Economic Considerations for Growing Industrial Hemp:
Implications for Kentucky's Farmers and Agricultural Economy
Department of Agricultural Economics, University of Kentucky
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Introduction and Background

Kentucky lawmakers have passed legislation to develop a regulated framework that would allow production and marketing of industrial hemp to potentially evolve in the Commonwealth if it is legalized at the federal level. In the midst of a relatively small, but growing market for hemp-related products, the question of economic viability for farmers specifically and of a Kentucky hemp industry in general, remains very uncertain. Opponents question the potential economic impact of this controversial industry and further claim that any expected profitability would not compensate for the additional monitoring costs. They also remain concerned that industrial hemp production would perpetuate additional illegal drug activity. Proponents counter that industrial hemp could provide economic benefits and jobs given emerging market opportunities if the industry were allowed to fully develop as a commercial enterprise.

Market enthusiasts identify thousands of potential products which can be produced from industrial hemp. Such items include clothing, cosmetics, lotions, shampoos, soaps, paper, food, feed, beer, biofuels, animal bedding, building materials, insulation, car moldings among many other consumer and industrial products. Industrial hemp is grown for its seed and for the fibers from its stalk. (see **Appendix I** for a production and supply chain for hemp). There are many merits of hemp fiber and oil -- superior fiber length, strength, and absorbency, excellent oil quality for both industrial and feed uses, potential environmental benefits, and a myriad of other applications. Sales of hemp products to U.S. consumers have reportedly topped $500 million in recent years, while U.S. hemp imports continue to grow. (Hemp Industry Association)

Kentucky was the dominant US producer of hemp during the 1840s up until the mid 1850s before cotton and imports of other materials led to the crop's demise during the latter half of the 19th century. In response to the demand for rope, twine, and other products during the war effort of World War II, production of industrial hemp peaked in the United States in the 1940s. Kentucky was still a significant producer, but several other Midwestern states (Illinois, Wisconsin, Minnesota, Iowa) were much larger. In 1943, U.S. hemp production established a record high of 145 million pounds (141 million pounds of fiber and 14.0 million pounds of seed), with Kentucky's 52,000 acres possessing a 10% production market share (98% of seed production, but only 2% of fiber production).

Despite expanding sales and uses for industrial hemp, along with Kentucky's storied history of the crop, the success of an industrial hemp industry in Kentucky ultimately is dependent upon whether it is profitable for farmers, processors, and manufacturers relative to other options. The question addressed in this study is *Would industrial hemp production be profitable for Kentucky farmers and be beneficial to the overall Kentucky agricultural economy?*

In addition to industry interviews, this study draws upon several recent Canadian studies, a recent Congressional Research Service (CRS) report, and two studies conducted at the University of Kentucky in the late 1990s. Specifically, this report offers:

- A policy review and update
- A review of world production and trade trends
- A more in depth look at the Canadian hemp industry
- An examination of U.S. market for industrial hemp and related products
- Enterprise budgets to analyze hemp profitability for Kentucky farmers
- Issues, opportunities, and challenges for Kentucky producers, processors and the industry

Given the many uncertainties about consumer markets, infrastructure adoption, pricing information, agronomic uncertainties, potential but undeveloped markets and conflicting signals from published articles and data sources, this study does not offer point estimates for acreage or job creation.

[1] This was a group effort made up of the following faculty, Lynn Robbins, Agricultural Economics (AEC); Will Snell, AEC; Greg Halich AEC; Leigh Maynard, AEC; Carl Dillon AEC and David Spalding, Horticulture.

A Policy Review and Update

Legalizing the production and marketing of industrial hemp has initiated political debate over the years among national and state lawmakers addressing this controversial issue. More than 30 U.S. state legislative bodies have introduced hemp-related legislation (e.g., production/marketing provisions, resolutions, commissions, economic studies) since the mid 1990s with twenty states introducing legislation so far in 2013. Nineteen states have passed pro-hemp legislation, with nine states including Kentucky actually passing laws to establish a production and/or government oversight framework to enable hemp production to occur if the federal law is modified, (Vote Hemp). (see **Appendix II** for more details)

Kentucky Legislation

Over the past couple of decades there has been much public discussion and even legislative attempts in the Kentucky General Assembly related to researching and legalizing the production of industrial hemp in Kentucky. In 1994, Governor Brereton Jones established a special task force to investigate the potential of fiber crop production in Kentucky, including industrial hemp. In 2001, a bill was passed into law to develop an industrial hemp research program which would be monitored by a newly created Industrial Hemp Board (HB 100). But strict federal regulations and regulatory costs prohibited any university research trials evolving from this legislation. After several unsuccessful attempts to address the hemp issue in recent legislative sessions, the issue resurfaced in the 2011 Commissioner of Agriculture race, led by the eventual winner, James Comer. The "hemp" bill, Senate Bill 50 (SB 50) was introduced by state Senator Paul Hornback in January 2013, and eventually passed in the 2013 Kentucky General Assembly. This bill established a legal regulatory framework for the production and marketing of industrial hemp, if the federal government would amend current policy or if Kentucky could obtain a federal waiver. It became law once Kentucky's Governor Steve Beshear elected to not veto (i.e., sign) the bill, citing the challenges hemp production would invoke on enforcing illegal marijuana production in the state. Kentucky's legislation is based on a system of issuing production licenses to eligible growers for the production of industrial hemp with a THC (or tetrahydrocannabinol, the chemical responsible for most of marijuana's psychological effects) content that does not exceed 0.3%. The program would involve the Kentucky Department of Agriculture (KDA), the state's Hemp Commission, the Kentucky State Police and other local law enforcement personnel, and the University of Kentucky College of Agriculture, Food and the Environment. (see Appendix III for the roles to be played by KDA, the Kentucky Hemp Commission, licensed industrial hemp growers and the makeup of the Kentucky Hemp Commission).

Recent Federal Action

Following passage of SB 50, the fate of hemp production in Kentucky moved to Washington DC. In recent years there have been several bills introduced in the U.S. Congress to allow the production of industrial hemp while maintaining the illegal status of marijuana production. Specifically these bills amend the Controlled Substances Act to differentiate industrial hemp and marijuana based on its THC content and transfer regulatory authority from the federal government to individual states. The most recent legislative action, the Industrial Hemp Farming Act of 2013 (H.R. 525) was a bipartisan bill introduced in the U.S. House of Representatives by Thomas Massie (R-KY), with 28 original co-sponsors, which currently has increased to 42 co-sponsors. This bill was followed with a companion bill (S. 359) in the U.S. Senate, introduced by Senator Ron Wyden (D-OR), with co-sponsors Senators Rand Paul (R-KY), Mitch McConnell (R-KY), Jeff Merkley (D-OR), and Bernard Sanders (I-VT). These similar bills call for the removal of the federal restrictions on the cultivation of industrial hemp by defining it as distinct from marijuana (based on THC content) and allowing its production and processing in accordance with state laws. These bills were referred to the Judiciary Committees in both chambers in addition to the Committee on Energy and Commerce in the U.S. House.

If enacted, this legislation this could lead to the production and processing of industrial hemp in states that have adopted a regulatory legal framework, but would still be subject to DEA regulations. Another option would be for Kentucky to receive a federal waiver from the DEA which would provide an exclusive opportunity for Kentucky growers to produce hemp or allow universities to develop research programs. While both of these outcomes face many political challenges, there is strong support by Kentucky legislators, both state and federal. Kentucky's two senators, Mitch McConnell and Rand Paul, along with Kentucky's Congressmen Thomas Massie, John Yarmuth,

Brett Guthrie, Ed Whitfield, and Andy Barr have publically revealed they support federal action to allow industrial hemp production to move forward in Kentucky. Citing drug enforcement concerns and lack of economic evidence, Kentucky's Congressman Hal Rogers opposes the effort.

While the two stand-alone Congressional bills have not been addressed by their respective committees, pro-hemp legislators have recently attempted to move federal hemp legislation forward by attaching it to the Farm Bill. The U.S. Senate, which passed its version of the Farm Bill, failed to include a proposed amendment that mimicked the Senate's version of the Industrial Hemp Farming Act of 2013. In a joint statement Kentucky Senators McConnell and Paul stated the exclusion of the industrial hemp amendment was one of the reasons they opposed the Senate Farm Bill. They further stated "Although we're disappointed in the lack of consideration of our industrial hemp amendment, it is only the beginning of our legislative efforts. We are committed to continuing to look at all options to win approval of this important legislation for job creation in Kentucky."

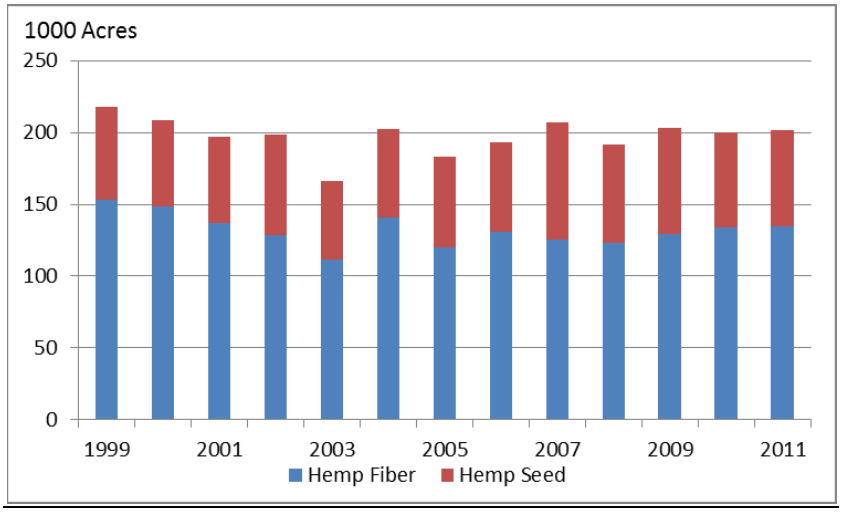
In the U.S. House, Kentucky's Congressman Thomas Massie was successful in getting a hemp amendment he co-sponsored to be a part of the final House Farm Bill package. Unlike the Senate hemp amendment which enabled farmers to grow industrial hemp, the House amendment only allowed production of industrial hemp for university research. With much uncertainty regarding future action on a Senate/House farm bill conference committee, other federal hemp legislative options include to attach it to another bill or to move forward with the original bills as stand-alone legislation.

In addition to Congressional action, Kentucky's Governor Steve Beshear recently wrote President Barack Obama asking for his help with hemp, stating "While experience in Canada tells us that the economic opportunities in the hemp industry are still largely unknown, we want to explore any and all opportunities that have the possible potential for job creation and enhancing rural economies in areas of our state."

World Production, Trade and Price Trends

After a steady and significant decline during the 1960s-1980s, the Congressional Research Service (CRS) chart below (using FAO data) reveals that world hemp acreage in aggregate has been fairly stable over the past decade (see Figure 1). However , it is important to point out that the FAO data excludes data for Canada and other North/South American nations, which would lead to a modest increase in total world hemp acreage (along with production) in recent years. While overall total production has been increasing, seed production has been increasing relative to fiber production.

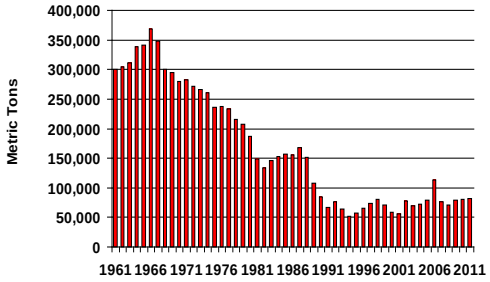
Figure 1: Hemp Fiber and Seed, Global Acreage (1999-2011)



Source: CRS Report, FAOSTAT, http://faostat.fao.org/site/567/default.aspx#ancor.

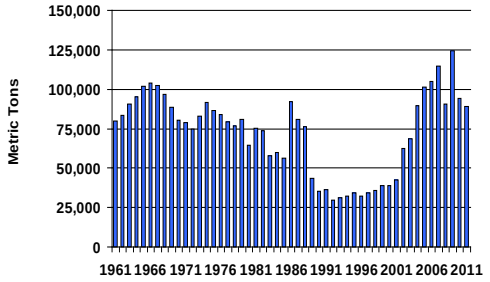
Notably, world hemp fiber production fell from over 300,000 metric tons in the early 1960's to less than one-fourth that level in 2011. (see Figure 2) However, it appears that global fiber production has been fairly stable over the past twenty years, despite declining acres devoted to fiber production (indicating that yields have improved). Due to high costs of transporting fiber, world trade is relatively small --averaging 942 metric tons from 2007-2011. Trends in the global hemp fiber market may be signaling that economic opportunities for hemp fiber products are challenged.

Figure 2: World Hemp Fiber Production



Source: FAOSTAT

Figure 3: World Hemp Seed Production



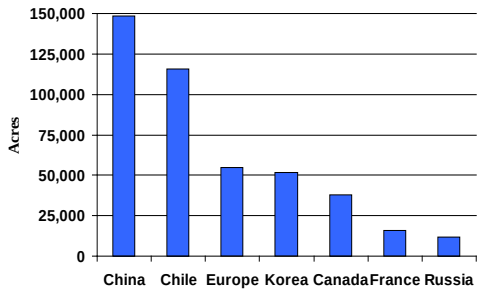
Source: FAOSTAT

Alternatively, hemp seed production has grown from around 33,000 metric tons in the late 1990's to average over 100,000 metric tons per year from 2005-2011, with hemp seed exports mirroring the gains in global hemp seed production.

Various sources reveal that hemp is grown in more than 30 countries worldwide. China is the dominant producer in the global hemp market, accounting for nearly 150,000 acres in 2011. Europe remains an important player in the global hemp market, growing over 50,000 acres in 2011, but its share of the world market is declining. On the other hand, Canada is emerging as a growing influence on the global hemp production and trade.

According to the March 2013 CRS report, "Hemp production in the United States faces competition from other global suppliers. The world market for hemp products remains relatively small, and China, as the world's largest hemp fiber and seed producer, has had and likely will continue to have major influence on market prices and thus on the year-to-year profits of producers and processors in other countries." (Johnson, p.22)

Figure 4: 2011 Hemp Acreage for Selected Countries/Regions



Source: FAOSTAT/Health Canada

China's dumping of hemp seed on the world market in the late 1980's and early 1990's, for example, demonstrated that increased production would lower world prices. Hemp seed prices fell 43% (from an average of 26.5 cents to 15 cents per pound) during the late 1980s and early 1990s. This lends some credence to the conventional wisdom that increased hemp production would lower world prices, thereby creating some increase in world demand. Hence, as two other studies indicated, thin markets lead to great price volatility (Vantreese and USDA, ERS).

Europe has historically been a significant player in the global hemp market, although area harvested has trended downward over the past decade. According to the European Industrial Hemp Association (EIHA), "Industrial hemp has been grown in Europe through the Middle Ages in many European countries like The UK, France, The Netherlands, Germany, Spain and Italy. "Today Hemp is a niche crop, cultivated on 10,000 to 15,000 hectares (24,700 -37,000 acres)in the European Union. " and "... is a valuable crop for the bio-based economy." (Carus, Michael, et al, p. 1, parentheses added).

European hemp producers received production subsidies in the past to support their industry. However, as part of Common Agricultural Policy (CAP) reform, these subsidies were reportedly phased out in December 2012. EIHA claims that the removal of this subsidy, coupled with increasing returns and subsidies from other "energy" crops is expected to adversely impact future hemp supplies from European producers. Consequently, the EIHA is supporting CAP reform related to its "greening" initiative based on the alleged environmental benefits of hemp production (Carus, Michael, et al.).

An In Depth Look at the Canadian Hemp Industry

Although Canada is not the world's largest or the lowest cost producer, they will likely be the chief competitor if production eventually becomes legal in the United States. Canada's hemp industry has been evolving over the past two decades. The Canadian government initially issued research licenses in 1994 to grow industrial hemp on an experimental basis. Starting in 1998, commercial production became legal with licenses and other regulatory provisions (including production, processing, transporting, delivery, sale and trade) provided by the Office of Controlled Substances of Health Canada. The number of cultivation licenses issued by Health Canada varies from year to year, exceeding 500 in 2006 to a low of 80 in 2008. Last year, Health Canada issued 489 cultivation licenses for 196 individuals. As Canadian acres have been growing from the recent low in 2008, the licenses per farmer increased for three years then leveled to average 2.7 licenses per farmer. However, the size of the industrial hemp enterprise on each farm has continued to increase, nearly quadrupling in five years from 58.3 acres in 2008 to 202.6 acres per farmer in 2012 (Health Canada).

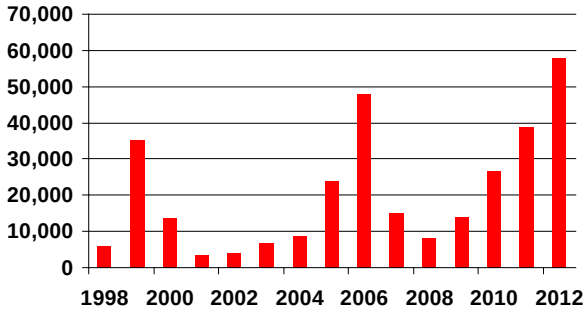
During its early years of development, Canada's hemp industry experienced a lot of volatility and some challenging times. Canadian growers were issued slightly less than 6,000 acres of industrial hemp production in 1998. On optimistic demand expectations created by Consolidated Growers and Processors (CGP) Inc. of California, acreage soared to more than 35,000 acres in 1999. But the demise of the Californian company led to acreage plummeting to around 13,500 in 2000 and down to just over 3,000 acres in 2001. Following the 2004 U.S. court decision which overruled DEA's authority to ban the importation of hemp products into the United States, acreage rebounded in 2005 and swelled to nearly 50,000 acres in 2006. A market correction from the overproduction of an extremely large crop in 2006 plus profitability from other crops caused plantings to fall to less than 10,000 acres in 2008.

Canadian hemp acreage has been growing steadily since 2008, increasing to 58,000 in 2012 (see Figure 5). This growth came on the heels of improving processing technology, research, government financial support (see below), increasing number of Canadian businesses developing hemp products and overall growing demand, primarily import demand by the United States which accounts for approximately 90% of Canadian international sales. Canada's gross producer hemp seed cash receipts have been around $30-35 million in recent years. (Alberta update, p. 5).

Early estimates are for around 70,000 acres to be planted in 2013 and one industry source indicates a goal of 100,000 acres by 2015. (Canadian Hemp Trade Alliance) A recent Canadian study claims that without production

subsidies, “European costs of producing fiber are making Canadian production more competitive. European processors are viewing Canada and Australia as regions of the world in which more reliable and cost effective fiber can be produced.” (p. 27, Alberta Hemp Cost study).

Figure 5: Canadian Hemp Acres



Source: Health Canada

What about the future for the Canadian hemp industry in the midst of potential changes in U.S. hemp policy? Canada has an established industry and is aware of the threat the U. S. could provide. As a consequence they are likely to exhibit a strong competitive reaction. Canada’s head start in the North American market for hemp seed and oil also would likely have a negative effect on the profitability of a start-up industry in the United States. According to the authors of the Alberta study, "... legalizing production in the U.S. could displace Canadian demand with U.S. production." (p.2) These authors, at least do not see U.S. production filling any new needs and by implication no major expansion in demand.

The Canadian government has been investing in supporting their hemp industry by providing grants and no-interest loans. In 2010 and 2011 the industry received almost $1.3 million to help the hemp industry increase production capacity and make new inroads into the U.S. market. Given an established infrastructure and markets, government investment, an on-going research program, it seems unlikely the Canadian hemp industry will simply roll-over if the industry evolves in the United States.

According to the 2012 Alberta study, "The longevity of the more recent growth will remain dependent on the development of a well established primary and secondary processing capacity." (p.4). This has been a continuing theme in hemp analyses since Vantreese's study in 1998. In Canada, "... the hemp oil processing value chain is relatively well established, (but) the hemp straw value chain is considered to be underdeveloped and restricted due to technology gaps. (Alberta, p.10)

Conclusions from the above two studies done 15 years apart indicate the importance of a proven and cost effective technology for decortication. It was an important challenge 15 years ago and continues to be one today in Canada. As the Alberta study reports, "Until this issue (decortication technology) is resolved it will continue to be a significant challenge to develop the hemp fiber industry and to farmers who are growing hemp primarily for seed, but wish to sell the hemp straw as a by-product." (p.10 parentheses added). Decortication technology continues to be a significant challenge to hemp fiber industry development and to farmers who are growing hemp primarily for seed, but wish to sell the hemp straw as a by-product." (p,10) In fact, "Over 80% (of the 2011 Canadian production) was for seed production." (p.31)

They further emphasize this point and add the need to expand market demand and reduce production costs when they say "... there are significant efforts underway to further refine fiber processing technology. These efforts when combined with those targeting the development of markets for seed, fiber, 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." (p.37) The authors point out that Canadian growers are " 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." (p.37) They conclude by stating "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. "(p.37)

Recognizing a lot of positive production and market trends, a separate Canadian study (National Industrial Hemp Strategy) offered numerous challenges facing Canadian hemp producers including:

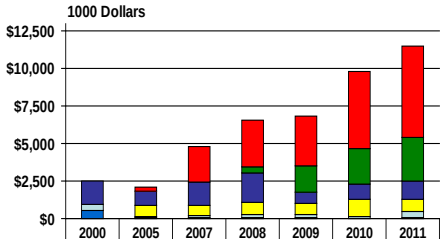
- "Cash flow problems could be created for those who seed a significant proportion of their acreage to hemp;
- Interest costs on the stored crop can be significant when storing crop for years;
- There is a real risk that an entire crop could be lost while in storage;
- Relatively higher production costs for hemp to comply with the country's licensing regulations (compared to other global jurisdictions, which may not be regulated);
- Limited number of processing facilities that may threaten long term growth, and;
- Need for continued research and public education."

The above studies and global trends indicate that hemp seed holds the most promise in a growing world market because the hemp oil processing value chain is relatively well established while the lack of a proven and cost effective technology for decortication continues as a major bottleneck for hemp fiber processing. These same opportunities and challenges facing Canadian hemp growers will also affect U.S. growers of industrial hemp, at least in the near- to mid-term.

The U.S. Market for Hemp and Related Products

While industrial hemp production is illegal in the United States, hemp and hemp products can be legally imported and sold in the United States. Unfortunately, data on hemp imports is difficult to assess due to data reporting classifications (Johnson, p.6). According to the reported official trade data, after decades of importing small amounts, U. S. hemp imports spiked upwards to nearly $7 million during 1986-88 and then fell back to negligible levels. Beginning in the late 1990's hemp fiber and related processed products stabilized at a little over $2 million until 2005 when it grew rapidly to reach almost $11.5 million in 2011 (see Figure 6). In general, U.S. hemp imports have grown significantly in percentage terms over the last few years, but are small in absolute value.

Figure 6: Value of U.S. Imports of Selected Hemp Products



	2000	2005	2007	2008	2009	2010	2011
Seed		271	2350	3111	3320	5154	6054
Oilcake				460	1811	2369	2947
Fabrics	1617	923	1579	1924	751	1024	1188
Oil		711	693	835	726	1129	839
Yarn	396	68	82	202	212	115	425
Raw/Processed Not Spun	525	101	88	57	52	33	41

Source: CRS using data from USITC

Since 2007 seed products (seeds themselves, oil and oilcake have increased from 63.5% of hemp imports to 85.6%. In that same period oil and oilcake has become more predominant in the mix of seed products although seeds themselves still account for 61.5% of the seed product mix, down from 77.2% in 2007. Reportedly most of the U.S. hemp seed imports are used for hemp based foods, supplements, and body care products (March 2013 CRS Report).

"Finished goods such as clothing, shoes and hats made from 100% hemp, or those that have any hemp content, are combined with other natural fiber imports and are not reported separately by the U.S. government. Other consumer goods that contain some hemp content (such as hemp shampoo, hemp paper, and hemp jewelry) are also not included in these statistics. " (Vantreese) Also, "Trade data are not available for finished products, such as hemp-based clothing or other products including construction materials, carpets, or hemp-based paper products. (Johnson) Thus the data above underestimate total imports of hemp products into the United States.

Canada represented a relatively small percentage of U.S. hemp imports in 1998, but became a major source for U.S. hemp imports in 2000 and that role has continued at varying degrees since (FAOSTAT Data Search). Currently, Canada accounts for 60-90% of the total U.S. hemp import market, followed by China, Romania, Hungry and other European countries (Johnson). Thus, if the U.S. were to legalize industrial hemp production, U.S. hemp producers, processors, and manufacturers will have to compete with imported hemp seed and hemp products, which would most likely involve hemp imported from Canada.

According to various sources, there are currently a growing number of Canadian companies (Hemp Oil Canada Inc., Hempola Valley Farms, Fresh Hemp Foods Ltd., Ruths Hemp Foods, Cool Hemp, and Natures Path) developing and marketing a wide variety of hemp seed products (including snack foods, hemp meal and flour, edible oil, shampoo and conditioners, moisturizers, commercial oil paints, beer and aromatherapy and cosmetic products). In addition, there appears to be a growing demand for hemp products originating from organic production. Recently, Hemp Oil Canada Inc announced it is first in the world to gain international food safety accreditation for hemp food (p.1, Manitoba Agricultural News).

A representative of a Canadian processing company pointed out that even a large oil customer who might use 30,000 lbs of hemp seed oil per year, would account for approximately 96 acres of production. Processors also say however, that the market has a strong potential upside once the credibility of U.S. legalization sets in and interest is regenerated in the production of hemp.

Fiber processing and finding fiber processors raises more questions than answers and is a source for pessimism. As one Canadian processor stated, "... it is my opinion that the potential North American hemp market is not as large as most people believe and will take time to develop. In the next five years it is unlikely that no more than one hemp fiber processing plant can be supported. If Kentucky were to build a hemp fiber processing factory no more than 25 direct jobs would be created." He goes on to say, “if there were a real demand for the products there would be more hemp fiber processing plants operating in Canada than there are!"

As Kentucky has begun discussing creating a hemp industry there is anecdotal evidence of processors who have shown interest in locating here. For example, one of the largest producers and processors of hemp food products and oil in North America say they have watched the U.S. developments with respect to growing hemp for many years. They are interested in ultimately opening a U.S.-based facility in the future, once they are assured that the Federal authorities will accept the state legislation and allow Kentucky producers to grow the crop without interference.

And yet, a non-existent U. S. industrial hemp industry does not impede processing firm's investment in other countries. It is notable that foreign investment in hemp processing facilities in China, Europe and Canada are small. It is logical to assume that these decisions were based on prudent business sense. None of the large multinationals has openly supported the legalization of hemp in the U.S., which it seems they would if there were profits to be made here. Why? The world corporate community seem to have access to plenty of raw material and low labor costs (China and Eastern Europe), and a stable economic and political environment where hemp production is legal (the European Union). So processors may be saying, why bother with U.S. politics? (Vantreese p.28) Based on comments above, Canada seems to reflect that view as well.

"Nevertheless, the U.S. market for hemp-based products has a highly dedicated and growing demand base, as indicated by recent U.S. import data for hemp products and ingredients, as well as market trends for some natural foods and body care products. Given the existence of these small-scale, but profitable, niche markets for a wide array of industrial and consumer products, commercial hemp industry in the United States could provide opportunities as an economically viable alternative crop for some U.S. growers." (Johnson, p.22)

Hemp Production Profitability in Kentucky (See **Appendix V and VI** for more details)

The direct profit potential of industrial hemp is a critical component to a farmer when considering enterprise mix. The decision-making process should include:

- Alternative enterprises
- Risk
- Resource competition
- Ability to use assets such as machinery for other enterprises

Although industrial hemp could be profitable unto itself, farmers need to consider alternatives that might be more profitable, especially in light of the currently favorable prices for row crops. Many aspects of risk for industrial hemp are difficult to determine. Production risk from fluctuating yields is unknown. Price volatility for fiber and seed might be considerable. In this case policy risk is especially uncertain because of the possibility of changing legal conditions. Questions remain as to whether crop insurance markets will arise if industrial hemp should be legalized and whether or not it will be subsidized. Effects of hemp on yields of other crops in rotation as well as competition for resources are important. For example, how do field time spent, capital usage and cash flow associated with hemp production compete relative to other possible crops in the rotation? A related issue regards the ability to use assets such as machinery for other enterprises. Retrofitting some machinery for hemp comes with an investment that is not recouped in the event it is altered later when exiting hemp production.

Consequently net returns are highly speculative for the U.S. market given unknown market and non-established infrastructure and cost of compliance. This analysis compares hemp production to row-crop production and was done for various soil productivity classes. Prices and yields are difficult to predict leading to wide ranges in costs and returns. To narrow the results for the purpose of this analysis UK specialists estimated hemp yields relative to 125 bushel corn ground. These yields were then changed in proportion to a range of corn yields to come up with four soil productivity levels. This approach was necessary because potential hemp yields for Kentucky have not been researched and are highly speculative.[2]

Expected Hemp Yields (Fiber and Seed) Based on Various Corn Yields (hemp yields at normal moisture content)

	Low Productivity (100 bu corn)		Medium-Low Productivity (125 bu corn)		Medium-High Productivity (150 bu corn)		High Productivity (175 bu corn)	
	Fiber Yield Tons/Acre	Seed Yield (lbs)	Fiber Yield Tons/Acre	Seed Yield (lbs)	Fiber Yield Tons/Acre	Seed Yield (lbs)	Fiber Yield Tons/Acre	Seed Yield (lbs)
Fiber Only	***4.6***		***5.8***		***6.9***		***8.1***	
Dual System	***2.2***	***520***	***2.8***	***650***	***3.3***	***780***	***3.9***	***910***
Seed Only		***600***		***750***		***900***		***1050***

[2] When hemp is harvested for fiber only, it is generally harvested when the male plants start to pollinate. As a result they are harvesting both the male and female plant. When it is harvested for both seed and fiber the male plant has already died and has largely disappeared. Thus for fiber-only yield will likely be close to double in volume and be of a much higher quality.

P and K fertilizer application rates were assumed to be at the removal rate of the crop for both fiber and seed production. Because removal rates were not available for industrial hemp, switch grass rates were used for fiber, and canola removal rates were used for seed. Nitrogen requirements were assumed to be 125 units for all productivity classes and production systems. N, P, and K were all assumed to be priced at $.50 per unit.

Hemp production is a relatively simple process in that it requires a well established seed bed and planting can be accomplished with existing planting equipment whether for seed or for fiber. Harvesting hemp seed will require some modification of existing combines so as to harvest the tops of the plants and leaving the bulk of the stalk. Storage of hemp seed will be essentially the same as for any other oil seed crop. Harvesting of the stalk will likely require a sickle bar mowing machine as opposed to the disk mowers whose blades rotate. The stalks will be allowed to dry to the point that any leaves will shatter when the crop is baled. The current process for fiber separation prefers a longer stalk produced by the round bales as opposed to square bales. After baling, the bales will need to be protected from the weather. Hemp production will be tough on equipment due the tough nature of the hemp fiber and will thus have higher depreciation and repair costs compared to hay production.

Machinery costs were estimated by using custom machinery rates as the baseline costs for all operations. (see Appendix V for the machinery operations used for the three production systems). A number of modifications to the custom rates were made to reflect differences in hemp production compared to grain and hay production. Adjustments needed to be made for cutting and raking since hemp yields are typically much higher than hay on an acre basis. Also, hemp fiber is very tough compared to hay which would increase wear and tear on machinery. Finally, wheat heads for combining hemp seed would need retrofits of roughly $25,000-30,000.

Results

Fiber and oilseed sales prices are highly uncertain and thus a wide range of prices were used to determine profitability potential. Three different combinations of fiber and oilseed prices are presented based on assumed values from other studies and limited market data. *However, no inference should be made as to what we expect prices to be as this cannot be determined with limited market data*.

The following table shows net returns, excluding land costs for $75/ton fiber and $0.70/lb seed. See **Appendix V** for similar calculations for lower ($50 fiber/ton and $0.50/lb seed) and higher price ($100/ton fiber and $0.90/lb seed) combinations.

Net Hemp Returns/Acre (does not include land cost)
$75/ton Fiber and $.70/lb Seed

Production System	Low Productivity	Medium-Low Productivity	Medium-High Productivity	High Productivity
Fiber Only	-$167	-$149	-$130	-$112
Dual System (fiber plus seed)	$42	$125	$208	$290
Seed Only	$119	$217	$315	$412
Notes: Costs include labor and depreciation/overhead but not land costs. $3.50/gal fuel; N, P, and K at $.50/unit; 50 miles one-way trucking to market.				

Net returns are much better for oilseed production as compared to fiber production. Fiber-only production would be expected to show a negative return in almost all of the scenarios evaluated. The seed only system had better returns than the dual fiber-seed system in all scenarios evaluated. The seed-only advantage was mainly due to 1) extremely high removal rates for P and K with fiber compared to oilseed, and 2) higher machinery costs for fiber production compared to seed production.

The estimates above for the various hemp profitability scenarios can be compared to a corn-soybean rotation with the same four soil productivity classes in Central Kentucky (costs are higher than in western Kentucky.)

Corn-Soybean Returns/Acre for Central Kentucky (50-50 rotation)				
Corn Price Level Corn (per bu) Soybeans: $2.25X Corn Price	Low Productivity (100 bu corn, 32.3 bu soybeans)	Medium-Low Productivity (125 bu corn, 39.1 bu soybeans)	Medium-High Productivity (150 bu corn, 45.5 bu soybeans)	High Productivity (175 bu corn, 51.5 bu soybeans)
$4.00	$35	$100	$163	$224
$5.00	$121	$206	$289	$369
$6.00	$208	$312	$415	$515
Notes: Costs include labor and depreciation/overhead but not land costs. $3.50/gal fuel; N, P, and K at $.50/unit; 50 miles one-way hauling grain to market.				

The table above provides anticipated corn-soybean returns for Central Kentucky farms under our assumed price/yield parameters. Current corn prices (July 2013) are well above $6/bu, but long-term markets indicate prices around $5.00/bu. Net returns presented in these scenarios represent returns over all costs other than land.

Net Returns/Acre (does not include land cost) Hemp Fiber Production Only				
Yield Level (tons/year)	$50/ton Fiber Price	$75/ton Fiber Price	$100/ton Fiber Price	$125/ton Fiber Price
4.0	-$376	-$276	-$176	-$76
6.0	-$359	-$209	-$59	$91
8.0	-$342	-$142	$58	$258
10.0	-$325	-$75	$175	$425
Notes: Costs include labor and depreciation/overhead but not land costs. $3.50/gal fuel; N, P, and K at $.50/unit; 50 miles one-way trucking to market.				

The table above looks at a range of hemp fiber production levels and hemp fiber prices. Returns are negative with all production levels until prices approach $100/ton. Even with a 10 ton yield level and $100/ton fiber price, returns would only be $175 per acre. This would compare to nearly $290 per acre for corn-soybeans at $5/bu corn and $11.25/bu soybeans. Thus, despite interest among some horse farms for using hemp fiber for bedding, hemp fiber production does not appear to be a realistic option for Kentucky in the near future – see **Appendix VI** for more details on horse bedding.

Net Returns/Acre (does not include land cost) Hemp Seed Production Only				
Yield Level (lbs/year)	$.50/lb Seed Price	$.60/lb Seed Price	$.70/lb Seed Price	$.80/lb Seed Price
600	$11	$71	$131	$191
800	$102	$182	$262	$342
1000	$192	$292	$392	$492
Notes: Costs include labor and depreciation/overhead but not land costs. $3.50/gal fuel; N, P, and K at $.50/unit; 50 miles one-way trucking to market.				

To better evaluate hemp oilseed production, the table above examines a range of oilseed yields and prices. Note that the returns (if assumed prices and yields materialize) look much more competitive with corn-soybeans. The table below makes a more explicit comparison of hemp seed production only to corn-soybean production.

Hemp Returns/Acre (does not include land cost) Seed Production Only				
Seed Price/lb	Low Productivity (100 bu corn)	Medium-Low Productivity (125 bu corn)	Medium-High Productivity (150 bu corn)	High Productivity (175 bu corn)
$0.50	-$2	$66	$134	$202
$0.60	$58	$141	$224	$307
$0.70	$118	$216	$314	$412
$0.80	$178	$291	$404	$517
Corn-Soybean Rotation ($5/bu Corn/$11.25/bu Soybeans)	$121	$206	$289	$369
Notes: Costs include labor and depreciation/overhead but not land costs. $3.50/gal fuel; N, P, and K at $.50/unit; 50 miles one-way trucking to market.				

A straight comparison shows hemp seed returning about the same as the corn/soybean enterprise at approximately $.70/lb seed price on low productivity land and around $0.65/lb on highly productive land under our base scenario of $5.00/bu corn and $11.25/bu soybeans. Because crop insurance is not available for hemp, one would need to add roughly $50/acre return to the corn-soybean rotation (somewhere in the range $25-75/acre) to account for the crop insurance subsidy. This would raise the breakeven seed price to around $.80/lb for the lower soil productivity classes, and $.70/lb for the higher soil productivity classes. Where double-crop wheat is practiced, another $50/acre would be added ($25 – 75/acre) to corn/soybean profitability. This would raise the breakeven hemp seed price to around $.80/lb for the higher soil productivity classes.

While some previous studies indicated net returns exceeding $500/acre, most existing studies revealed a long-term net return generally in the $100 to $300/acre range, excluding any grower costs of regulation and crop security. Our study shows similar results for seed only production. The only instances yielding returns over $300/acre are those where the highest hemp prices and yields are used. Hemp can be grow on reclaimed land but likely would generate low yields and would be further constrained by the challenges evolving from the need for large farm equipment on reclaimed land. Hemp has been used in Europe and Russia for a number of years in the remediation of reclaimed lands for heavy metal removal but those crops are generally not harvested for commercial use.

From the above analysis it seems most likely that any hemp production in Kentucky will initially be for seed rather than fiber and only attractive at the upper end of our price estimates. Also, there are more established markets for hemp seed, and lower cost processing technology at this time than there are for the fiber. Fiber production may evolve as processing becomes more feasible, yields/prices increase, potential uses realized, and markets developed.

Also, the reader should recall that this analysis was tailored to Central Kentucky where hemp would be more competitive compared to Western Kentucky, where grain net returns, excluding land costs are higher (approximately $30-$70 per acre) compared to Central Kentucky.

Issues, Opportunities, and Challenges for Producers, Processors and the Industry

This study follows two previous studies conducted at the University of Kentucky nearly 15 years ago, the last time when the hemp movement had some momentum. Using a wide range of assumptions, the Thompson, Allen, Berger (CBER) study estimated that the demand conditions/opportunities present at that time would support roughly 80,000 acres of hemp production in Kentucky yielding approximately $200-$300 per acre return in the short run and around $100 per acre in the long-run as hemp prices would fall amidst increasing supplies. The authors concluded based on anticipated prices, costs, and yields, industrial hemp would have been the third most profitable crop in Kentucky, following burley and dark-fire-cured tobacco. However, it is important to point out that prices for competing enterprises (corns, soybeans, wheat) are much better today than at the time of their study. The study further identified three reasons why they expected Kentucky to succeed in developing a viable hemp market. First was to capitalize on central Kentucky's thoroughbred market using industrial hemp fiber to become the bedding choice for many horse farms. Second, Kentucky's soils, climate, and growing season may give the Bluegrass state a locational advantage. And third, was the potential benefit if Kentucky would become the first state, or one of the first states to legalize the cultivation of industrial hemp. While recognizing much uncertainty, the study estimated the development of the hemp industry in Kentucky would generate roughly 100 to 700 jobs. (Thompson Allen and Berger)

Vantreese in her 1998 study questioned some of the assumptions and demand projections in the CBER study. She further pointed out that the world market for hemp at that time was declining and not enticing advancements in processing technology or encouraging new investments, especially among large multinational companies who had access to cheap labor in developing nations and other more cost competitive materials than industrial hemp. (Vantreese)

Our analysis reveals that the U.S. market for products made from industrial hemp in the United States is relatively small, but it is growing, (especially hemp seed, unlike the trend in the late 1990s), and will likely continue to grow, and under certain assumptions (which are still very speculative at this point), hemp production for the seed only enterprise could be profitable for Kentucky farmers.

While interested parties want specific answers to potential acres, jobs, and economic impact that a hemp industry could generate in Kentucky, we agree with Johnson who stated in the March 2013 CRS report, "Given the absence since the 1950s of any commercial and unrestricted hemp production in the United States, it is not possible to predict the potential market and employment effects of relaxing current restrictions on U.S. hemp production. While expanded market opportunities might exist in some states or localities if current restrictions on production are lifted, it is not possible to predict the potential for future retail sales or employment gains in the United States, either nationally or within certain states or regions. "(p. 7).

Based on our analysis, here are some conclusions and thoughts for consideration.

- Despite different assumptions and methodologies, our budget projections appear fairly consistent with other studies, generally indicating that hemp seed production can compete with the profitability of mainstream grain crops under the upper range of our hemp seed yield and price levels.

- Hemp fiber has great upside potential, but little of that potential has been realized. Hemp fiber production does not appear profitable relative to other crops given our assumed range of fiber prices and yields. (Note: our upper range for yields is higher than other studies reviewed.)

- While showing some positive returns, under current market conditions, it does not appear that anticipated hemp returns will be large enough to entice Kentucky grain growers to shift out of grain production, except perhaps at the highest assumed prices for a hemp seed only enterprise. Lower grain prices and/or higher hemp yields or prices could expand this observation.

- If Kentucky's hemp industry would materialize to the size of the Canadian hemp industry, projected gross sales would total less than 1% of current Kentucky farm cash receipts. At 2012 Canadian acreage totaling 58,000 acres, Kentucky has four counties that each average around 150,000 acres of corn and soybeans. In other words, converting 10% of the corn/soybean acres in these four Kentucky counties would

approximate Canadian hemp acreage in 2012. On the other hand, it would take around 25% of the corn/soybean acres in the Bluegrass crop reporting district (23 county area) to match Canadian hemp acreage in 2012.

- In the long-run, there will be an upper bound on hemp oilseed prices that is directly related to the profitability of corn-soybean production. If oilseed prices produce exceptional profits (compared to corn-soybeans), this will entice additional hemp seed production. The end result would be an increased local supply of oilseed (roughly within a 100 mile radius of a processing plant) causing hemp seed prices to fall.

- Thin domestic markets coupled with international competition could lead to significant price volatility if supply can't be managed.

- Monitoring, security, and registration costs could be significant and are not included in our analysis. The fees established by SB 50 of $5 per acre, with a minimum $150 is at the low end of the ranges found in the literature – see Appendix IV for more details.

- The development of local Infrastructure appears critical to limit transportation costs and provide economic support to an uncertain industry. In addition, marketing , adoption of more efficient processing technologies, and production research are also extremely important to enhance the probability of success.

- There are many companies interested in using processed hemp, both fiber and seed, but, in Canada for example, far fewer have invested in doing the processing, especially fiber processing.

- Efficient and effective fiber processing techniques have been needed for at least 15 years and they have yet to surface.

- In the short run employment opportunities evolving from a new Kentucky hemp industry appear limited (perhaps dozens of new jobs, not 100s), as the industry matures the number of jobs generated by this industry could grow, but remains very uncertain.

- The development of a local research base of knowledge, an interested and willing/educated grower pool, and state financial incentives could encourage a processing industry to ultimately decide to locate in Kentucky.

Unfortunately this study does generate a lot of remaining unknowns and questions for further analysis and production research. These include:

- Will early concentration of processing, technology, and experience provide Kentucky an early advantage in the U.S. market or will the Canadian's two decades of market research, production, and market development be challenging to the Kentucky market?

- Can Kentucky hemp producers capture the straw bedding market for horses? The enterprise analysis in this study clearly reveals that without significantly higher fiber yields or fiber prices, hemp bedding will not be an attractive bedding alternative despite interest expressed by several individuals in the central Kentucky equine industry. (See Appendix VI for more details)

- Does Kentucky have a competitive advantage in terms of growing seasons and soils to generate higher yields and/or better quality hemp?

- How will other states and other countries respond to Kentucky hemp production?

- Will KY/US production displace Canadian and other imports or will a potential change in federal hemp policy broaden the market for hemp products?

- Will increased production lead to greater price volatility for a market without any risk management options (e.g. futures market, crop insurance or federal safety nets) for U.S./KY hemp growers?
- What would enable Kentucky to be a low-cost producer compared to other states and nations?
- Will Kentucky draw processors and other vital infrastructure?
- What hemp products hold the most opportunity for Kentucky acres/jobs?
- How can the regulated program be structured to not recreate a secondary rental market for licenses such as what existed under the federal tobacco program?
- Will consumers pay more for the products made from industrialized hemp based on alleged environmental benefits and uniqueness/novelty of hemp products?
- What about opportunities for certified seed?

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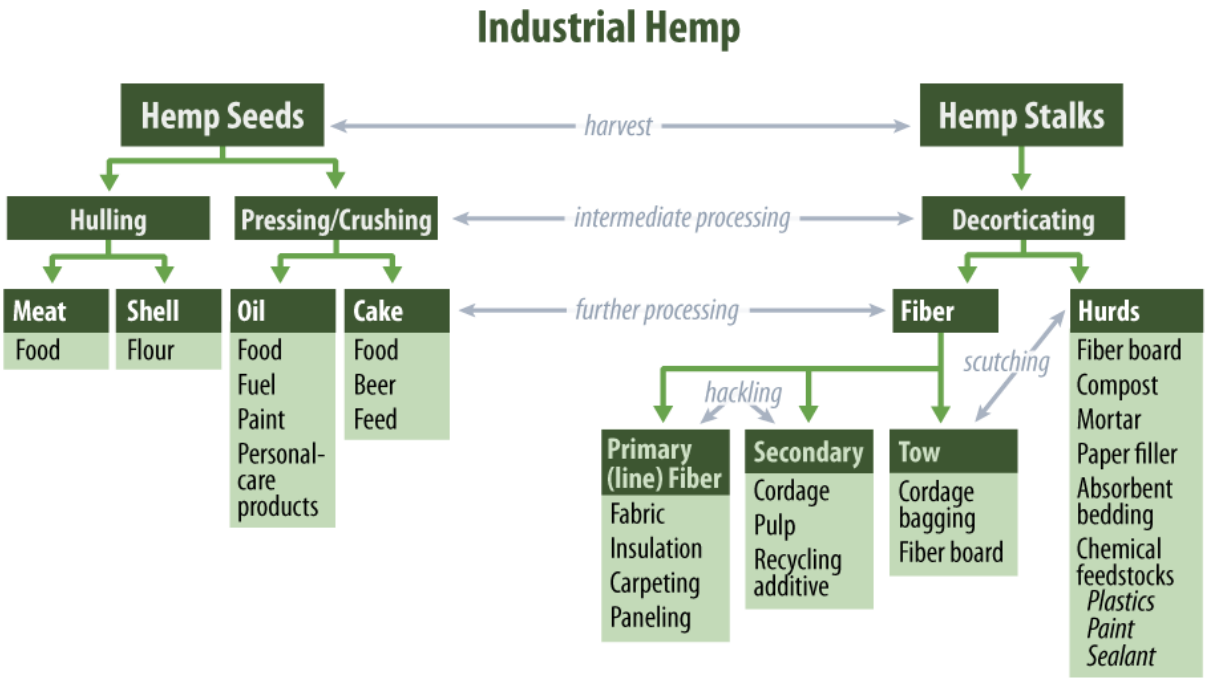
Author's Note: The world production and trade data presented in this paper were from several sources. Two sources, the FAOSTAT - search http://faostat3.fao.org/home/index.html#SEARCH_DATA and the UNDATA - search http://data.un.org/ , were gathered by JP Hesseldenz Business and Economics Academic Liaison, Reference Services, William T. Young Library. His efforts are especially appreciated. All other data were collected from the following sources by the author. FAS standard query http://www.fas.usda.gov/gats/ExpressQuery1.aspx All these sources are gratefully acknowledged.

Appendix I - Production, Processing and the Supply Chain

Industrial hemp is grown for its seeds or stalk. The stalk is used for its outer fiber and inner core or hurds. The figure that follows shows processing steps and final products. The processing and supply chains for hemp seed are shorter and easier to establish than for fiber, due to the lower technology requirements and the lower volume of raw product. Therefore, in Canada, "... 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." (p3)



Source: 2013 CRS report, adapted from D. G. Kraenzel et al., "Industrial Hemp as an Alternative Crop in North Dakota,"AER-402, North Dakota State University, July 23, 1998, http://purl.umn.edu/23264.

Appendix II - Legislation History

Federal Legislation

Legalizing the production and marketing of industrial hemp has initiated political debate over the years among national and state lawmakers addressing this controversial issue. In 1937 Congress passed its first law related to this issue requiring growers, importers, and processors to be registered and taxed. This legislation discouraged growing cannabis for marijuana production, while simultaneously encouraging the production of hemp for industrial purposes (primarily fiber and oil for use in World War II). According to the Congressional Research Service (CRS), competition from synthetic fibers following the war, taxation, and increasing public concerns over drug consumption, ultimately caused hemp production to decline and eventually cease beyond the late 1950s.

The Controlled Substance Act of 1970, the federal legislation which is currently in effect, declared all cannabis varieties, including hemp, as Schedule I controlled substances, with the U.S. Drug Enforcement Administration (DEA) serving as the regulatory authority (Title 21 US Code Controlled Substance Act). While not making industrialized hemp production illegal, this legislation required growers or researchers to obtain a permit from the DEA. The DEA did issue a research permit to the University of Hawaii in 1999, although the federal agency has reportedly never issued an individual grower permit. In 2003, the DEA issued two final administrative rules to effectively ban any imported products made from hemp from entering the United States, but this restriction was eventually overturned by a U.S. Court of Appeals ruling in 2004. Over the years there have been several unsuccessful Congressional attempts to modify the Controlled Substance Act to accommodate industrial hemp production in the United States, but most legislative activity on this issue during the past two decades has occurred at the state level.

State Legislation

More than 30 U.S. state legislative bodies (including Arizona, Arkansas, California, Colorado, Hawaii, Idaho, Illinois, Indiana, Iowa , Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montano, New Hampshire, New Jersey, New Mexico, North Carolina, North Dakota, Oregon, South Carolina, South Dakota, Tennessee, Vermont, Virginia, Washington, West Virginia, Wisconsin) have introduced hemp-related legislation (e.g., production/marketing provisions, resolutions, commissions, economic studies) since the mid 1990s with twenty states introducing legislation so far in 2013. Nine states (Colorado, Maine, Montana, North Dakota, Oregon, Vermont, Washington, West Virginia and now Kentucky have actually passed laws to establish a production and/or government oversight framework to enable hemp production to occur if the federal law is modified, (see Johnson and Vote Hemp*).* Last year, Governor Jerry Brown vetoed SB 676, the California Industrial Hemp Farming Act, stating "Federal law clearly establishes that all cannabis plants, including industrial hemp, are marijuana, which is a federally regulated controlled substance. Failure to obtain a permit from the U.S. Drug Enforcement Administration prior to growing such plants will subject a California farmer to federal prosecution. … Although I am not signing this measure, I do support a change in federal law. Products made from hemp - clothes, food, and bath products - are legally sold in California every day. It is absurd that hemp is being imported into the state, but our farmers cannot grow it." In addition to many states addressing the hemp issue, several national and regional farm organizations have voiced their support. Thus, while this debate received a lot of attention in Kentucky during the most recent legislative session and the 2011 Commissioner of Agriculture's race, it has the interest and attention in many other states as well.

Appendix III - The KDA & The Hemp Commission

The **Kentucky Department of Agriculture (KDA)** would provide administrative support for the hemp program which would include:

- Paperwork associated with issuing and processing licenses
- Testing (THC levels)
- Accounting
- Staffing

The **Kentucky Hemp Commission** would be delegated to:

- Establish two different hemp grower licensing programs – 1) research and 2) commercial markets
- Approve annual licenses, following a criminal background check by the Kentucky State Police
- Establish acreage, fees, monitoring program , recordkeeping and research (if applicable) for each license
- Forward copies of submitted applications to the Kentucky State Police to conduct criminal background checks
- Forward copies of approved licenses to the local sheriff, including name, address, size/ location of production
- Establish testing protocols
- Administer an industrial hemp research program (agronomic and economic focus) managed by the University of Kentucky Experiment Station, with collaboration from other Kentucky universities and research partners.
- Coordinate with the University of Kentucky Center for Applied Energy Research to study use of industrial hemp in new energy technologies such as producing biofuels, and electricity, production of industrial hemp on reclaimed mine sites, and examining environmental issues and other benefits/costs of using hemp for energy.
- Pursue any federal permits or waivers necessary to establish an industrial hemp research program
- Study ways to attract federal and private funding for the research program
- Provide annual reports to the Governor and the Legislative Research Commission (LRC) regarding the status and progress of the industrial hemp research program
- Coordinate with the Cabinet for Economic Development potential financial incentives in attracting hemp-related agribusiness firms
- Promote the research and development of markets for industrial hemp and hemp products
- Report to the Governor and the LRC regarding federal laws, market development, economic impact, research funding, grower educational programs, law enforcement concerns among other items related to the state's industrial hemp industry

Membership to the Kentucky Hemp Commission shall consist of the following members:

- Speaker of the House of Representatives or the Speaker's designee
- President of the Senate or the President's designee
- Chair of the Senate Agriculture Committee
- Chair of the House Agriculture and Small Business Committee
- Commissioner of the Department of Agriculture or the Commissioner's designee
- Commissioner of the Department of Kentucky State Police or the Commissioner's designee
- Executive Director of the Governor's Office of Agricultural Policy or the Executive Director's designee
- Dean of the University of Kentucky College of Agriculture or the Dean's designee
- One member representing each of the following institutions choosing to participate:
    - Eastern Kentucky University
    - Kentucky State University
    - Morehead State University
    - Murray State University
    - Northern Kentucky University
    - University of Louisville
    - Western Kentucky University

- President of the Kentucky Hemp Growers Cooperative Association
- President of the Kentucky Sheriffs' Association or the association president's designee
- President of the Kentucky Association of Chiefs of Police or the association president's designee
- Six members, three appointed by the Speaker of the House and three by the President of the Senate, representing the following interests:
    - Kentucky farmers with an interest in growing industrial hemp
    - Retailers of industrial hemp products
    - Wholesalers of industrial hemp products
    - Manufacturers of industrial hemp products
- Two at-large members on a recommendation of the chair and approved by a majority of the members of the commission

Licensed industrial hemp growers under this legislation must:

- Apply for an annual license from the Kentucky Hemp Commission
- Provide legal description and global positioning coordinate for the location of hemp production
- Pay a non-refundable application fee established by the Commission
- May sell industrial hemp to any business engaged in processing or manufacturing industrial hemp or hemp products, but must notify the commission of any sales or contracts
- Maintain production records and submit required documentation/filing
- Allow inspections by the Kentucky State Police
- Be the individual (or their designee/agent) to transport industrial hemp with proper documentation.

Appendix IV - Monitoring Costs

Section 3 of the Kentucky regulation states," ***To provide sufficient funds to pay costs associated with administering, monitoring, and testing industrial hemp, the department shall assess each licensee a fee of five dollars ($5) per acre, with a minimum fee of one hundred fifty dollars ($150) per applicant. Collections from this fee shall be equally divided between the department and the appropriate sheriff's department."***

The Canadian Hemp Trade Association (CHTA) charges for testing levels. "CHTA helps farmers find a licensed sampler and licensed testing lab. Sampling and testing usually happens before harvest in August. CHTA negotiates for best rate and receives a discount for members from both laboratory and sampler. Sampling can run between $140–200 and Testing is now about $150. These costs are by field. It is cost effective to plant in fewer fields." (the Canadian Public Health Association)

Minnesota has been studying regulation costs for several years. They are clear to say they have not captured all the associated costs. Still, they present one of the most detailed analyses. Their cost estimates, "... includes cost associated with administration for the program, laboratory cost estimates for sampling and testing, as well as IT services related to secure databases and GIS infrastructure to inventory growing sites, storage centers, export facilities, and manufacturing centers. Both lab and IT estimates include costs associated with personnel. This estimate does not take into account the fiscal impact for county sheriffs, state patrol, and local law enforcement crime laboratories, many of which are currently involved in controlled substance testing within their jurisdictions."

They assume, "... a possibility of 14,000 production acres comprising 250 sites and 100 growers (mirroring that of both Canadian provinces). If only one THC sample were taken for each site/year, then the MDA would be responsible for financial obligations relating to collecting, processing, analyzing, reporting and data sharing/archiving 250 hemp samples annually. However, sampling may also be required more than once during the growing season from field sites and may also be required from storage centers, export facilities and manufacturing centers."

These estimates exclude the fact that, "... any additional sampling will increase the costs associated with the program. Any validation of site acreages and storage facility size per grower by MDA will also increase costs to the department. ... The cost for the analysis of THC assumes that each growing site can be characterized by one field composite sample which equates to 250 samples/year." (Cortilet, PP.8-9).

The program responsibilities and level of oversight assigned to the MDA by this bill are lengthy and startup costs are relatively expensive especially for the laboratory performing forensic testing of THC." Despite this, "To sustain the program using these cost estimates and assuming startup funds are available for initial program development then the annual fees would need to be $33.32/acre or $1,866/site or $4,664/license or some combination of the three." (Cortilet, Appendix B)

Canada has reduced testing costs by reducing or exempting testing for approved cultivars, "...hemp of an approved cultivar consistently contains 0.3% THC or less when it is cultivated in a region, the Minister shall indicate in the *List of Approved Cultivars* that further testing under that section is not required for that cultivar in that region." (p.22, Canadian Industrial Hemp)

Therefore, Kentucky will reportedly be collecting $5.00 per acre with a minimum of $150 per site, when the two estimates reviewed above range from $150 per site up to $1,866 per site (based $33.32/acre).

Appendix V - Details and assumptions for Hemp Production Profitability Potential for Kentucky

A number of assumptions had to be made to keep this analysis tractable and so that it could be compared directly with competing farming operations. First, it needs to be understood that hemp would likely be grown only on the better agricultural soils. Given the high prices and expansion of row crops (corn-soybeans-wheat) in the last 3-5 years, this means that in the vast majority of cases hemp would be competing with these row crops. Even on land that is currently in hay or pasture, the potential conversion to hemp would still be in direct competition with row-crops for renting these acres.

P and K fertilizer application rates were assumed to be at the removal rate of the crop for both fiber and seed production. Actual application rates would be determined by soil test, and it is conceivable that on highly fertile land (where P and K levels have been built up over time) application rates would be minimal. However, in the long-term removal and application rates would have to be roughly in balance for a high-yielding crop like hemp.

Machinery costs were estimated by using custom machinery rates as the baseline costs for all operations. These rates are computed yearly for Kentucky conditions and can be found at:
http://www.ca.uky.edu/cmspubsclass/files/ghalich/CustomMachineryRatesKentucky2013.pdf
These rates are based mostly on very efficient custom operators who stretch their machinery capabilities to near capacity, and thus have lower fixed costs (depreciation and overhead) on a production unit basis as compared to typical farmers. Consequently, these rates are increased by 25% to make them more realistic for on-the-ground farming operations. Rates were also adjusted for $3.50 diesel fuel. Each custom rate is broken down for it respective portion for fuel/lube, repairs/supplies, labor, and fixed costs (depreciation/overhead). Trucking was assumed to be 50 miles one-way for both fiber and seed. Respective field operations for the three production systems are shown in the table below:

Machinery Operations Used for the Three Production Systems		
Hemp Fiber Only:	Dual System Fiber plus Seed:	Hemp Seed Production Only:
Chisel plow	Chisel plow	Chisel plow
Disk	Disk	Disk
Drill	Drill	Drill
Cut with sickle-bar mower	Combine with modified wheat head	Combine with modified wheat head
Rake	Truck to seed processor (50 one-way miles)	Truck to seed processor (50 one-way miles)
Bale with round baler	Cut fiber with sickle-bar mower	Bush-hog fiber residue
Transport to storage	Rake	
Truck to hemp processor (45 one-way miles)	Bale with round baler	
	Transport to storage	
	Truck to hemp processor (45 one-way miles)	

Three modifications to the custom rates needed to be made to reflect differences in hemp production compared to grain and hay production where these rates came from. First, since hemp yields are typically extremely high compared to hay yields, adjustments needed to be made for cutting and raking which were on an acre basis. Costs were assumed to increase 33% for these two operations for each 1.5 tons of fiber produced over the 1.5 ton average for hay production. In other words, if fiber production were double the volume of hay production, mowing and raking costs would increase by 33%. Second, hemp fiber is very tough compared to hay and increases wear and tear on machinery. Machinery repairs and depreciation were increased by 40% to account for this difference. Third, wheat heads for combining hemp seed would need retrofits of roughly $25,000-30,000 and this would need to be accounted for by increasing combining costs compared to wheat. Combining costs were increased 40% to account for this difference.

Calculations for lower ($50/ton fiber and $0.50/lb seed) and higher price ($100/ton fiber and $0.90/lb seed) combinations.

Net Returns/Acre (does not include land cost) $50/ton Fiber and $.50/lb Seed				
Production System	Low Productivity	Medium-Low Productivity	Medium-High Productivity	High Productivity
Fiber Only	-$282	-$292	-$303	-$314
Dual System (fiber plus seed)	-$117	-$74	-$31	$12
Seed Only	-$1	$67	$135	$202
Notes: Costs include labor and depreciation/overhead but not land costs. $3.50/gal fuel; N, P, and K at $.50/unit; 50 miles one-way trucking to market.				

Net Returns/Acre (does not include land cost) $100/ton Fiber and $.90/lb Seed				
Production System	Low Productivity	Medium-Low Productivity	Medium-High Productivity	High Productivity
Fiber Only	-$52	-$5	$42	$89
Dual System (fiber plus seed)	$201	$323	$446	$569
Seed Only	$239	$367	$495	$622
Notes: Costs include labor and depreciation/overhead but not land costs. $3.50/gal fuel; N, P, and K at $.50/unit; 50 miles one-way trucking to market.				

Appendix VI– Evaluating Hemp for Horse Bedding

Given the relatively high cost of transporting hemp fiber, it appears that it would be advantageous to find a local market for this product. Bedding for horses represents a potential local market for hemp. Some European and Canadian horse farms favor hemp straw over other bedding materials (such as wheat/rye straw, wood chips, shavings, pellets, and sawdust, and grass hay) due to its absorbency, longevity, softness, lack of dust, and biodegradable qualities. In addition, horses will evidently not eat hemp straw compared to some other forage bedding options. According to the Kentucky Equine Survey, Kentucky horse owners spent $21 million on animal bedding in 2012.

The straw bedding market for horse operations appears to be primarily for Thoroughbreds, with some using it only during foaling season or for stallions. Most horse show owners are currently using wood shavings and other wood by products, mainly due to its availability and convenience. Some Thoroughbred operations are moving away from wheat straw to rye straw (longer fiber) and even to grass hay for bedding due to its much lower cost.

While some farms producing wheat in Central Kentucky supply wheat/rye straw to Thoroughbred operations, most of the small grain produced in Kentucky is in the western 1/3 of the state. The combination of getting double crop soybeans out as quickly as possible after wheat harvest, plus the costs of transporting straw to central Kentucky, has typically limited production of wheat straw in western Kentucky. Consequently, a large percentage of the straw bedding for horses is purchased from out of state sources.

Thompson, Allen, and Berger (CBER study) et al examined the potential hemp straw market for horse bedding in their 1998 study. Assuming each horse would average 180 pounds of hemp straw per week, a 10% hemp straw adoption rate for the estimated 77,000 thoroughbreds in Kentucky when the study was conducted (1998), the CBER study projected that 36,000 tons of hemp straw could be sold annually in Kentucky. Given an average yield of 2.9 tons of hemp straw per acre, generated approximately 12,000 acres for Kentucky horse farms alone. The 2012 Kentucky Equine Study indicated that 54,000 thoroughbreds residing in Kentucky, -- 30% fewer than the estimate used in the CBER study. Using their methodology and updated numbers from the recent survey would yield approximately 8,400 acres of hemp production used solely as bedding for Kentucky Thoroughbred farms.

According to the 2012 Alberta study, 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 were not included in the Alberta cost of production benchmarks. If the decision was made to bale and sell straw, producers consulted felt that revenue approximately offset the costs in any event.

Ultimately for Kentucky horse farms to consider a new bedding option, hemp straw would have to be competitively priced with wheat/rye straw or perhaps grass hay bedding. Plus, farmers would have to examine net returns from hemp compared to alternative crops. Currently, retail straw prices are in the neighborhood of $160-$200/ton on volume purchases, which is equivalent to $3.20 to $4.00 per (40 pound) bale or approximately $190 to $240/acre based on average wheat straw yield of 1.2 tons per acre. (Smaller volume sales of square wheat straw bales generally range from $3.50 to $6.50/bale). Rye straw will generate a little more per acre due to higher yields, plus like wheat the opportunity to get the return from planting a second crop following the rye or wheat. Large roll grass hay used will generate around $50 - $80 per ton in a typical year or approximately $1/bale less than straw. Some horse operations are obtaining grass bedding by allowing custom hay operators to supply the hay on a share basis, effectively reducing pasture clipping expenses. Based on our enterprise analysis for hemp fiber production, it appears that unless price and yields are considerably above the ranges assumed in this study, hemp horse bedding returns will not be large enough to entice farmers to produce hemp as a bedding option.