ALBERTA HEMP COST OF PRODUCTION & MARKET ASSESSMENT

FINAL REPORT

PREPARED FOR

ALBERTA AGRICULTURE AND RURAL DEVELOPMENT

ECONOMICS AND COMPETITIVENESS DIVISION

EDMONTON, ALBERTA

PREPARED BY

SERECON MANAGEMENT CONSULTING INC.

EDMONTON, ALBERTA

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EXECUTIVE SUMMARY

Interest regarding industrial hemp continues to increase within Alberta's agricultural sector. Not only does the crop grow well in the province, but the increased consumer interest in sustainability and renewable resources suggests that potential markets will emerge for the oil and fibre products derived from plants.

The following study provides a detailed overview of the entire industrial hemp value chain in Alberta. It includes a review of hemp seed and straw processing as well as an analysis of hemp processing systems around the globe.

Specific emphasis was placed on developing benchmarks for the cost of production at the farm level. This is a critical success factor for Alberta production. Efficient production systems are essential to the long term development of a successful industry. The monitoring of this efficiency requires and understanding of the key cost elements, which can be used as benchmarks for assessing progress.

While there appears to be a tremendous opportunity for industrial hemp production and processing in Alberta it is recognized that there have been a number of false starts over the years. Many of the difficulties with industry development stem from the fact that supply chain relationships are not yet fully developed and as a result the industry is unable to fully commit on a longer term basis. The key factor to remedy this situation is finding stable end markets, specifically for fibre based products.

On the positive side, there are significant efforts underway to further refine fibre processing technology. These efforts when combined with those targeting the development of markets for seed, fibre, and hurd will be of critical importance to the sector. If these activities help to either increase competitiveness by reducing cost of production and/or increase potential markets, the benefits to Alberta would be significant.

Opportunities can only be realized if advances in the processing and end market development can be combined with increased experience and knowledge of production systems and costs at the farm level. Continued commitment on the part of all stakeholder groups is essential to the success of this process. The following document outlines many of the critical success factors and provides additional context to discussions about future directions for this industry.

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INTRODUCTION

PURPOSE

The goal of this project was to assess the feasibility of Alberta's industrial hemp industry value chain, including primary production and processing. This assessment includes an analysis of both hemp oil and fibre products.

Expert opinion was solicited from both experienced growers of industrial hemp as well as individuals involved in processing the products. Significant focus was on the development of benchmarks for the cost of producing hemp at the farm level in Alberta.

The study also examined the competitive drivers for the industrial hemp industry. This analysis was designed to assess the relative competitiveness of Alberta compared to other jurisdictions and included as part of an analysis of potential industry strategies and opportunities.

BACKGROUND

Cultivation of hemp originated in Central Asia thousands of years ago. Hemp has a long history of use as a food grain and as a source of fibre for clothing, rope and netting. China is the largest producer of industrial hemp, followed by Europe, Chile and North-Korea.

Industrial hemp has been grown in Canada since 1606, as it was one of the first crops brought to Nova Scotia by Samuel de Champlain's botanist, Louis Hebert.

Cannabis cultivation spread from South America to Virginia and to Kentucky in 1775, followed by Missouri and Illinois. Cannabis production rapidly flourished in these states between 1840 and 1860 due to a strong demand for sailcloth and cordage by the United States (US) Navy (USDA, ERS, 2000). After a time, increased production and conflicting concurrency of the cotton industry in the South States displaced most domestic hemp production (Dempsey 1975, Ehrensing 1998). The imports of jute and abaca, which were cheaper than cannabis, also impacted hemp production in a negative way.

Despite its long history in Canada, species of industrial hemp (Cannabis sativa) were banned in 1938 under the Opium and Narcotic Drug Act. Canada was not alone in this action. The plant was banned in a majority of countries internationally in 1961 under the United Nations' Single Convention on Narcotic Drugs. These actions were mainly taken due to the fact it was confused with a different type of Cannabis, whose leaves and flowers contain a large amount of a psychoactive drug known as delta-9 tetra-hydrocannabinol (THC).

Recognition of this issue resulted in varieties of cannabis containing very low levels of the THC being legalized in Germany, Great Britain, Austria, and Switzerland in 1990. Canada followed this trend and since March 12, 1998, the production and cultivation of industrial hemp has been legalized under license from Health Canada under Bill C8[1].

Hemp production was never outlawed in either Russia or China; however, commercial cultivation still declined in the 1930's as hemp was simply replaced by artificial fibres.

[1] American News Service. Hemp Legalization Sparks Growth of New Industries. http://www.berkshirepublishing.com/ans/HTMView.asp?parItem= S031000480A

Despite these restrictions and legal issues, hemp production was promoted in the US and Canada during the Second World War. This demand was due to restrictions on the import of jute or abaca. Restrictions on the production of industrial hemp were implemented again at the end of the war.

As previously mentioned, *Cannabis sativa*, regardless of its narcotic content, is classified as a Schedule I controlled substance within the *Marijuana Tax Act of 1937*, (USDA, ERS,2000). The Drug Enforcement Administration (DEA) can license the crop under *the Controlled Substance Act of 1970*. However it has so far refused to do so, even for small plot sample sizes. This issue has become increasingly more complex as a number of states have recently legalized hemp production but none have yet been able to convince the DEA to grant the federal license required – in addition to the one provided by the State[2]. The states that currently have legislation include:

- Minnesota
- North Dakota
- Hawaii
- Kentucky
- Maine
- Maryland
- Montana
- West Virginia

As a result of the resistance of the DEA and its impact on production, the United States is the biggest hemp importer in the world and the main export market for Canada. Exports to the US totalled $8,588,296 in 2010, which means a 170.2% growth from 2007.

The relative importance of the US market for Alberta production makes the current discussions in the US very significant to the Canadian industry. On the one hand, legalizing production in the US could displace Canadian demand with US production. On the other hand, it may well help advance the use of the product as more groups explore potential innovative ways of incorporating it in different products.

Some of the most common food products made from hemp seed include: hemp meal and flour, nutritional bars, edible oil, pasta, cookies, beer, lactose-free milk and even ice cream. Other non-food products derived from hemp seed include shampoo and conditioners, moisturizers, aromatherapy and cosmetic products.

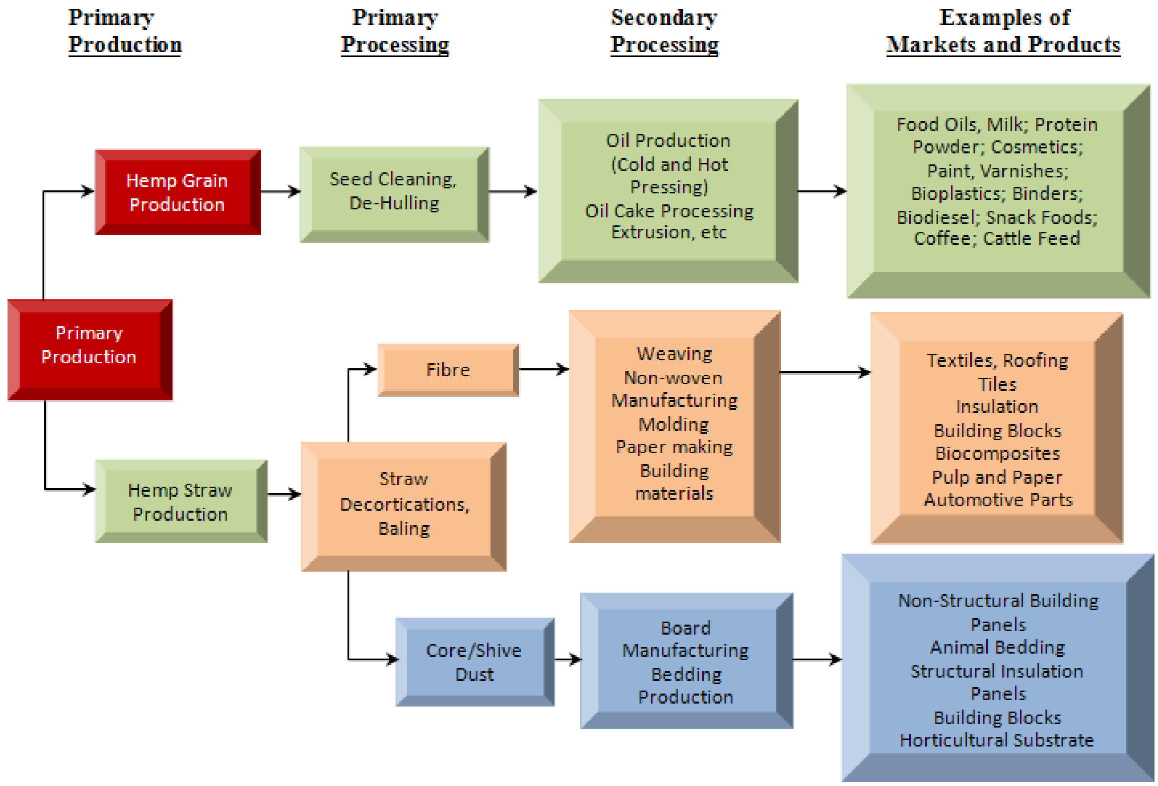
The Canadian industrial fibre industry is very much in the early stages of development. With current and projected high oil prices and the greater emphasis on environmental considerations, there has been a revival of natural fibre use within the textile, building, plastic and automotive industries. This interest is reinforced by the emerging social trend of the agro-industrial markets and local production, allowing economic development and independence versus imported materials.

[2] *The Hemp News*. www.hemp.org/news/category/cannabis/industrial-hemp-development-act (March 30, 2012)

INDUSTRIAL HEMP VALUE CHAIN

Figure 1 provides a simplified representation of the industrial hemp value chain. The value chain involves primary production, several stages of processing and end product manufacturing and marketing.

Figure 1: Elements of Canadian Hemp Value Chain



A viable hemp industry value chain of the nature that would lead to a long term sustainable sector does not yet exist in Canada. There has been limited research and development within the production sector and some information gaps for specific segments of the value chain remain (AARI, 2008). Historically, this was the case with straw separation technologies (decortication). On a positive note, significant strides are being made with respect to decortication research both through the Alberta Biomaterials Development Centre (ABDC) as well as other entrepreneurial initiatives.

The Canadian supply and value chains for hemp seed are significantly shorter and easier to establish than for fibre, largely due to the lower technology requirements and the lower volume of raw product. This has led to the situation where current production is primarily focused on growing hemp for seed – either for consumption, or as certified seed for other growers. While seed products are reasonably well established, the markets are not yet fully developed. This results in inadequate consistent demand to command a stable supply from producers.

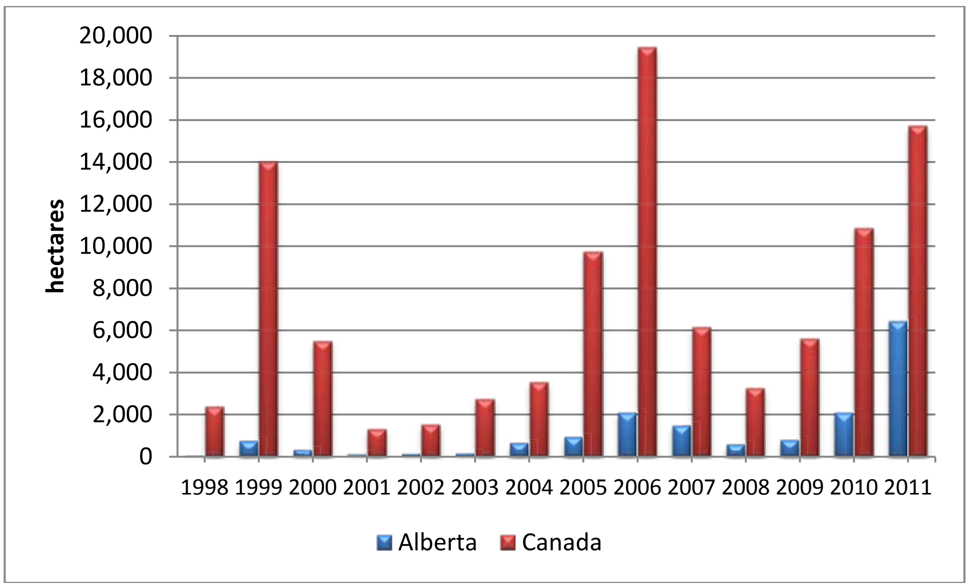
HEMP PRODUCTION

Industrial hemp is grown for its seed, for the straw (fibre and core), or for both purposes (dual purpose hemp). Currently in Alberta and Canada, most of the hemp is harvested for its seed, with the straw generally being a waste product, or at best, covering the cost of removal from the field.

Figure 2 shows the area of hemp production for Alberta and Canada from 1998 to 2011. The variability in production area can be observed over this period. There has been a more consistent increase since 2008, with a total of 6,434 hectares being registered in 2011.

There was a flurry of production in 1999 and 2000, following Health Canada legalizing the cultivation of industrial hemp. The seeded hectares declined until 2003, and began increasing slightly. In 2006 the industrial hemp production acreage was more than double compared to 2005 from 916 hectares to 2,103 hectares. Much of this production was driven by the promise of the development of large scale industrial fibre plants in Manitoba, which encouraged farmers to plant substantial hemp area in anticipation of the processing needs of these plants. None of the plants materialized, leaving farmers with large inventories of hemp straw.

Figure 2: Comparison of Alberta & Canada Hemp Production Area 1998-2011 (Hectares[3])



Source: Health Canada

A considerable proportion of the total acreage is devoted to the production of seed for consumption purposes. The producers of this seed stock are also some of the most vocal proponents of hemp production, largely because they are optimistic about the potential demand for hemp that they feel will lead to a more consistent market with increased processing. Unfortunately, this optimism, as yet fully realized, has contributed to years where the market was saturated with product due to oversupply, namely 1999 and 2006. The longevity of the more recent growth will remain dependent on the development of a well established primary and secondary processing capacity.

[3] While not stated explicitly in the Health Canada publication, the fact that the areas is based on license approvals would suggest that this is seeded vs. harvested area.

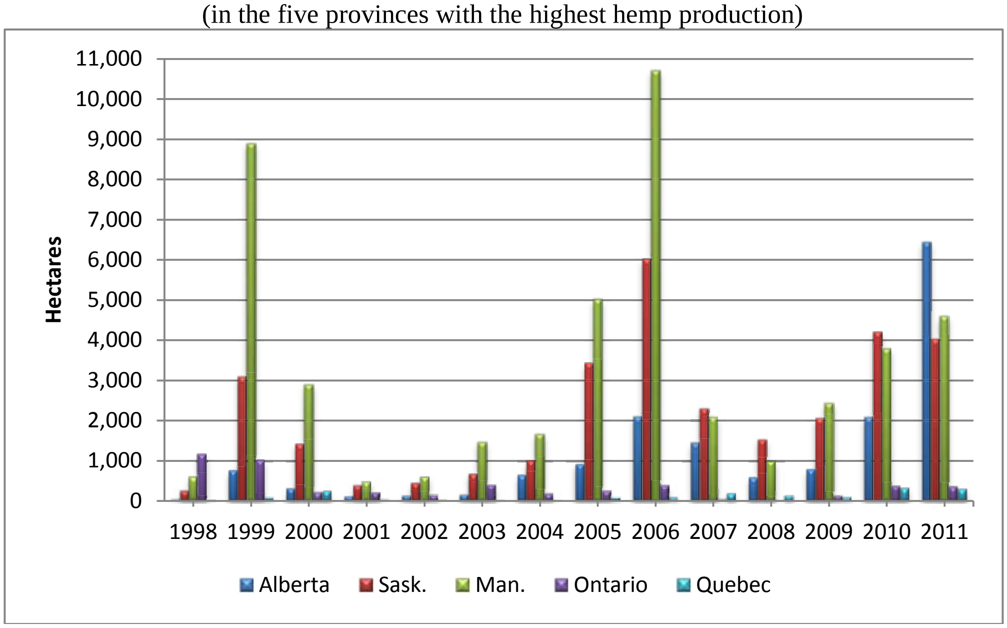
Some of the common seed varieties that have been tested in Alberta are Finola, Fasamo, Crag, Uso 13, and Uso 31. Most of the seed varieties originate from Europe, primarily Poland and France. The yield of hemp on dryland varies given the seed variety, soil conditions, timing of harvest, and annual climatic conditions.

Since 1995, industrial hemp research plots have been grown in various parts of Alberta to evaluate the potential of this crop for both seed and fibre production (AAFC, 2001). In these research plots, the seed production can vary from as low as 220 kg/ha, to a high of 1,800 kg/ha (AARI, 2008). The mean expected yields would likely average nearly 850 kg/ha, or 350 kg/acre. If seed varieties are selected for seed yield only (versus dual purposes), the average yields can exceed these averages.

The hemp straw yield is also quite variable; averaging between 6-12 tonnes per hectare (2.4 to 4.8 tonnes per acre) for the higher yielding varieties like Crag, on dryland (AARI,2008). Under irrigated conditions, there is the potential to increase both seed and straw yields by 60 to 80% above dryland production.

Figure 3: Hectares of Hemp Seeded 1998-2011

(in the five provinces with the highest hemp production)



Source: Health Canada

In 2010, Alberta was the third largest province in terms of licensed hemp production acreage with 2,086 seeded hectares following Saskatchewan (4,212 hectares) and Manitoba (3,799 hectares) (Figure 3). In 2011, seeded acreage in Alberta more than tripled compared to the previous year, putting Alberta in the leading position with 6,434 seeded hectares of industrial hemp.

Canada exports industrial hemp in the form of hemp seeds, fibre, oil and oil-cake. The top ten export markets are listed in the Table 1. The majority of exports are going to United States, which in 2010 was more than $8.59 million.

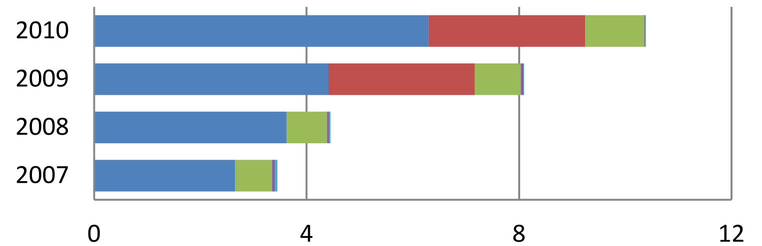
Table 1: Canada's Top 10 Hemp Markets[4] (Value $ CDN)

Country	2007	2008	2009	2010	Growth 2007-2010
TOTAL:	**3,454,149**	**4,451,285**	**8,093,228**	**10,386,744**	**201%**
United States	**3,178,444**	**3,966,157**	**6,642,667**	**8,588,296**	**170%**
United Kingdom	38,895	57,143	137,778	481,593	1,138%
India	0	0	520,185	356,743	-
Ireland	89,360	58,291	128,740	268,626	201%
Netherlands	0	37,803	79,237	162,018	-
Germany	16,679	1,140	24,853	128,781	672%
Japan	80,899	61,552	112,569	106,285	31%
Belgium	0	175,637	113,999	98,613	-
Italy	0	23,059	129,159	29,694	-
New Zealand	2,000	5,400	64,978	27,850	1,293%

Hemp seeds, whether they are processed or otherwise, represent the largest percent of the Canadian export total. Seed exports totalled $6.29 million in 2010 (Figure 4). Exports of hemp oil were initiated in 2009 and reached $2.96 million in 2010. This includes oil and its fractions whether or not refined (but not chemically modified). Oil-cake exports and other solid residues of hemp seed, whether ground or pelleted, have grown 59.2% since 2007, while the hemp fibre (*Cannabis sativa*, raw or retted) and the hemp fibre otherwise processed but not spun have declined - 61.9% and 87.4% respectively since 2007.

[4] Statistics Canada (HS Codes 12079910, 15159020, 23069010, 53021000, 53029000)

Figure 4: Canada's Exports to All Countries by Industrial Hemp Products ($ CDN)[5]



	2007	2008	2009	2010
Hemp seeds (HS 12079910)	2,656,276	3,625,804	4,408,474	6,294,072
Hemp oil & its fractions (HS 15159020)	0	0	2,758,817	2,957,333
Oil-cake & other solid residues (HS 23069010)	695,870	756,341	864,072	1,107,886
True hemp fibre (HS 53021000)	57,342	44,463	55,233	21,826
True hemp fibre processed (HS 53029000)	44,661	24,677	6,632	5,627

[5] Statistics Canada (HS Codes 12079910, 15159020, 23069010, 53021000, 53029000)

FERTILIZER & HERBICIDES

Hemp grows quickly and after the crop is established it is extremely competitive with weeds. As a direct result, the need for significant herbicide use is minimized. In fact, hemp has been promoted by some as a crop requiring minimal use of fertilizers and chemicals. On the other hand, research conducted by AAFC[6] indicates that hemp requires fertilizer applications similar to high yielding wheat. This is largely due to the need to produce a high biomass yield. As a result, while not necessarily requiring additional fertilizer when compared to traditional annual crops, the claims of minimal fertilizer requirements do appear to be misleading.

An interesting comparison has been made between industrial hemp production and canola production, as many Alberta growers report using similar inputs to hemp as when growing canola. This is discussed in greater detail in the Cost of Production section later in this report.

There are a number of producers growing hemp under organic production systems. In fact, some hemp industry experts estimate that approximately one-third of Canadian hemp seed production is certified organic (AAFC, 2005). The crops' natural ability to compete during initial establishment and throughout the growing season provides a significant advantage in the ability for organic production.

HARVEST

The harvesting of hemp can be challenging. The standard practice for dual purpose hemp is to first harvest the hemp seeds, much the same as a conventional cereal crop. The remaining straw is then baled for possible further processing. If the crop focus is on the straw only (which is most often the conventional European method), the hemp crop is harvested either by mowing and then baling, or much like a silage crop which, is left loose for subsequent processing.

Producers consulted during this study reported the importance of harvest timing, both with respect to manageability of the crop and to fibre quality for textiles.

[6] Hemp Production in Saskatchewan. http://www.agriculture.gov.sk.ca/Default.aspx?DN=e60e706d-c852-4206-9959-e4b134782175 (March 30th, 2012)

HEMP PROCESSING

The processing of hemp is undertaken in two major streams – the primary and secondary processing of the seed into oil and other products; and the separate primary processing of the straw into fibre and core/hurds. The latter is followed by various secondary processing systems to convert the fibre and core/hurds into other higher valued products.

HEMP SEED PROCESSING

Hemp seed generally goes through the primary processing steps of:

- Cleaning, de-hulling and bagging of the seed for direct consumer consumption.
- Cleaning, de-hulling and the pressing of the oil (cold pressing) to generate unrefined crude oil.
- Further oil processing to generate refined oil which can be used in a wide range of industrial, food, cosmetic, biodiesel, and other products.
- Processing and packaging of the by-product "hemp cake" which can be used as a livestock feed, or further processed to produce hemp protein, and hemp powder.

Important secondary processing technologies, only now being developed, include the production of polymers for use as bioplastics, and wood/fibre binders.

Hemp Oil Canada (St. Agathe, Manitoba), is currently considered to be the largest hemp oil processor in Canada. Current sales are in the range of $10 million plus per year, with expected growth to $40 million within five years. Hemp Oil Canada contracts approximately 2,400 hectares of organic and conventional hemp acres (primarily in Manitoba) and produce hemp seed oil, hulled hemp seed, toasted and sterilized hemp seed, hemp flour, hemp protein powder and hemp coffee. Acreage is expected to increase in response to to the rising demand for oil.

While the hemp oil processing value chain is relatively well established, the hemp straw value chain is considered to be underdeveloped and restricted due to technology gaps.

HEMP STRAW 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, and cannot readily be used as animal feed. It can be cultivated back into the soil to improve organic matter content, but this posed considerable difficulty in years with high straw yields (largely due to the likelihood of equipment malfunction and costly incorporation into the soil).

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 pelletized or used in the biofuels industry, though it is in some cases simply discarded.

As indicated in Figure 1, 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 the present time there is no equipment for practical use available in Canada. Equipment options and industry processing capacity are discussed below.

Chemical separation –. The National Research Council (NRC) and the Alberta Research Council (ARC) have undertaken some research in this area with industry. At this point, there is no known commercial application of this process in Canada.

The lack of availability of a proven and cost effective technology for decortication has historically been a major bottleneck for hemp straw processing. Until this issue is resolved it will continue to be a significant challenge to develop of the hemp fibre industry and to farmers who are growing hemp primarily for seed, but wish to sell the hemp straw as a by-product.

There has been considerable research in the last few years and a number of processing systems exist in western Canada, with further companies showing interest in potentially establishing Alberta based processing plants. It is interesting to note that the decortication processes are well established in Europe, suggesting that the concern over technology may be largely perceptual, and that potential solutions may be closer than initially thought.

Alberta Hemp Processing Systems

While there are only a few hemp decortication plants operating in Canada, there are a number of systems in the pilot stage. There are also a few commercial operating systems in Europe, but only approximately ten decortication plants are known to be operating commercially in the world. The following provides an overview of a few of the major European systems, as well as the status of the Canadian companies and systems.

The following is a summary of the current status of Western Canadian hemp decortication and processing plants:

- **Clear Line, Winnipeg** – This company is focused on setting up a non-woven matting line. Work has been done with the Manitoba government and the Composite Innovation Centre in Winnipeg to look at technology transfer options. It appears that this project will no longer go ahead.
- **TTS Inc, Edmonton** – TTS has struck a joint venture with the Town of Drayton Valley, and Weyerhauser, to establish a non-woven matting line in the old wood manufacturing plant. TTS has acquired the matting line equipment from a dormant plant in Vancouver and has been transported to the site. The project is still moving ahead, although opening date has not yet been announced.
- **Emerson Hemp Distributors – Emerson, Manitoba** – This primary processing plant for hemp straw is located in Emerson, Manitoba. The plant has been operating for several years, and has been selling hemp fibre and core into both the Canadian and US animal bedding and the green building materials markets. The technology was developed privately and can decorticate hemp straw at a rate of 1.5 to 2 tonnes per hour.
- **Gilbert Plains Processing, Manitoba –** This plant is in a state of development and construction. It is owned by Chinese investors and the technology they plan to use is also from China. The plant is hoping to use single purpose straw hemp (as opposed to dual purpose hemp, which is the conventional practice). They have plans to handle 18,000 tonnes of hemp fibre per year, but this is felt to be quite

optimistic as is their suggested processing speed of 1.5 to 2 tonnes per hour according to some industry experts.

- **Schweitzer Mauduit (SM), Manitoba –** SM has been a long term processor of flax straw into fibre for speciality papers such as cigarettes and fine papers, much of which is exported to France. They have been considering the processing of hemp, and have done some research and development work at Alberta Biomaterials Development Centre (ABDC) in Vegreville.
- **ABDC, Vegreville** – A cross-ministry partnership of Agriculture and Rural Development (ARD), Sustainable Resource Development (SRD) and Alberta Innovates Technology Futures (AITF)The ABDC has been involved in the research and development of hemp and hemp processing systems. Hemp research plots have been established in the Vegreville area to evaluate the agronomic performance of a range of hemp varieties under different soil, climatic conditions, and agricultural production practices. The pilot plant uses European equipment. It has the largest biomass processing pilot plant fractionalization capacity in North America.
- **Naturally Advanced Technologies, Vancouver** – This company has been promoting a "Crailar" technology over the past 8-10 years[7]. This was developed jointly with the National Research Council Canada (NRC) and the AITF. They produce textile products, and for the most part have been using flax bast fibres. Much of their processing has been done in the US.

As is evidenced from the above overview of plants, there are few commercially operating hemp decortication technologies in use in Alberta, though there are several companies considering establishing commercial processing facilities. However, there are also a number of active research and product development initiatives (i.e. the ABDC in Vegreville). In addition, there are individual entrepreneurial efforts being made at developing mobile processing technology and specialized processing technology for textile fibre.

European Hemp Processing Systems

Europe continues to lead Canada in the development of hemp processing technologies and in the marketing of processed products into the animal bedding, automotive, paper, and biocomposite industries. The following information is available from company websites and through discussions with industry contacts:

- **Hempflax, Zwolle, Holland** – Hempflax is a processor that contracts with growers in Holland and Germany. Their processed fibre goes to Germany to be further processed into insulation products and the automotive industry.
- **Van Dommele, Belgium –** This is a well established equipment manufacturer who makes a broad range of biofibre processing equipment. One of their systems was recently purchased by the ABDC BioIndustrial Initiative, and is being used in the pilot facility at ABDC Vegreville.
- **Albert Dun, Oude Pekela[8]** – These individuals have established a new line of hemp decortication equipment over the past five years with a Russian partner. The processed fibre goes into the animal bedding industry and the reminder into the paper and automotive industries.
- **Hemcore (Hemp Technology), United Kingdom –** This company is reported to be the largest hemp processor; however, information on the volume of their production is difficult to obtain. The company produces hemp fibre using the Van Dommele system for the automotive, paper, bedding, horticulture, and insulation markets. There are indications that this company is considering building a commercial plant in Alberta.

[7] CRAiLAR® Fiber Technologies Inc. is a wholly owned subsidiary of Naturally Advanced Technologies.
[8] While these individuals may be part of a formal corporate entity, this information was not publically available at the time of the study.

- **BaFa, Germany –** This company processes 5,000 to 6,000 tonnes of hemp straw per year. The current sales are in the range of $2.5 million Euro per year. They contract production from approximately 100 farmers.

Hemp companies in Europe have gone through a series of ups and downs. At the beginning of the 1990s, hemp cultivation in the European Union took place almost exclusively in France. Other countries started cultivating hemp between 1993 and 2000. By 2004, the area under hemp cultivation in the EU had almost tripled, amounting to approximately 16,000 hectares (Karus, 2005).

Before the collapse of the former Soviet Union, the areas under hemp cultivation in Eastern Europe (Romania, Hungary, Bulgaria, Poland and the Czech Republic) alone had amounted to almost 100,000 hectares. This has been significantly reduced, partially in response to changes in value chain relationships after the fall of the Soviet Union (Karus, 2005).

In 2005 there were nine known companies in Europe that were holding a stake of between 70 and 90% in the total area under hemp cultivation and hemp fibre production in the European Union. Most companies were from Germany and Netherlands, but also from United Kingdom, Italy and France.

In 2000, these formed the European Industrial Hemp Association (EIHA) as an informal federation, which become an official organization in 2005.

COST OF PRODUCTION

ALBERTA COST OF PRODUCTION

A comprehensive Alberta industrial hemp cost of production did not exist prior to this study. Some other provinces, most notably Manitoba, have conducted cost of production analyses for hemp. COP information provides an important benchmark for producers in those provinces for comparison in the crop planning process.

In the course of this study, five Alberta producers completed a survey on their farms' cost of production – one from the Black soil zone, two from the Brown soil zone, and two from the Dark Brown soil zone. This information was used to establish initial benchmarks for dryland and irrigated production systems. Specific cost elements included:

- Seed
- Fertilizer
- Herbicide
- Crop Insurance (only hail coverage available)
- Labour
- Machinery Repair
- Fuel
- Irrigation (where applicable)
- Other

This information provided an indication of hemp's contribution margin. Contribution margin is the difference between the sales price or gross revenue for a crop and the total variable costs incurred. It measures the contribution by that particular crop to covering the overall fixed costs of operation of the farm. Unfortunately, the information obtained was initially quite variable due to a lack of data points, in addition to significant differences between producers in their agronomic practices.

An overview of the results were tabulated and presented at a growers workshop held in central Alberta. The process enabled the group to reach consensus on the cost estimates growers felt were most appropriate to be used as benchmarks.

There was a significant factor in assessing producers' cost accounting as it is not typically detailed enough to provide significant and useful financial information in most cases. Our observation confirms that there is a lack of cost-based accounting in agriculture, making it difficult for producers to effectively make production decisions between crops.

Perhaps, the biggest insight was that many producers' records of costs were not detailed, perhaps reflecting less focus on or knowledge about the benefits of cost-based accounting. Stakeholders also disclosed that there is a significant amount of sensitivity with releasing financial information. This is not surprising and is not inconsistent with producers in other areas.

Despite these challenges, two very distinct cost profiles were established: one for dryland crops; and one for irrigated crops. Those growers from other regions wanting to use the benchmarks will need to extrapolate from this data using their knowledge of local agronomics and the relevant production cost estimates for other field crops in their region.

The market assessment elements of this study examine products and markets for both seed and fibre production potential. However, at present hemp is grown in Alberta almost exclusively for its seed. Benchmarks were therefore prepared solely for the cost of producing hemp seed, as there is insufficient information to establish benchmarks for fibre production. Table 2 below provides those benchmarks, for hemp grown with irrigation and in non-irrigated ("dryland") situations. The sections that follow will provide the details of the methodologies used in arriving at these benchmarks.

Table 2: Cost of Production Benchmarks for Alberta Hemp Seed

	Benchmark Dryland Alberta Hemp	Benchmark Irrigated Alberta Hemp
Yield (lbs/ac)	$280 - 800	$500 - 1,500
Expected Market Price ($/lbs)	1.00	1.00
Total Crop Sales ($/ac)	**$280 - 800**	**$500 - 1,500**
	$/ac	**$/ac**
Seed Cost	47.50	57.50
Fertilizer Cost	72.50	77.50
Herbicide Cost	24.50	24.50
Crop Insurance	9.00	13.50
Fuel, Oil & Lube	6.85	17.85
Machinery Repairs	9.35	20.80
Building Repairs	1.00	2.00
Labour	18.00	18.00
Operating Interest	2.00	5.00
Irrigation Expense	0.00	29.40
Other Expenses	36.50	36.50
Total Crop Expenses ($/ac)	**227.20**	**302.55**
Contribution Margin ($/ac)	**$ 52.80 - $ 572.80**	**$ 217.35 - $ 1,217.35**

Seeding Costs

Seeding rates and their corresponding cost estimates reported by Alberta growers were quite uniform, ranging from $45 to $65 per acre. From producer feedback, it appears the primary difference is not seed price, but seeding rate.

Seeding rates varied by local climatic conditions and were subject to adjustment as experience with production develops across regions. The seeding rate also varied considerably based on the specific variety being seeded.

Certified seed appears to be easily available, although growers reported needing to source the seed from other provinces due to the suppliers being located in Saskatchewan, Manitoba, and British Columbia. Certified seed is grown in Alberta as well, but is cleaned and sold primarily through Hemp Genetics in Saskatchewan, and Parkland Seed Growers and Hemp Oil Canada in Manitoba. There are also some certified growers who sell seed directly to other producers. In 2011, the cost of certified seed was generally $2.00 - $2.50 per pound, though some newer varieties and organic seed ranged from $2.50 to $4 per pound.

Fertilizer Costs

Fertilizer showed the largest range of all costs reported by growers, ranging from no application of fertilizer whatsoever (by both organically-certified and conventional growers) to a high of $120 per acre (having applied 45 kg or 100 pounds of nitrogen, 9 kg or 20 pounds of phosphorous, and 4.5 kg or 10 pounds of sulphur per acre).

This range is due to soil diversity, nutrient availability, crop rotations and other agronomic conditions. However, it also became clear there is still a considerable lack of standard production practices given hemp is still seen as a novel crop and many growers have limited experience growing it.

Some producers report success by growing hemp after legumes, as a way to reduce the need for nitrogen fertilization. However, research both in Canada and internationally has shown hemp to respond well to significant application of supplementary fertilizer, depending of course on the availability of nutrients in the particular soil on which they are grown.

Due to the relatively low acreage of hemp and limited experience both by primary producers and crop researchers, fertilization recommendations are currently not as easily available due to a lack of research trial data as those for more conventional Canadian crops. In the absence of other published recommendations, several growers stated they use fertility recommendations for canola as their guide to fertilizing their hemp crops. For most growers, this means they apply significant nitrogen and supplementary sulphur either before or during seeding operations.

Herbicide Application

Although the majority of growers use herbicides, there were several growers who did not apply herbicides, largely as a result of the agronomic characteristics of the crop which allow it to compete more effectively. As with fertilizer, official herbicide recommendations are difficult to obtain.

This study did not involve any detailed examination of agronomic practices and will not make any recommendations for herbicide application. In the absence of specific herbicide recommendations for hemp, the costs of herbicides for other crops were used as a general guide.

During consensus workshops, there was considerable discussion about common chemical weed control regimens used by growers, which included pre-seeding herbicides for control of grasses and a number of broadleaf weeds. Most growers also reported separate post-emergent applications of graminicides and herbicides for broadleaf control. Several growers expressed that the graminicide was essential for them, as buyers of hemp had little tolerance for wheat and barley seed, which is difficult to separate from hemp seed.

Cleaning and Drying Costs

Both cleaning and drying of hemp seed can be a very significant cost to growers. There is currently a large range of cleaning costs to individual growers, depending largely on harvest timing, availability of adequate ventilation storage facilities on farm, and the weed profile for the specific crop. Stakeholders suggested that cereals were particularly undesirable and difficult to clean out of hemp seed, on the other hand, not all growers incurred cleaning costs.

Drying costs can be significant, but unfortunately there was insufficient data to effectively estimate them for Alberta. The reality is that moisture and ambient air temperature will vary, making drying is usually very difficult to estimate for any crop. This was especially the case since many of the growers used aeration bins while others used heated driers. Both Manitoba and Ontario cost of production estimates included $20 per acre as a drying cost for hemp produced for seed, so this estimate has been incorporated into the "Other Expenses" for the Alberta benchmark

Crop Insurance

The Agriculture Financial Services Corporation (AFSC) does not currently provide general crop insurance for hemp crops in Alberta, but hail insurance is available. Several growers reported complete crop failures due to hail over the past few years and a number of growers reported having purchased insurance. This cost is therefore included in the benchmark cost of production figures.

The range of insurance premiums for hail for areas growing substantial hemp acreage is in the 4 to 10% range, with the most common being 6 to 7%. A 6% premium was used in the benchmark. This is based on the maximum coverage offered by AFSC and the maximum hail coverage in 2011, which was $150 per acre on dryland and $225 per acre on irrigated land. These estimates do not take into account that premiums can be decreased by producers choosing a rate with a 10 or 25% deductible.

Yields

Caution should be used in interpreting the revenue potential using the cost of production benchmark, given that the yields reported by growers in this study varied widely. Dryland hemp seed yields ranged from 325 to 568 kg per hectare, with a standard deviation of 135 kg/ha. The range for yields on irrigated land was even greater, from 340 to 1,645 kg/ha, with a standard deviation of 930 kg/ha.

This variability is consistent with results from research-scale plots by ARD and ABDC, in which the seed production varied from as low as 220 kg/ha to a high of 1,800 kg/ha. The mean expected yields would be about 850 kg/ha. If seed varieties are selected for seed yield only (versus dual purposes), yields can exceed those averages. The hemp straw yield was also quite variable. On dryland, the average straw yield was reported to average between 6 to 12 tonne per hectare (2.4 to 4.8 tonne per acre) for the higher yielding varieties.

Given the small number of growers and the high variability of yields between regions, growers, and years, the cost of production benchmark therefore includes a range of yields. Calculating the arithmetic mean of the few yields reported by growers would give an erroneous perception of accuracy.

Straw Revenue and Costs

Most of the hemp varieties grown in Alberta are commonly seen as dual-purpose varieties, producing both seed and straw. No growers reported any significant revenue from the straw. Some producers simply chop and spread the straw at the time of harvest, but many choose to bale it.

The producers consulted in this study related that the cost of baling is generally covered by expected revenues from the sale of straw. The straw is usually only sold to local buyers due to the high cost of transportation, and is often used as bedding for livestock. A significant number of growers also reported difficulty in finding buyers for the baled straw and were more inclined to chop and spread, unless the volume of straw was so large that it would be economically justified.

Given the variability in practices, the straw cost and revenues are not included in the cost of production benchmarks. If the decision is made to bale and sell straw, producers consulted felt that revenue approximately offset the costs in any event.

Marketing Risk

Care should be taken when interpreting the benchmark cost of production, as one must take into account the production and market risks associated with hemp. It became clear from consultations with growers that the largest risk at present is related to marketing risk - the potential of not finding a market for the hemp seed.

A number of growers reported having difficulty finding a buyer. In fact, several reported instances of hemp seed being stored for periods greater than one year after harvest while they sought a market for their product. This has three significant risk effects on the producer:

1. cash flow problems could be created for those who seed a significant proportion of their acreage to hemp;
2. the time value (interest) on the stored crop can be significant when storing crop for years; and
3. there is a real risk that an entire crop could be lost while in storage. Most growers reported the need not only to dry the hemp seed at the time of harvest, but also to rotate the hemp seed within aeration bins to ensure that they do not have excess spoilage.

COP FOR FIBRE

It is important to clarify that cost of production estimates presented in this study are for the production of hemp for seed. At present there is insufficient data for the publication of cost of production estimates for hemp grown primarily for fibre. The limited number of growers, very small acreage, and limited number of years of data would not allow for accurate calculation of the cost of production for fibre hemp.

Growers presented some observations that might be useful to those considering growing hemp for fibre. It is clear that seeding costs would be considerably higher, with seeding rates being as high as 200 lbs per acre (approximately 4 to 5 times the average seeding rate used by seed hemp growers). The seed cost per pound may also be somewhat higher for speciality fibre varieties.

Nevertheless, the potential revenue premium available in specialized markets may make an investment in these higher costs worthwhile. One grower expects to ultimately generate high revenue given both the potential for high volume production per acre and high price for specialty textile fibres, but he is not actively selling to those markets yet. There are also significant differences in terms of agronomics, as both seeding and harvest timing are of high importance if the fibre is destined to be used for textiles.

At present, information from Manitoba is most informative for those who might be considering growing hemp exclusively for fibre production. Given the history of some crops having been grown specifically for fibre in that province, Manitoba has developed cost of production benchmarks that may serve as a useful reference to potential Alberta growers.

The reality is that further study will be required to develop accurate cost of production estimates for Alberta hemp fibre in the future. Current production acreage is simply too small and agronomic practices not sufficiently standardized to allow the publication of standards at present.

COMPARISON TO COSTS IN OTHER PROVINCES

Some initial background research has been completed with respect to the evaluation of the cost of production of hemp in other jurisdictions. Manitoba in particular and to a lesser extent Saskatchewan, has conducted hemp cost of production research. This provides a base upon which to compare Alberta costs of production (COP).

Cost estimates for hemp seed (oil) and fibre (straw) in Manitoba (2011) are presented in Table 3. The cost of hemp seed for seeding is estimated at $40.00 per acre, while the seed cost for fibre production is $61.25 per acre. No reliable revenue estimates were obtained in the Manitoba data.

Of note, the production cost model used in Manitoba assumes that herbicides, fungicides or insecticides are not used in the production of hemp. In Alberta, there were also several growers that reported no herbicide and fungicide use (including, but not limited to those growing certified organic hemp).

Costs for fertilizer in the Alberta surveys were as high as $120 per acre. While this was not representative, average fertilizer rates were definitely higher than first anticipated by comparison to Manitoba, with Alberta growers reporting average costs in the range of $40-75 per acre for fertilizer. Likewise, both dryland and irrigated crops in Alberta had significant herbicide costs, leading to a benchmark estimate of $24.50 per acre.

Table 3 shows comparison for those elements of cost of production available through published sources in Manitoba and Ontario.

Table 3: Comparison of Alberta Hemp Cost of Production Benchmark to Other Provinces

	Alberta Benchmark Dryland Hemp for Seed (2011)	Alberta Benchmark Irrigated Hemp for Seed (2011)	Manitoba Hemp for Seed (2011)	Manitoba Hemp for Fibre (2011)	Ontario Hemp for Seed (2006)
Yield	280 - 800 lbs/ac	500 - 1,500 lbs/ac			400 - 1,200 lbs/ac
Expected Market Price	1.00 /lb	1.00 /lb			$0.45 - 0.85 /lb
Other Revenue	0.00	0.00			0.00
Total Crop Sales	**$280.00 - 800.00**	**$500.00 - 1,500.00**			**$180.00 - 1,020.00**
Seed Cost	47.50	57.50	40.00	61.25	40.00
Fertilizer Cost	72.50	77.50	56.90	70.40	81.00
Herbicide Cost	24.50	24.50	0.00	0.00	19.00
Crop Insurance	9.00	13.50	16.13	0.00	15.00
Fuel, Oil & Lube	6.85	17.85	16.25	16.75	6.00
Machinery Repairs	9.35	20.80	13.50	13.50	4.00
Building Repairs	1.00	2.00	0.00	0.00	0.00
Labour	18.00	18.00	18.00	18.00	3.00
Operating Interest	2.00	5.00	5.06	5.04	9.00
Irrigation Expense	0.00	29.40	0.00	0.00	0.00
Other Expenses	36.50	36.50	33.30	13.30	153.00
Total Crop Expenses	**$ 227.20**	**$ 302.55**	**$ 199.14**	**$ 198.24**	**$ 330.00**
Contribution Margin	**$52.80 - 572.80**	**$197.45 - 1,197.45**			**$150.00 - 990.00**

Comments			
	No formal revenue estimates were included in the Manitoba data.	No formal revenue estimates were included in the Manitoba data.	Other costs include $100/acre for custom combining and $20/acre for drying.

COMPARISON TO OTHER CROPS

Alberta Agriculture and Rural Development makes cost of production estimates available for the most common field crops. Those cost estimates are unique for many zones of the province, based primarily on soil types. While it was hoped that hemp costs could also be estimated for different zones, this was not possible due to the small number of growers. The largest concentration of detailed data, both in terms of completed data sheets and workshop participation, came from southern Alberta hemp growers. For this reason, the cost of production benchmarks provided in this report are all for dryland dark brown soil-zones or irrigated brown soil-zones. The small number of growers also made it impossible to provide a separate estimate for organic production.

Table 4 compares the cost of production for hemp to the costs for other common crops (wheat, barley, canola and peas) for dryland production in the dark brown soil zone. Table 5 presents these comparisons for irrigated production in the brown soil zone.

As the data suggests, many of the main costs are very comparable, largely the field operations are very similar between hemp and common cereal crops. However, there are very marked differences in the seed costs for hemp, which are significantly higher than for cereals, canola, and peas.

Fertilizer costs also ranged widely since some reported no fertilizer at all while one grower applied up to 45 kg or 100 lbs of nitrogen per acre. While there is a large range of practices, it is clear that average fertilizer application rates for hemp are significantly higher than for wheat, canola, or peas. Growers said that canola fertilizer application rates based on soil test could be used as a general guide for hemp, but that 20 extra pounds of nitrogen per acre would be required by hemp.

Many growers may not be starting hemp production after hearing examples of high labour requirements for solving problems during harvest and straw management. However, it appears that many of those issues have been sorted out by growers as they gain experience with the crop. Only marginally more time is now needed for hemp field operations and management than for other crops. The consensus was that the labour cost estimates from Manitoba would serve as the best benchmark value for Alberta, in the absence of more accurate data.

Revenue potential appears to be significantly higher for hemp than for other field crops. There was clear consensus that hemp seed could be sold in 2011 for an average of $0.90 to $1.00 per pound. However, care should be taken with the use of the yield data to estimate overall revenue potential, as the range of yields reported was extremely large (113-680 kg/ac or 250-1,500 pounds of hemp seed per acre).

Table 4: Comparison of Hemp Benchmark for Seed to Other Crops (Dryland, Dark Brown Soil Zone)

	Alberta Benchmark Dryland Hemp for Seed (2011)	Feed Barley	Spring Wheat	Canola	Field Peas
Yield (unit/ac)	280-800 lbs	70.00 bu	45.00 bu	30.00 bu	45.00 bu
Expected Market Price	$1.00 / lb	$4.50 / bu	$8.75 / bu	$12.00 / bu	$7.00 / bu
Total Crop Sales ($/ac)	**$280.00 - 800.00**	**$315.00**	**$393.75**	**$360.00**	**$315.00**
Type of Expense	**$/ac**	**$/ac**	**$/ac**	**$/ac**	**$/ac**
Seed Cost	47.50	18.04	26.34	39.14	38.92
Fertilizer Cost	72.50	54.50	49.00	68.00	18.00
Herbicide Cost	24.50	14.00	31.50	30.50	38.50
Crop Insurance	9.00	10.50	10.50	17.00	12.50
Fuel, Oil & Lube	6.85	13.20	12.02	14.71	14.85
Machinery Repairs	9.35	8.75	8.75	8.75	8.75
Building Repairs	1.00	1.00	1.00	1.00	1.00
Labour	18.00	13.09	13.09	13.09	13.09
Operating Interest	2.00	4.33	5.34	6.88	4.77
Irrigation Expense	0.00	0.00	0.00	0.00	0.00
Other Expenses	36.50	24.74	22.76	19.17	23.76
Total Crop Expenses ($/ac)	**$227.20**	**162.15**	**$180.31**	**$218.24**	**$173.14**
Contribution Margin ($/ac)	**$52.80 - 572.80**	**$152.85**	**$213.44**	**$141.76**	**$141.86**

Source: *AgriProfit$ Cropping Alternatives for Alberta Crop and Forage Producers*, ARD, Gov of Alberta[9]

[9] http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/econ10238 (2011)

Table 5: Comparison of Hemp Benchmark for Seed to Other Crops (Irrigated)

	Benchmark Irrigated Alberta Hemp	Feed Barley	Spring Wheat	Argentine Canola
Yield (unit/ac)	500-1,500 lbs	110.00 bu	90.00 bu	60.00 bu
Expected Market Price	$1.00 / lb	$4.50 / bu	$8.75 / bu	$12.00 / bu
Total Crop Sales ($/ac)	**$500 - 1,500**	**$495.00**	**$787.50**	**$720.00**
Type of Expense	**$/ac**	**$/ac**	**$/ac**	**$/ac**
Seed Cost	57.50	22.55	33.87	39.14
Fertilizer Cost	77.50	79.50	79.50	98.00
Herbicide Cost	24.50	23.00	35.00	50.50
Crop Insurance	13.50	16.00	16.00	26.00
Fuel, Oil & Lube	17.85	27.50	26.25	27.50
Machinery Repairs	20.80	21.00	20.05	19.50
Building Repairs	2.00	2.00	2.00	2.00
Labour	18.00	20.03	20.03	20.03
Operating Interest	5.00	6.25	7.42	9.38
Irrigation Expense	29.40	15.36	14.40	24.00
Other Expenses	36.50	45.11	45.45	34.98
Total Crop Expenses ($/ac)	**$302.55**	**$278.30**	**$299.97**	**$351.03**
Contribution Margin ($/ac)	**$197.45 – 1,197.45**	**$216.70**	**$487.53**	**$368.97**

Source: *AgriProfit$ Cropping Alternatives for Alberta Crop and Forage Producers*, ARD, Gov of Alberta[10]

HEMP PROCESSING COSTS

The hemp processing industry has only a few participants, making the development of a public costing model difficult, given the need for confidentiality. On the other hand, there are some reliable costs that can be presented for a small pilot facility (4,200 tonnes). While this type of a facility would not produce sufficient volumes to meet industry demands – other than small niches like those associated with pet bedding – it does give some idea of the relative capital and operating costs.

Even when developing the costs for the pilot plant, the discussion of processing costs must be interpreted in the appropriate context. The reality is that there are a number of factors that can affect productivity, thus the cost per unit. As a result, the following outline should be interpreted as providing an indication of an approximate range of costs that could be expected for a small facility.

[10] http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/econ10238 (2011)

The costs for such a primary processing plant can vary dramatically depending on the source of the equipment. If European sourced equipment is used the cost of the equipment will be $4 million to $5 million as a minimum. The costs of then commissioning a plant would total in the range of $7 million to $9 million[11].

A case study analysis[12] has been undertaken of the investment and operating costs, and the expected returns of establishing an on-farm industrial fibre plant, based partially on the equipment and technology now used at the Emerson plant in Manitoba.

This assessment assumes a greenfield project – a new operation built from the ground up – in which the land and building infrastructure needs to be assembled. The processing plant would be operated in an open sided pole shed (possible removable sided shed). This shed would be set on a concrete pad. The shed would be used for the processing line, processed materials bagging, baling, and short term storage. A reasonable shed size for the processing unit is 40 feet by 80 feet, and with a minimum height of 20 feet.

An early raw material facility would be established in a separate pole shed to allow for one month's raw material supply, or for up to 500 tonnes of straw. Using this shed, the annual storage cost per tonne is estimated at $12 (Collins, et al. 1997). Maintaining onsite capacity for 500 tonnes is therefore estimated to cost between $5,000 and $7,000. Alternative storage methods could be employed which would be cheaper such as plastic wrap on ground, reusable tarp on pad etc. These other methods are cheaper, but result in greater losses due to spoilage.

The main processing unit consists of a raw material preparation unit which breaks up the round or square bales, and aligns the straw for insertion into the main processing unit. The main processing unit is modular in structure, taking the raw materials, and beginning the process of fibre separation and decortication. Through the process, the fibre fraction is separated and channelled in one direction, and core fractions are channelled in a separate direction. Depending on the degree of separation or purity required, the processed fibre and core can be reprocessed in a further processing model. The last component of the system is a bagging unit (for animal and pet bedding), or a bale compressor for other end uses.

The working capital needs are based on a four month period before market revenue can be expected to support operations. That time is required for commissioning, testing, and scaling up, but costs would be incurred during that time for raw materials, salaries, interest and overhead.

As indicated, the total cost of infrastructure, the processing unit, and working capital to reach operational capacity is in the range of $1.5 to $1.7 million according to industry specialists.

A fibre processing plant will produce a range of decorticated and fractionated products, each with their own value, depending on the final market (Table 6). The fibre fraction, which typically represents 15 to 20% of the volume of the raw material on a dry matter basis, is usually the most valuable. The end markets are into the textile/carpet industry, bioplastic composites, paper industry, insulation, and potentially into automotive parts. Current market prices are in the range of 30 cents per pound, or $660 per tonne. There is the potential to sell the fibre for up to $1,000 per tonne, once specialized textile and bioplastics markets are developed.

The remaining core can be separated by core length and purity, for a number of markets. These include use as animal and pet bedding, as composite material in concrete, as construction materials, as erosion blankets, or for further processing into fuel pellets. The range of value of these core fractions is from 12 to 18 cents per pound, or $269 to $396 per tonne. These marketable core materials will generally constitute about 60 to 70% of the raw material mass volume.

The remaining 15 to 20% of the raw materials is dust and small particles lost in the production process. Unfortunately, there is not yet a fully developed market product.

[11] Based on discussions with industry stakeholders.
[12] Based on Hemp Feasibility Study prepared for 100 Mile House Hemp Association.

The weighted average value of the fibre and core materials, FOB the plant is estimated to be in the range $370 to $390 per tonne.

Table 6: Weighted Average Value of Industrial Fibre Revenue Determination

Fraction	Proportion	Estimated Value/lb	$/kg
Fibre	15-20%	0.30	0.17
Clean shiv or core	40-45%	0.18	0.12
Mixed shiv and fibre	20-25%	0.12	0.09
Dust and fine fibres	15-20%	-	-
Total	**~100%**	**0.173**	**0.38**

Source: Serecon Management Consulting and Mallot Creek Associates, 2010. *Feasibility Assessment, Integrated Hemp Fibre, Oil and Food Investment Opportunity*.

The projected revenue, costs and profits of a plant processing 4,200 tonnes of hemp/flax straw per year has been estimated for a plant with an hourly capacity of 3 tonnes. Operating 8 hours a day, this would require the plant to operate 175 days per year, or based on a 5 day week, approximately 9 months. The revenue, based on the above weighted average revenue is estimated at $1.58 million annually.

The major cost assumptions used include (Table 7):

- Range of raw material cost of $80 to $100 per tonne, plus transport costs of $20 to $25 per tonne, for delivered cost of hemp straw of $100 to $125 per tonne.
- An estimate of labour hours per tonne processed of 0.8 hours. Results in total direct labour hours per day of 19 hours, and a labour cost per tonne of $15 to $22, based on a wage up to $27 per hour inclusive of benefits.
- Estimated fuel costs were $5 to $10 per tonne.
- Electrical use at current rates per tonne estimated at $10 to $20 per tonne.
- Total capital investment of $1.6 million (land, building, equipment, operating capital)
- Proportion financed at 50% and an interest rate of 7%.
- Management costs typically vary from $105,000 to $147,000 per year.

Projections of income, costs and profits have been prepared using these assumptions. The expected gross margin, at this level of annual output of 4,200 tonnes of raw material processing varies from $668,640 to $929,040 or from $159 to $221 per tonne. The net profit before tax is expected in the range of $101,640 to $572,040 or from $24 to $136 per tonne. Again, it is critical to recognize that this estimate represents one potential outcome and can be significantly affected by various operating factors.

This scale of operation using 4,200 tonnes of hemp straw would need a production supply base of approximately 1,400 acres, based on an average yield of 3 tonnes of dry matter per acre.

Table 7: Projected Hemp Processing Income and Costs for Fibre

				Annual		
Annual Volume (tonnes)				4,200		
Capacity per Hour	3 tonnes					
Hours per Day	8 hours					
Days of Production				175		
Revenue	**376**			**1,580,040**		
Direct Costs	**Per Tonne**			**Annual**		
Raw Material Straw.	80	-	100	336,000	-	420,000
Raw Material Transp.	20	-	25	84,000	-	105,000
Labour Costs	15	-	22	63,000	-	92,400
Fuel Cost	5	-	10	21,000	-	42,000
Electrical Costs	10	-	20	42,000	-	84,000
Packaging Cost/Tonne	15	-	20	63,000	-	84,000
Maintenance	5	-	10	21,000	-	42,000
Miscellaneous Cost	5	-	10	21,000	-	42,000
Total Processing Costs	**155**	**-**	**217**	**651,000**	**-**	**911,400**
Gross Margin	**159**	**-**	**221**	**668,640**	**-**	**929,040**
% Gross Margin	42%	-	59%	42%	-	59%
Overhead						
Sales and Administration	15	-	30	63,000	-	126,000
Depreciation	25	-	40	105,000	-	168,000
Interest	10	-	15	42,000	-	63,000
Management	25	-	35	105,000	-	147,000
Insurance, Building Costs	10	-	15	42,000	-	63,000
Total Over Head	**85**	**-**	**135**	**357,000**	**-**	**567,000**
Net Profit Before Tax	**24**	**-**	**136**	**101,640**	**-**	**572,040**
Less Taxes 20%	5	-	27	20,328	-	114,408
Net Profit After Tax	**19**	-	**109**	81,312	-	**457,632**

In summary, there are a number of important considerations that must be made in determining the economics of processing hemp fibre. Given the uncertainty about many factors, it would take considerable effort, money and time just to assess the viability of a facility. This may be a contributing factor to their being only one commercial operating hemp decortication plant in western Canada, located at Emerson, Manitoba.

MARKET ASSESSMENT – OVERVIEW

This section provides a general overview of applications for hemp fibre, as well as a review of current realities with focus on the European hemp market. The following section, beginning at Page 29, will review the market opportunities for each of a number of product categories.

MARKET OVERVIEW

As previously indicated, Europe is more advanced than Canada when it comes to the development of hemp processing technologies, and in accessing new markets. In the industrial domain, Développement Agro-Industriel Franco-Allemand group (DAIFA), a consortium of businesses located in eastern France, has reached a leading position in Europe in the automotive plastics market. DAIFA group is specialized in the purchase, development, production, processing and marketing of plastics and plant-based raw materials for automotive processors and for the energy sector.

The use of natural fibres at the industrial level improves the environmental sustainability of the parts being constructed, especially within the automotive market. Within the building industry, the interest in natural fibres is mostly economical and technical; natural fibres insulate better than conventional materials.

The European Industrial Hemp Association (EIHA) suggests that:

- a majority of produced fibre (70 to 80%) is used for specialty pulp for cigarette papers and technical applications;
- about 15% is used in the automotive sector; and
- 5 to 6% is used for insulation mats.

In addition they indicate that:

- approximately 95% of hurds are used as animal bedding; and
- almost 5% are used in the building sector.

More than 95% of seed is sold for animal feed (bird seed, bait for fishing). The remainder is used as food (whole grains, hulled seed and oil), as body care products and as cosmetics (Karus, 2004).

MARKET APPLICATIONS

Hemp is a high quality premium fibre and there are significant market opportunities. While many opportunities have already been identified, it is undeniable that many other potential uses exist. The purpose of this section is to highlight some of the known areas of demand. This is not to imply that these are the only areas and additional innovative concepts will always be welcomed by stakeholders.

The bast fibres are usually used for textiles (including carpets and clothing) and industrial uses, such as geotextiles, erosion control blankets, and composite reinforcements and fillers. This is currently the largest use for hemp fibre. The high strength, low weight and cost of natural fibre make it a sought after substitute for fibreglass and synthetics in a range of molded composites including car parts, construction materials and consumer goods. Some of the more interesting applications under development are reinforced bioplastics, in which hemp and flax fibres are added to conventionally or naturally produced plastics.

Some of the advantages of using hemp for fibre in industry include: excellent physical properties in strength and modulus, cost effectiveness in composite and paper applications and increasing availability. A wide range of fibre formats and qualities are now becoming possible. Hemp fibres can be fabricated to be lighter, stronger and cheaper than fibreglass.

The wood-like inner core fibre of the hemp plant can be used for animal bedding (as animals do not eat it due to its high absorbance and undesired palatability). It can also be used for garden and horticultural industry mulch, and as building material such as hempcrete. Hempcrete is a hemp-based construction material that is composed of a mixture of hemp hurds (shiv), lime, sand, and cement. It is marketed under names like Hemcrete, Canobiote, Canosmose, and Isochanvre and is felt to be easier to work with than traditional lime mixes. It also acts as an insulator and moisture regulator, lacking the brittleness of concrete and consequently not needing expansion joints.

Hemp and flax use in industry is attractive as it can be grown and manufactured in accordance with sustainable and ecological principles.

Natural fibres such as hemp cannot necessarily compete on price with waste products (wood, straw, stover etc.). Products such as biofuels or medium density fibreboard (MDF) are technically possible, but typically are not cost competitive. The rising cost of resources worldwide is helping make agricultural natural fibres more economically competitive, but their cost is still an issue. That being said, hemp and flax could technically replace many bioproducts of petroleum, including plastics and composites products.

The agronomics of hemp production combined with the increased focus on sustainability suggest that there is potential for robust growth in the demand and use of natural fibre. The rising price of energy and oil in particular, continue to increase the cost of synthetic fibres making hemp fibre a more cost effective alternative.

The idea of replacing a non-renewable resource that is pumped or mined from the ground with a renewable, annual resource from plants like hemp or flax is not new. What has changed is the increased demand for sustainable materials from builders, designers, architects and owners with a sustainable focus.

Hemp fibre fits well into this market place and there are many products that are either commercially available today or will be in the near future. Initiatives such as LEED (Leadership in Energy and Environmental Design) are standardizing and expanding the acceptance of the green building industry within conventional construction.

THE EUROPEAN HEMP MARKET

Europe has enjoyed a competitive advantage over Canada due to the availability of production subsidies under the European Common Agricultural Policies (CAP). The EU subsidy was based on the fibre content of the straw, and set at 90 Euros (Based on a 30% fibre yield). This amounts to about 27 Euros or $35 Canadian per tonne of straw at current exchange rates. This subsidy will gradually be removed - if you grew hemp in 2008, this level of inventory will be subsidized until December 30, 2012, and then removed. There is no subsidy for new hemp production planned at the present time.

The eventual removal of this subsidy is creating supply impacts for the hemp processors in Europe. In addition, the market returns from growing other conventional crops is increasing relative to hemp straw production returns.

European costs of producing fibre rising is making Canadian production more competitive. European processors are viewing Canada and Australia as regions of the world in which more reliable and cost effective fibre can be produced. These changes provide significant opportunity for Canada, and by extension Alberta, as European manufacturers seek reliable and cost-effective supplies of fibre.

INDIVIDUAL PRODUCT MARKET ASSESSMENT

PRODUCT CATEGORIES

Industrial hemp products can be used in many market categories through secondary processing – a overview of those categories and some examples of potential products are presented below and discussed in greater detail throughout this section. .While the markets are generally divided into seed and straw-based products, there are some potential products which combine the oil and the hemp fibre (reinforced bioplastics, for example).

Hemp Seed and Oil:

- Cosmetics, aromatherapy, shampoos, moisturizers
- Industrial products and ingredients used in paints, varnishes, surfactants, lubricants, biodiesel
- Biopolymers for the production of bioplastics
- Natural binders for panel board manufacturing
- Food, and functional/nutraceutical food products - hemp cooking oil, hemp seeds, hemp milk, butter, protein powder, hemp flour

Hemp Straw (bast fibre and internal core):

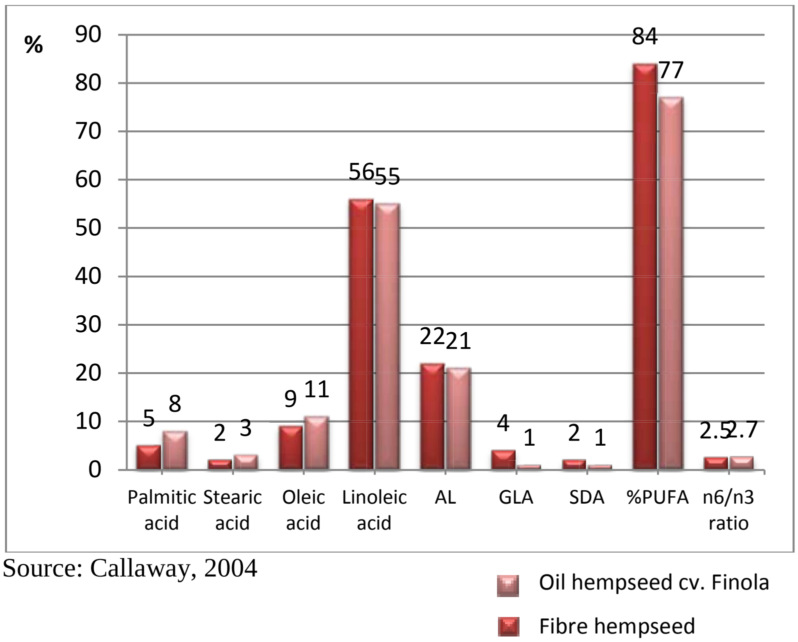
- Textiles and carpets
- Green building materials which include:
  - Family of products integrating hemp fibre and core with concrete and other construction matrixes, including reinforced concrete panels, blocks, sprayed on concrete
  - Structural insulated panels (SIP's), with hemp bast insulation inserted between two structural panels
  - Structural and non-structural panel boards
  - Roofing tiles
- Reinforced bioplastic products – integration of fibre with hemp oil based biopolymers, for production of a range of products – building materials, biodegradable plastics bags, counter tops, car parts, computer cases
- Animal bedding – horses, poultry, pets
- Energy pellets – pelletizing of hempcore fractions using hemp oil ingredient lubricant.

Individual market assessments are provided for some of the more significant product market categories – both seed and hemp straw based.

HEMP SEED MARKETS

While much attention is often paid to the large volume of fibre produced by hemp, the seeds of the plant are a valuable commodity due to their nutritional value. The seeds contain approximately 35% oil by weight. The oil contains 80% polyunsaturated fats (PUFAs) and is an exceptionally rich source of the two essential fatty acids (EFAs) linoleic acid (18:2 omega-6) and alpha-linolenic acid (18:3 omega-3).

Figure 5: Typical Fatty Acid Profiles (%) of Hempseed Oils



Source: Callaway, 2004

Table 8: Typical Protein Content

Amino acid	%
Alanine	1.28
Arginine	3.10
Aspartic acid	2.78
Cystine	0.41
Glutamic acid	4.57
Glycine	1.14
Histidine	0.71
Isoleucine	0.98
Leucine	1.72
Lysine	1.03
Methionine	0.58
Phenylalanine	1.17
Proline	1.15
Serine	1.27
Threonine	0.88
Tryptophan	0.20
Tyrosine	0.86
Valine	1.28

The oil made out of the seeds is high in protein and contains many essential amino acids, as outline in Table 8 above. Individual amino acids values are given in grams per 100 g. Essential amino acids are indicated by pink color[13].

The seeds are currently being sold most commonly as whole seed to the consumer, though a considerable amount is dehulled and sold as "hemp hearts", while the hulls (which are very high in protein) are sold separately. Hemp oil is also made available to consumers for use in cooking, though there are some issues with rancidity.

The major market for hemp production in Canada is Hemp Oil Canada, who is using a cold press system to produce food and industrial oils. They also process some of the seed into "nuts" and other snack food items, as well as the further processing of the by-product oil cake into protein powder, flour, cattle feed and other products.

Detailed market information for hemp seed and related products from the seed (oil, hemp cake, protein powder, cosmetics) is not directly available. Through both COP interviews and workshops, it became clear that the cash sales price of hemp seed in 2011 was approximately $0.90 - $1.00. It is therefore possible to calculate reasonable indirect estimates of farm level returns, based on harvested acreage and average yields.

[13] Data derived experimentally at MTT (the National Agricultural Laboratories in Jokionen, Finland).

In 2011, Canada had 15,720 hectares of production, up from 10,856 hectares in 2010 (Health Canada). Over 80% of this was for seed production. The average yield varies by variety, but a reasonable average yield is approximately 500 kg per acre or 1,100 pounds per acre.

It is possible to develop a crude estimate of the retail or final consumer value of the hemp seed industry. Expert opinion is that the primary, secondary processing values add an additional 250% to the farm level value. Based on this assumption, the total added value of the industry is estimated to be in the range of $38 million annually for Canada.

Most of the value of the hemp seed industry in Canada is generated by the oil processing segment. A significant portion of the production in exported to the United States for this purpose. In 2010, Canada exported $8.59 million in hemp seeds, oil and oil meal, with approximately $3 million of that being oil and its fractions (Figure 4).

INDUSTRIAL STRAW FIBRE MARKETS

The markets for the different products that can be produced from the hemp straw are much less developed. While there are a number of reasons for this reality, one of the main issues has been limited processing technology. When this is combined with a lack of industry knowledge both in production and processing, the problems become more significant.

However, with recent activity both in refining technology for processing and product development activity, it has been suggested that if these limitations are overcome, the sector could be a major value added sector for the Alberta and Canadian agricultural industry.

Some of the specific market opportunity segments are discussed below.

Specialty Panels

Hempcore (hurds) is increasingly used in building materials, specifically in different types of panel boards. This product then finds its way into numerous value added products such as furniture as well as specialty panels.

The Canadian panel board commodity market is very competitive and price sensitive. The basic commodity board end of the market is not considered to be a practical focus for board made from hempcore. The best market may actually be with the higher valued uses of hemp board as “specialty” panels.

In the EU, hempcore is an input into the manufacturing of panel board and has a value almost equal to twice that of wood based panels. The major reason for this added value is that from 1,000 kg of hempcore, approximately 45% more end product can be produced than typical wood based products.

Some of the advantages of hempcore board are:

- Each unit of input produces up to 45% more boards
- The boards made from hemp are significantly lighter in weight, with the same thickness and structural properties
- Less labour is needed in the construction due to the lighter weight, and
- The transportation costs are approximately one half of conventional board. Due to the lighter weight, trucks can carry twice as much product given highway weight restrictions.

One major problem found in Europe in the hemp panel board market is the inconsistent colour, due to the highly variable weather conditions. This is a critical issue in the marketplace.

The tables below provide price quotes of hemp panel boards sold in Europe, followed by a comparable table of different panel board prices in Canada.

Table 9: European Hemp Fibreboard Prices (2008)

Thickness		Prices	
mm	Inches	Euro/m^2	$CND/sheet(1)
16	0.63	6.44	12.88
19	0.75	7.65	15.30
22	0.87	8.86	17.72
28	1.10	11.27	22.54
38	1.50	15.30	30.60

Sheet : 4 feet by 8 feet
Source: Secondary research, EU industry consultation

Table 10: Selected Canadian Panel Board Prices ($ CDN) 2008

Panel Board Type	9.95 mm	12.7	15.86
OSB	7.48	7.98	12.98
Particle Board	11.98	16.98	18.98
MDF	20.98	21.87	24.87
HDF (¼ in)	15.29		
Spruce Plywood	12.98	17.98	19.89

Given the competitive analysis, the four major opportunities for panel boards are:

1. acoustic panels: panels used in applications where sound reduction is important - such as production of audio speakers, office wall/ cubical partitions;
2. office and home furniture where weight, toxicity of flame retardants and environmental concerns are important;
3. flooring, flooring underlays - where high density fibre board hemp panels are manufactured; and
4. for utilization in environmentally friendly home construction.

Despite the many opportunities, there also appear to be considerable barriers to the effective development of the supply chain. Some of the constraints to the introduction of hemp based panel boards in western Canada include:

- lack of experience by end users of hemp based boards;
- end users, such as in the furniture industry, are very concerned as to the risks of supply of a new product such as hemp panels;
- in order to be environmentally superior there is the need to utilize natural resins, or glues that are made from soy, canola, or other vegetable oil products. There are some products on the market, but a local

supply and natural resin technology has not been established in Alberta. That being said, there is a potential for hemp oil to be utilized as a natural fibre binder; and

- obtaining sufficient, consistent supply has been a problem for some entrants into the panel board market. There have been a number of failed fibreboard companies and products, using wheat or fescue straw over the past years.

There is no existing manufacturing capacity for hemp panels in Alberta. A plant in Forestburg has closed and the status of the Wanham plant is unknown.

Several initiatives are underway and companies identified in British Columbia, Alberta and Manitoba who have an interest in testing and utilizing hemp based products in their unique environmentally sustainable home, resort, and community development projects. The ultimate outcome of these initiatives is as yet unclear and far from certain.

As previously stated, particle boards are classified in the market as low, medium, and high density panels. The low density panels have the potential to be utilized in the acoustic building market. Additional markets would include use in wall panels, speaker boxes and residential audio rooms.

High density hemp panels have possible applications within the flooring market. This market typically uses imported cork and bamboo flooring products. There is interest expressed for using hemp board as a substitute. The manufacturers' price in these markets is about $3.00 per square foot, or almost $100.00 per four by eight foot sheet.

The Alberta furniture industry is a major market consideration for hemp based panels. In Alberta, there are 10 furniture manufacturers – four in Calgary, and six in Edmonton. These firms mainly make high end office furniture, furniture for residences, kitchen cabinets, and a range of other high valued products. A significant part of this output is exported.

Alberta imports in the range of 20 million square feet of panel board for the manufacture of furniture products. The opportunity to supply this market domestically exists.

Bedding Market Opportunities

The bedding market issues and potential are discussed below for each of the major market segments. Three main avenues exist for the possible sale of hempcore (hurds) as bedding:

1. the horse industry;
2. the poultry industry; and
3. the pet industry.

There is essentially no market potential within the pig industry, as this industry does not use a significant amount of bedding. There is also limited potential in the dairy industry because many other bedding options are still cheaper.

Within each of these industries, the main competing products are wood shavings, straw, and shredded paper. There are numerous other supplementary products that can compete effectively with the use of hemp for bedding. It should not be expected that the bedding market would serve as a primary driver for the development of a hemp supply chain. Rather, these may serve as an economic alternative for the removal of residual hemp straw grown primarily for its seed.

Horse Bedding

There is potential in the equine industry. Bedding is typically more important for horse owners than it is for other livestock sectors. Part of this is due to the socioeconomic reality of the sector and part is due to the actual recognition by owners of the importance of the bedding to the specific animal.

The estimated size of the hempcore animal bedding market in Europe was over 25,000 tonnes annually in 2003, the last year for which statistics are available. The market size has stabilized, due to lack of supply. There are indications the market size for hempcore could or would have grown by five to eight times, if there would have been more supply.[14]

A factor that has supported the growth of the use of hempcore in Europe, is that other products that traditionally could be used, such as shavings, are being used more for burning and other energy applications. Increased demand for the substitutes creates a potential market opportunity for hemp as bedding.

Hempcore for bedding in Europe is sold typically in 15 kilogram bags. The prices range from 260 to 275 Euros per tonne delivered at European harbour port (CDN $340 - $360 per tonne). These products are destined for markets in the Netherlands, France and Germany.

There are a number of companies, both in British Columbia and Alberta, (i.e. EcoBioFuels Inc., Calgary) currently in business. Others are getting into the business of producing and shipping waste wood products, generally in pelletized form, to Europe. This market response is mainly due to the stronger demand for these products in their energy industry.

In Canada, the major horse bedding market is in Ontario, but there are also significant opportunities in Alberta and British Columbia. Industry insiders have suggested that they have identified a significant buyer of horse bedding. The indication is that this company will buy containers of hempcore packaged in 14 kg bags, for about $320 per tonne, not considering freight or delivery costs. These bags are being sold in the retail market for about $9.90 per 14 kg bag, or about $700 per tonne basis as of the fall of 2011. However, if sold in greater quantities into a wholesale horse bedding market, this price would not hold, but would be closer to $5.50 per bag, or about $400 per tonne.

There are over 300,000 horses in Alberta, with 60,000 horses in each of the Edmonton and Calgary areas. In Edmonton, a major high end user is Northland Park track and stables. In Calgary, Spruce Meadows, and the Calgary Stampede complex are the largest users.

A potential marketing strategy would be to enter the horse bedding markets in Alberta and provide sample products to Northlands Park, the Calgary Stampede Park and to Spruce Meadows. They would use the product on a test basis; information would be secured from them on the product performance with respect to moisture absorbency, odor control, cleanliness, and quantity requirements per animal, compared to existing products such as wood shavings, and straw. If this was successful it could potentially result in an important market segment.

The use of bedding (currently mostly pine shavings) has been estimated for the approximately 12,000 of the 60,000 horses that are in high end stables in Edmonton and Calgary areas. The typical stabled horse uses 60 bales per year (with each bale weighing 1,089 kg), which results in the use of about 13,000 tonnes of shavings or bedding of some kind.

Most of the bedding used by horses are wood shavings. These are sold either in loose/bulk form, or in compressed bags. The bag compresses 8-10 cubic feet into one 3.25 cubic foot bag for shipping and storage. A typical bag weighs 18-20 kg.

[14] European Industrial Hemp Association, 2005.

The current cost of pine shavings, packaged in 3 cubic foot bags is approximately $3.75 per bag (before freight) for a bag weighting 17 kg, and a minimum order of 500 bags. This equates to a price per tonne at the factory of $217. For smaller quantity orders of between 100 to 500 bags, the price is about $4.50 per bag, or $261 per tonne.

Suppliers are the United Farmers of Alberta (UFA), Sundre Forest Products, and Spray Lakes Forest Products. UFA produces a compressed kernel product, made out of wood, which sells for $5.25 per 16 kg bag, or about $330 per tonne.

Market indications are that the cost of waste wood raw materials for use in the bedding and fibreboard markets in Alberta and Canada will increase over time relative to hemp products. Environmental restrictions and the movement of timber processing to lower cost areas will drive this trend. Two of the most recent fibreboard plants in Alberta have closed over the past two to three years for various reasons (Forestberg plant and the Wanham plant). Regardless of the reasons, the economic viability of the plants was not there.

Hempcore could be price competitive compared to most wood based shavings. Ultimately, the end users must be educated and convinced as to the performance criteria of hempcore bedding. For example, hempcore is reported to be three times more absorbent than shavings, controls odor better, and volume requirements per animal are less.

Poultry Bedding

The poultry industry in Western Canada presents another opportunity for the sale of hemp hurds as bedding material. The market size assessment in this study was focused on the broiler sector of the poultry industry, primarily because it is the largest single component of the industry, has shorter production cycles (compared to layers), and is the larger consumer of bedding.[15]

The British Columbia broiler industry is over three times larger than the Alberta industry. In British Columbia, the annual production is in the range of 181 million birds per year, and in Alberta the industry is in the range of 53 million birds.

The estimated use of bedding materials is based on the following assumptions:

- 1 broiler per sq foot of building area;
- 1 inch of bedding depth; and
- shavings weight of 2 kg per cubic foot, or 52 kg per cubic yard.

Other statistics of note with respect to the use of bedding in the poultry industry are:

- broiler barns: currently spend 2.19 cents/square foot per cycle, one inch thick, up to six cycles per year;
- breeder and pullet barns: 7.48 cents per square foot per cycle, 3.5 inches thick; and
- breeders – layer barns: 4.24 cents per square foot, 2 inches thick.

Based on the size of the two industries, the annual consumption of bedding in the British Columbia and Alberta broiler industry is:

- British Columbia: 29,000 tonnes per year
- Alberta: 8,600 tonnes per year

The British Columbia broiler industry itself spends in the range of $4 million per year on bedding. The Alberta broiler industry spends approximately $1.2 million. Bedding costs in British Columbia and Alberta are estimated at $8 million and $3.0 million respectively.

[15] Expected changes to the structure of the laying industry – the movement from conventional to colony cages – may provide additional opportunities in the layer sector in the near future.

Significant market barriers for selling a new bedding product into the poultry industry include:

- product price: must compete against shavings, currently is at a delivered price of approximately $250 per tonne;
- ease of use and application: must be in a bulk form, which can be quickly and easily blown into and distributed within the barns, using existing spreading equipment;
- animal health disease prevention: the most critical issue facing the poultry industry is with respect to ensuring high level biosecurity standards. Any new or existing product must be able to meet biosecurity standards, and be supportive of disease management; and
- environmentally friendly and easily disposed of: manure, bedding management. Waste disposal is a growing issue for the poultry industry.

It is important not to forget specialty poultry, ducks in particular, which have a much higher need and place a higher value on the bedding they use. Ducks typically use three times the amount of bedding annually than do most other birds. Ducks have much higher water content in their manure, resulting in a greater requirement for bedding.

More Opportunities

The small animal bedding market is a higher valued market than the horse bedding market. The estimated price of small animal bedding (pet market) is near 400 Euro or $520 CDN per tonne. The product is packaged in 1 to 4 kg bags. The capacity requirements for entry into this market through the European supermarket chains, is beyond the capacity of the current industry. The volume requirements to enter this market are in the range of two million bales per year (an estimated 4-5 million kg per year).

In Canada, the small animal pet bedding market has significant potential for hempcore bedding. The retail price ranges for existing pet bedding products is in the range of $500 to $600 per tonne, typically in 1 kg packs. The existing products are either recycled paper, and imported fibres like coconut and other fibres.

The pet industry is less price sensitive than are many other possible end uses in other segments of the bedding industry.

One other application for hempcore is in the organic bedding market, primarily for organic poultry production. There currently is no supply of organic bedding, at the same time as the market is growing.

There are opportunities within the horticulture garden market for hempcore products. These include replacement of coco fibre growth and peat moss substrates. One issue for horticulture applications is the level of pH and electrical conductivity. These levels would need to be established for hempcore to determine its fit within this sector.

One other lower valued application is in the replacement of tree bark. A related application is with respect to use in greenhouses, particularly in the winter and cooler periods. Hempcore may reduce temperature losses in greenhouses, resulting in less heat requirements and reduced energy costs.

Currently wood pellets are used in this industry. Prices for a 15 kg bag of wood pellets are in the range of $5 to $6 per bag, or 16 to 18 cents per pound.
It is generally recognized, that the energy value of hemp pellets is superior to wood pellets. They also have the advantage of creating less emissions and providing less residual ash left after burning.

Further testing and validation of hemp based energy pellets would be necessary to develop this niche market.

CONCLUSIONS

This project assessed the feasibility of Alberta's industrial hemp industry throughout the complete value chain, including primary production and processing.

Input from experienced growers of industrial hemp was considered and used to develop benchmarks for the cost of producing hemp for seed in Alberta. While costs are higher than for other typical field crops, the revenue potential for hemp significantly outweighs those cost differences. The critical success factor for maintaining or increasing the potential revenue is the development of reliable end markets.

Hemp production for seed has a number of very important advantages. The supply and value chains for hemp seed are significantly shorter and easier to establish than those for fibre and hurd products, largely due to the lower technology requirements. The weight of the raw seed end product makes transportation logistics much easier. These and other considerations has led to the situation in Alberta where current production is primarily focused on growing hemp for seed – either for consumption or as certified seed for use by other growers.

While this is obviously an important element of the market, there is considerable market development needed for all aspects of the product in order to ensure that the demand for seed continues. While seed products are reasonably well understood, the markets and value chains for them are not fully developed. The result is that there has often been a significant oversupply leading to producers unable to sell their product. This instability creates significant issues for the sector and needs to be addressed in order to ensure market growth.

The industry is in a difficult position. While there is the potential for hemp supply chains to develop rapidly in Alberta, the necessary condition would be to have assurances that there would be a market, particularly for fibre-based products. It would appear that having an appropriate scale fibre processing operation in addition to manufacturing and high end buyers/users, is key to the success of these supply chains. Demand for the end product is obviously the key to the development and success of the market.

On the positive side, there are significant efforts underway to further refine fibre processing technology. These efforts when combined with those targeting the development of markets for seed, fibre, and hurd will be of critical importance to the sector. If these activities help to either increase competitiveness by reducing cost of production and/or increase potential markets, the benefits to Alberta would be significant.

In conclusion, significant strides are being made with respect to fibre processing technology in Alberta, including some potential for further commercial processing capacity. Likewise, many growers are developing experience in growing hemp over a number of years, reducing some of the production risks inherent to a crop relatively new to the province.

Despite these many positive features, the reality is that continued commitment is needed in order to generate the necessary contribution margins for producers. This commitment extends through the value chain from producers willing to commit to the crop, processors willing to work with the technology and a significant research effort on both technology and end market development.

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