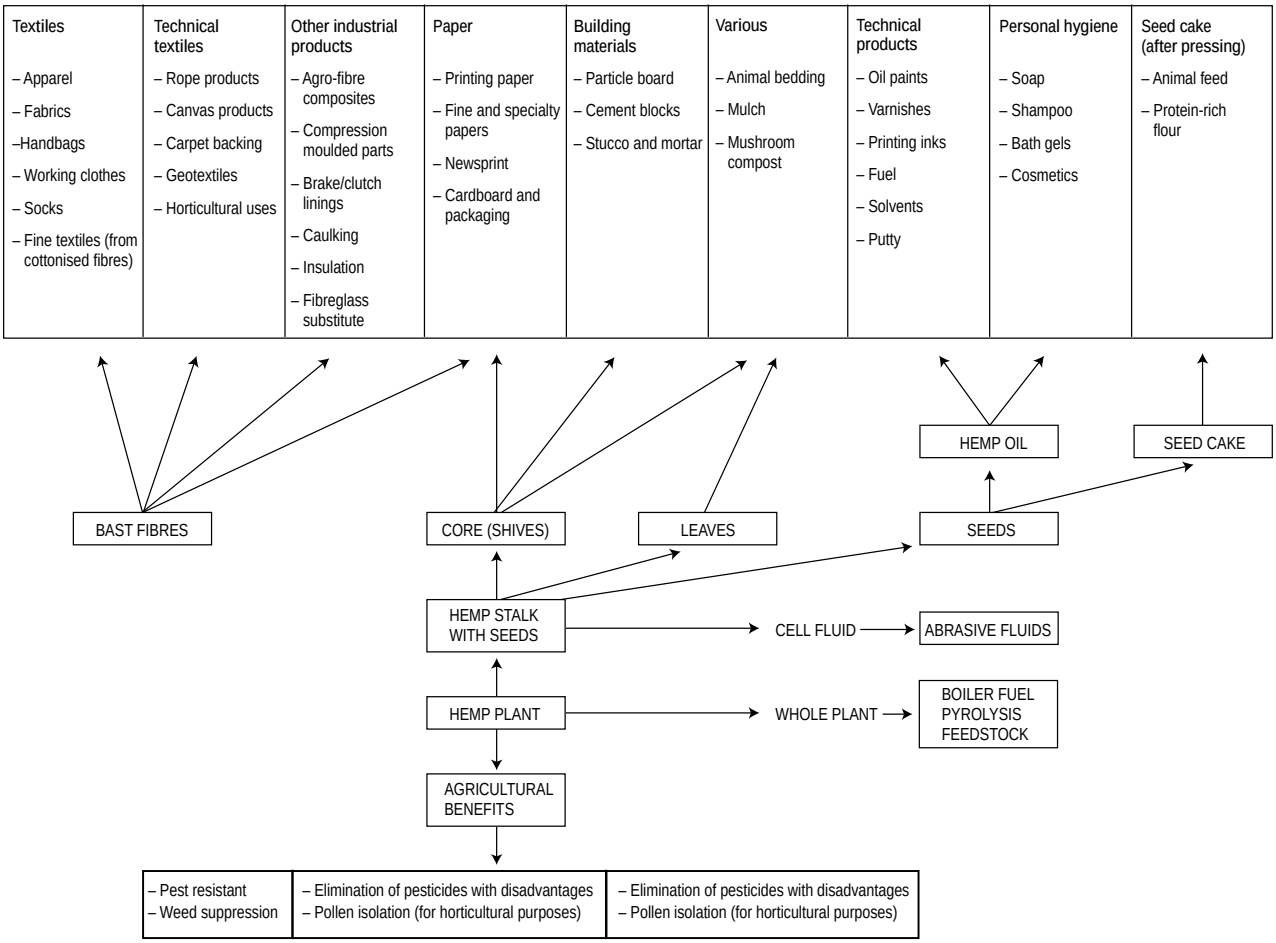
Yield

Reliable data on yield is currently difficult to obtain, though yields of around 10–12 tonnes per hectare of dry stem have been reported in NSW under irrigation. References suggest bast fibre is recovered at a rate of 35–40% from stems. These yields will need to be substantially higher if industrial hemp is to compete with other broadacre summer crops for similar variable input costs (water, nutrients etc).

Profitability

Reliable data on profitability is currently unavailable. However, if total stem yields are conservatively assumed at 10 t/ha (dry weight basis) and priced at approximately $245/t, this equates to $2,450/ha. With estimated growing costs of

Figure 8. Potential markets and commercial applications of hemp



approximately $800–$1,200/ha, on this basis there is potential for industrial hemp to compete with other broadacre summer crops, once infrastructure is established.

Frequently asked questions

1. Marketing – is NSW DPI going to assist?

NSW DPI does not propose to take a direct role in the marketing of industrial hemp. A number of marketing organisations already established in NSW are investigating market opportunities for industrial hemp.

2. Are there any organisations to join?

No. The industry is still in its infancy.

3. Is NSW DPI going to organise industrial hemp growing workshops?

If there is demand from local regions, NSW DPI extension officers will conduct information workshops to inform potential industrial hemp producers.

4. Where can I source seed?

Seed may be sourced from authorised growers in other states including Queensland, Tasmania and Western Australia. Seed used must have a low THC concentration of less than 0.5%.

5. Are there any processing plants in NSW?

No. There is currently no processing plant or infrastructure in NSW to deal with the primary processing of industrial hemp. There is a processing plant located at Dalby, Queensland. Mobile processing units are used in Queensland as the cost of transporting plant material more than 100 km makes production unviable.

6. Can you sow imported seed from overseas?

Yes. Once the seed has passed quarantine inspection procedures. However, northern hemisphere varieties tend to have too long a growing season for NSW conditions, due to the growing season in the latitudes from which they were selected. Most varieties currently in use in Australia are of Chinese origin. Some plant breeding is currently under way in Queensland and NSW under trial conditions.

7. Can other crops be grown following industrial hemp?

Yes. There is no literature stating otherwise. If best management practices are adopted there is no reason why industrial hemp could not become part of the farming system as a rotational crop.

8. **Can industrial hemp be used for 'bush tucker'?**

   No. Use of industrial hemp plant material or oil is not permitted in the production of food for human consumption.

9. **Can industrial hemp be used to purify water?**

   Yes. Industrial hemp has been described as a mop crop because it can be used effectively in water reticulation; research is being conducted into its role in reducing salinity levels in the soil.

10. **Why is industrial hemp considered a green crop?**

    Industrial hemp requires less water and chemical application than other fibre crops.

    When manufactured into building products its insulation properties result in reduced need for heating and cooling and provides a carbon sink.

    Industrial hemp can readily be used in the making of environmentally friendly paper.

    Textile manufacture from industrial hemp fibre reduces the dependence on environmentally unfriendly synthetics.

Conclusion

In an ever-changing world with greater environmental awareness and attention to the environment, industrial hemp with all its positive attributes and potential products could well be a valuable agricultural commodity. Development of new markets and manufacturing could greatly benefit rural economies.

Until the scale of production increases significantly, efficient mechanisation for harvesting and processing is explored, and value adding systems are established (industry development), the economics of industrial hemp production and marketing in NSW will remain unknown. The majority of industrial hemp in the world is grown or processed using low mechanisation and high labour inputs. In NSW the industry is likely to be broadacre, mechanised and capital intensive to achieve viable gross margins.

Identifying suitable growing locations and streamlining farming and processing systems would also be useful initiatives for development of the industry.

Figure 9. Aerial view of a well grown industrial hemp crop in southern NSW. Note the male (with seed heads) and the female plants.

Acknowledgements

Much of this information was derived from a conference report 'Industrial hemp', Rural Industries Research and Development Corporation 1995. Discussion paper on the feasibility of industrial hemp fibre industry in Australia. Rural Industries Research and Development Corporation, Barton ACT.

Further information

www2.dpi.qld.gov.au/hemp/16241.html
www.dpiw.tas.gov.au
www.ecofibre.com.au
www.croptech.com.au (when asked for user name and password, just press cancel)
www.agrifibre.com.au

ISSN 1832-6668

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Job number 8818