

INDUSTRIAL HEMP: GLOBAL MARKETS AND PRICES

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I. INTRODUCTION

There continues to be considerable discussion regarding the viability of industrial hemp as a supplemental production alternative. Many assume that both the economic (lack of sustained profitability) and the political environment will effectively frustrate renewed hemp production in the US. Others believe that the industrial hemp industry can be revitalized in the US.

Alternative crop enterprises must be thoroughly evaluated. Although industrial hemp production is illegal in the US, the world market can provide useful insights into the direction this market is moving. However, both misinformation and lack of information persists regarding hemp. It is not the author's intent to project normative comments, but to provide factual market intelligence.

II. EXECUTIVE SUMMARY

Industrial grade hemp can be produced without the psychoactive properties of marijuana. Agronomically, hemp can easily be grown around the world and competitive advantage may depend more on local processing capacity. Although hemp possesses some superior qualities for fiber and oil uses, processing remains relatively expensive as compared to other alternatives.

Industrial hemp production has remained legal throughout most of the world and the private sector has been free to invest in production research and processing facilities. Nonetheless, the world hemp market continues to contract and is dominated by many low-cost producers. Hemp fiber production is only one-sixth the volume of the early 1960s (China, South Korea and the Former Soviet Union produce about 70% of world supply) and hempseed production has fallen by half during this period (China alone produces about three-fourths of world supply). Although the hemp industry is subsidized in the European Union, production there remains negligible.

Similarly, world hemp fiber exports have fallen from more than \$12 mil in the early 1960s to currently less than \$5 mil. In 1996, the US imported \$1.4 mil of hemp and hemp products. Of that amount, nearly all (\$1.3 mil) was value-added hemp goods (woven fabrics and yarn).

The political environment remains mixed in the US. A few states have authorized limited hemp research, while state sovereignty remains debatable in face of severe federal growing limitations. Nationally, American Farm Bureau has endorsed further hemp research, while the Drug Enforcement Agency remains adamantly opposed to industrial hemp production.

World prices are highly variable and might not provide a realistic picture if production was legalized in the United States, given the sensitivity of price to changes in production levels. While current projected break-even prices for hemp fiber and seed production appear to lie below world prices, the US possesses a small domestic market and little hemp processing capacity. Thus, US farmers would compete, at least initially, with low-cost producers and subsidized production from the EU, in supplying raw product.

Table of Contents

I. Introduction.....	Page 1
II. Executive Summary.....	Page 1
III. List of Figures.....	Page 3
IV. Industrial Hemp.....	Page 4
a. Definition	
b. Varietal Issues	
c. Cultivation	
V. Processing.....	Page 6
a. Fiber	
b. Hurds	
c. Seeds and Oil	
d. Constraints to Processing	
VI. World Situation.....	Page 8
a. World Production	
b. World Trade	
c. US Imports	
VII. Political Environment.....	Page 16
a. International	
b. United States	
1. State Efforts	
2. USDA White Paper	
3. American Farm Bureau	
4. Drug Enforcement Agency	
c. Kentucky	
1. Governor's Task Force on Hemp and Related Fibers	
2. Kentucky Attitudinal Survey	
3. Lexington Herald-Leader	
4. Louisville Courier-Journal	
5. First Annual Industrial Hemp Conference	
VIII. Costs of Production and Price Data.....	Page 20
a. Production Cost Estimates	
b. World Prices	
c. Profitability of Hemp Versus Other Crops	
IX. Conclusions.....	Page 31

III. List of Figures

	Page
World Hemp Fibre and Tow Yield (select years; 1970-96)	5
World Market Share: Hemp Fibre and Tow Production (1996)	8
World Hemp Fibre and Tow Production (1961-96)	8
World Hempseed Production (1961-96)	10
World Market Share: Hempseed Production (1996)	10
World Hemp Fibre and Tow Major Exporters (1995)	11
World Hemp Fibre and Tow Exports (1961-95)	11
World Hemp Fibre and Tow Major Importers (1995)	12
World Hemp Seed Exports (1961-95)	12
World Hemp Seed Major Exporters (1995)	13
World Hemp Seed Major Importers (1995)	13
US Industrial Hemp Imports (1993-96)	14
Woven Fabrics of Other Vegetable Fibers (True Hemp): 1996 US Import Market Share	14
True Hemp, Raw or Processed But Not Spun: US Imports 1993-96	15
Yarns of Other Vegetable Textile Fibers (True Hemp): US Imports 1993-96	15
Price Required for Farm Gate Break-Even: Hemp Fiber	22
Price Required for Farm Gate Break-Even: Hemp Seed	22
Break-Even Price for Stalk When Growing Seed and Fiber	23
Average Hemp Fibre and Tow Export Prices for Major World Suppliers (1995)	24
World Hemp Fibre and Tow Export Prices (1981-95)	25
Average Hemp Seed Export Prices for Major World Suppliers (1995)	25
World Hemp Seed Export Prices (1981-95)	26
Estimated Hemp Prices and Revenue from Various Sources	27
Expected Profitability of Hemp for Seed and Stalk vs. Other Crops	30
Estimates of Net Returns per Acre for Kentucky Crops	31

Authors Note:

An earlier version of this paper was published in January of 1997. Primary differences are: 1) The exclusion of India, Pakistan and Bangladesh from world production and yield data. Thanks to Jon Gettman for bringing it to my attention that reported data for these countries refer to Sunn hemp, and not true hemp (*cannabis sativa l.*), the focus of this endeavor; 2) US import and export data for 1996 has been included which was not available at the original time of publishing; and 3) legislative updates across the US.

All world production and trade data presented in this paper was gathered from the Food and Agriculture Organization of the United Nations. Trade statistics for the US were gathered from the US Bureau of Census. Both sources are gratefully acknowledged.

IV. INDUSTRIAL HEMP

Definition

Cannabis sativa l. includes both industrial hemp and marijuana. Cannabis is a bast or long fiber plant containing variable concentrations of tetrahydrocannabinol (THC), the psychoactive ingredient. Industrial hemp is a term which commonly refers to cannabis grown for fiber. Most cultivated hemp is reported to contain less than 1% THC. Cannabis produced for drug use is most commonly termed marijuana. Since the mid-1970s, THC levels of confiscated marijuana in the US have averaged between 3-4%; confiscated sinsemilla (a high-potency seedless variety) averaged over 8% THC. The concentration of THC in cannabis is dependent on both environmental and genetic factors. Although individual seeds or plants of hemp are difficult to distinguish from marijuana, fields of cannabis grown for hemp fiber are easily distinguished from those grown for marijuana because of plant spacing. Industrial hemp is planted extremely closely to encourage fiber production and discourage leaf production. Conversely, hemp grown for seed is planted further apart, very similar to marijuana plant spacing. While industrial hemp would have little or no value as a psychoactive product, sources disagree about the possible impacts of hemp cultivation on law enforcement efforts to control marijuana.

Varietal Issues

Most developed countries that permit industrial hemp cultivation limit production to those varieties with less than 0.3% THC. Industrial hemp growers in the European Union use only EU-registered varieties, most of which are owned by a French Cooperative and all containing less than 0.3% THC (consistent with EU regulation). Some have suggested that that limit be increased to less than 1% THC (still well-below the narcotic level) to take advantage of the Chinese and Eastern European varieties available and their genetic properties. Conversely, the French have recently advocated lowering the limit to 0% THC (amidst assertions that the French have made further breakthroughs in seed genetics that might appease hemp opponents and allow the French to further corner the certified hempseed market).

Ongoing varietal research is also conducted by the International Hemp Association. The IHA (based in Amsterdam, Holland) and the Vavilov Research Institute (St. Petersburg, Russia) have preserved nearly 400 types of cannabis seeds. This cooperative project supports continued hemp production to provide seed for long-term storage and for research distribution. Other collaborators include Ukraine and Italy. The VIR/IHA Cannabis Germplasm Preservation project is seeking additional funding to maintain an active collection.

While there are many varieties of hemp with very low THC concentration levels, there is some evidence that those varieties with higher THC concentrations could have agricultural benefits over the lower THC varieties. This is particularly true for those varieties grown for their oil. This was confirmed by the Centre for Plant Breeding and Reproductions Research, though they agreed that “hemp can be a useful crop even if it is legally constrained to varieties low in THC”.

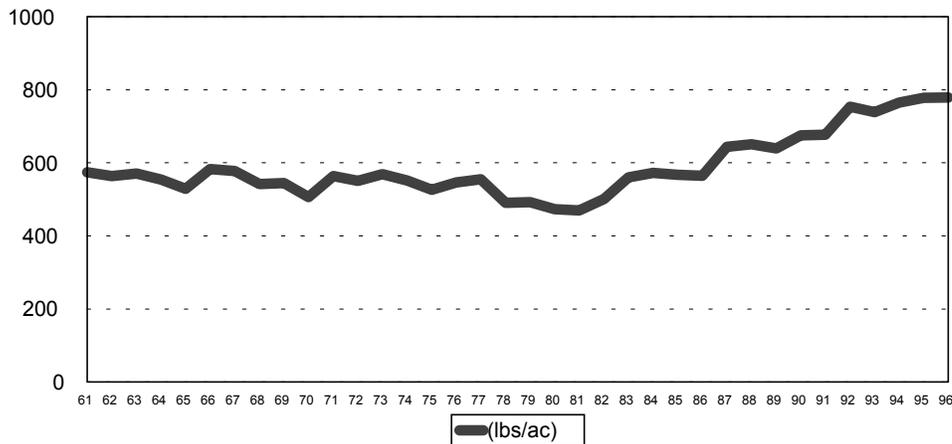
The United States (USDA) has abandoned all hempseed stock collections.

Cultivation

Industrial hemp has the capacity to grow in a multitude of different climates, altitudes, soils and weather conditions. Kentucky does not appear to have any unique advantage in growing hemp, despite our history of production. Hemp is sown during April or May and typically planted densely in rows (at least 150 plants per square meter to maximize fiber production and about one-fifth that density if grown for seed production). Drilling is recommended for uniformity, using a standard grain drill or a modified alfalfa seeder. It is also recommended that the ground be non-compacted and well-drained, using only light cultivation. Small amounts of herbicides may be required, although pesticide use would probably not be necessary, and nitrogen fertilizer should be applied in the spring, with similar application rates to that of corn.

Very little else is required until harvest (with the exception of irrigation if precipitation is less than 200mm over the course of the growing period). Most fiber varieties reach 10 to 12 feet tall in 3 to 4 months time (with a full range of 6-16 feet), with very little foliage produced. In late summer the plants are harvested and the foliage is returned to the soil. Over the last 35 years, hemp fiber and tow yields have slowly increased from about 550 lbs/ac in the 1960s to almost 800 lbs/ac in 1996. (Tow refers to the short broken fibers used for yarn, twine and stuffing.) As expected, yield variability exists across countries: over the last five years hemp fiber and tow yields have averaged 1,202 lbs/ac in China; Russian Federation 283 lbs/ac; and France 575 lbs/ac. Yields are lower in France since most French production is for the seedstock industry.

World Hemp Fibre and Tow Yield



These minimal planting requirements suggest that from an agronomic perspective hemp could be widely grown in many countries. Consequently, competitive advantage may depend more on local processing capacity, due to the bulkiness of the raw commodity.

As one farmer said, “harvesting is when the problems start” and initial estimates of harvesting and processing costs are frequently only one-fourth of actual costs. Harvesting can be done with

existing baling machinery, but can be very rough on equipment because it easily wraps around the cylinder since most machinery is not customized to harvesting hemp. Harvesting hemp can also produce large amounts of dust and workers should wear protection such as facial masks. Baled, industrial hemp can be left in the field for long periods of time, depending on the end-use.

V. PROCESSING

Industrial hemp is grown for its fiber (outer bark), hurds (woody inner core of the stalk) and seeds (primarily for oil). The fiber length and cellulose and lignin content are key quality parameters.

Fiber

Hemp stalk averages around 20-30% bast fiber (the strong woody fiber obtained chiefly from the phloem of plants). The basic markets for bast fibers include specialty textiles, papers (including specialty and recycled papers) and cordage (such as rope). Specialty papers include teabag paper, cigarette paper, carbon tissues and condensing tissues. However, bast fibers are only a small part of the plant stem and separation tends to lead to high production costs. This is somewhat offset by the inherent superior strength of hemp fiber.

In recent years, several European countries, such as the Netherlands and Germany, have conducted research on industrial hemp as a possible fiber for textile and paper production. Dutch research suggests that industrial hemp is not competitive in the specialty paper market, but may be used as a fiber supplement to recycled paper pulp. The growing market for recycled pulp and paper (due to rising wood prices and regulatory practices) may increase the demand for agricultural fibers to strengthen recycled papers.

Small pulp mills for processing flax, hemp and other specialty fibers have arisen in Britain, Spain and Eastern Europe. Purportedly, no US mills have the capability to convert hemp fiber into yarn and production costs are quite high (around \$15/square meter according to one New Jersey importer). Significant competition exists in the specialty textile market (for example, from linen and flax) and cotton, which accounts for 98% of the natural cellulose textile fiber market. Although hemp clothing has surged in popularity, specialty fiber markets tend to be cyclical.

Another market for bast fibers, fiber resin composites, is used to make composite board. Again, industrial hemp fibers are desirable, due to their length and strength, and research continues in this area.

Despite optimism for future uses of hemp fiber, increased competition from synthetic fibers has reduced the use of hemp fiber by the textile industry. It has also been shown that kenaf has many economic advantages over hemp as non-wood fiber for the paper industry. Further, special grades of paper are limited to less than 5% of the normal demand of other major grades of paper, such as newsprint.

Hurds

Approximately 70-80% of the stalk is composed of hurds or the woody inner portion. Essentially, hurds are the by-products of extracting the bast fibers from the stalk. Hurds are 50-70% cellulose, lending itself to paper, particle board, biodegradable plastics, and animal bedding (most of the hemp grown in the United Kingdom is for the horse industry) uses.

Seeds and Oil

Similar to soybeans, pressed hemp seeds are comprised of seed oil and seed cake (or meal). The seed is approximately 30-35% oil by weight and can be used for: food (the oil is over 70% polyunsaturated or cholesterol-fighting essential fatty acids and contains all 8 essential amino acids); fuel (mixed with 15% methanol for fuel 70% cleaner than petroleum diesel); and paints and varnishes. The seed cake contains 25% protein and can be used as a supplement to wheat flour. The whole seeds can be eaten (20% high-quality digestible complete protein) by humans and used for bird seed. However, due to the high content of polyunsaturated oils, hemp seed oil is fairly unstable and becomes rancid rather quickly unless preserved.

Despite the quality of hempseed oil, average oil yields (kg/ha) are lower than for any other major oilseed crop, with the exception of cottonseed (which is a dual purpose crop in that the seed is almost a by-product).

A group of German researchers has also developed a laundry detergent and an industrial cleaner produced from hemp oil and yeast. Various sources have reported 20-25,000 different uses for industrial hemp fiber, oil and seeds. Not to be deprecating, figures such as these can be easily exaggerated or matched by other products (for example, corn).

Constraints to Processing

Industrial hemp fibers cannot be easily separated into fibers of consistent quality without specialized machinery. Pulping hemp fibers can use either traditional mechanical or chemical pulping techniques or a combination of both. The latest Dutch research shows that a chemi-mechanical pulping process may prove to be the most cost-effective for hemp pulp. The Germans have introduced other innovative methods of fiber separation using steam explosion and ultrasonic waves.

According to the Dutch Institute for Agrotechnological Endeavors, the average hemp pulp and paper mill produces about 5,000 tons per year, compared to a minimum of 250,000 tons for a wood fiber pulp mill. There is some evidence that the higher fixed costs of the hemp mill necessitates higher prices received for hemp paper products, such as specialty papers (including cigarette paper, coffee filters, and insulating and grease proof papers).

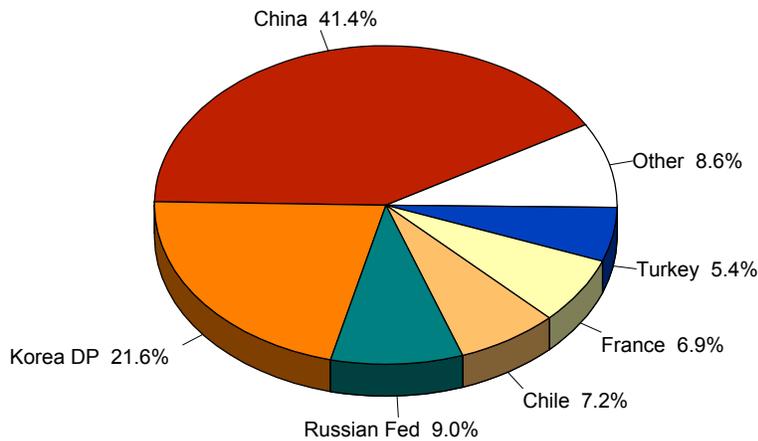
VI. WORLD SITUATION

World Production

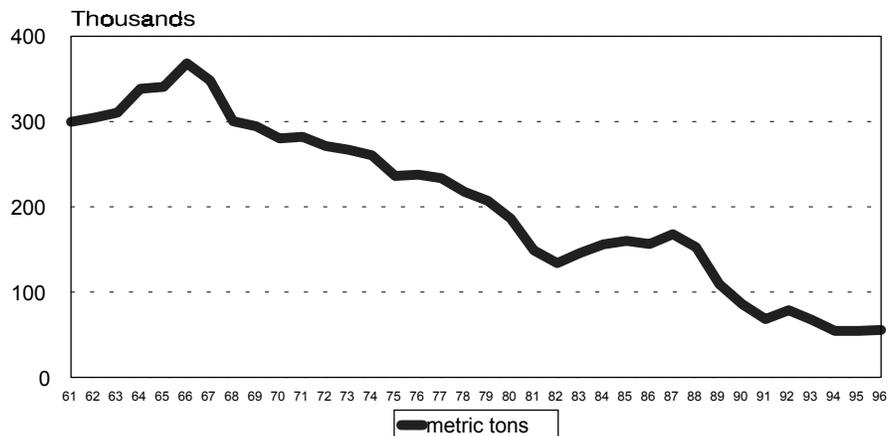
In 1996, world hemp fiber production was about 55,600 metric tons, with China, South Korea and the Russian Federation as the lead producers (none of these countries has ever made industrial hemp cultivation illegal). These three countries produce more than 70% of total world supply. China, Russia, Ukraine, Romania and the European Union all subsidize hemp production. Although more publicity has been given to revitalized hemp production in the European Union and Canada, these countries remain negligible producers.

Notably, world hemp production has been on the decline, falling from over 300,000 metric tons in the early 1960's to one-fifth that level today. Although some have argued that there has been a resurgence in interest in industrial hemp (due to the growing world demand for natural fibers, the drop in flax prices and the adoption of more advanced cultivation and processing techniques) production statistics do not bear that out as of yet.

World Market Share: Hemp Fibre and Tow Production (1996)



World Hemp Fibre and Tow Production



The European Union subsidizes the cultivation of renewable crops (such as hemp and kenaf) primarily for research purposes. Industrial hemp production has been subsidized in the European Union since at least 1988 and is cultivated on over 24,000 acres in France, Spain, Austria, the Netherlands and England. Hemp production has been legally grown in France without interruption. Although the European Union offers subsidies to growers, not all EU countries participate due to individual country growing restrictions. The subsidy is equivalent to about US\$100 per ton or about US\$1,022 per ha (\$414 per acre). Currently, French hemp fiber sells for about US\$200 per ton, including the subsidy. Growers must obtain permits and crops are subject to inspection and, as noted previously, the THC content of hemp grown in the European Union cannot exceed 0.3%. These subsidies keep hemp prices artificially high in the EU and are expected to be phased out beginning this crop year.

Since 1982, all cultivation of hemp had been outlawed in West Germany, with the exception of the use of hemp as a pollen insulator in the commercial breeding of beets (supposedly no other plant provides such an impermeable barrier to outside pollination). However, due to significant pressure from farmers, Germany lifted the ban on growing low-THC hemp in late 1995. A large hemp contractor in the United Kingdom also receives a government grant as part of an effort to stimulate rural labor employment. Hemcore, a large private company in Britain, has contracted for 1600 hectares (their fourth crop) last year. Switzerland also permits hemp cultivation with some restrictions.

In addition to the production subsidies given to European Union producers, the Romanian government also subsidizes 50% of the cost of hemp planting seeds. US private investment already exists in the Hungarian hemp processing industry.

In Poland, a small amount of industrial hemp is being grown commercially and more is planned for cellulose production. Current research there has shown the advantages that hemp has in reclaiming soil that has been contaminated with heavy metals. Industrial hemp does not appear to be affected under such growing conditions.

Hemp production in the Ukraine has fallen by over 150,000 ha since the 1950's and was about 2000 ha in 1996. The Institute of Bast Crops has been researching hemp genetics and agronomics for over 60 years and currently maintains about 300 varieties.

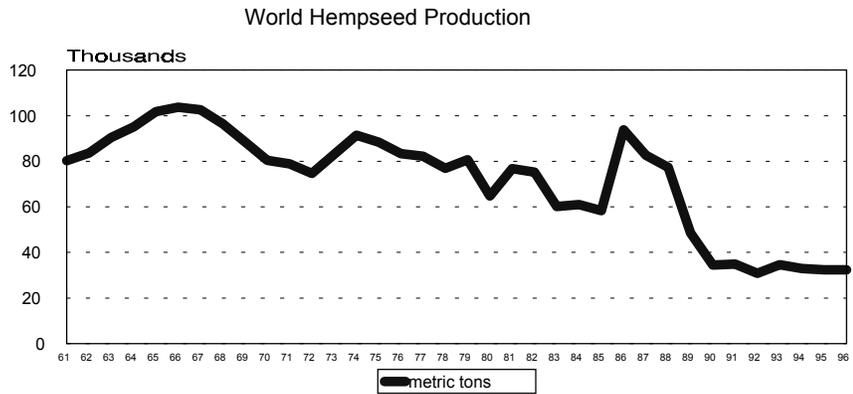
Although hemp production remains illegal in Australia, field trials did begin last year under strict licensing requirements. Similar conditions exist in South Wales and Tasmania. Interestingly, opium poppies are cultivated in Tasmania, so the infrastructure already exists to monitor the production of governmentally regulated crops (possibly paving the way for industrial hemp production).

In 1994 Canada produced its first hemp crop after 50 years of prohibition. Industrial hemp (less than 0.3% THC) can be grown in Canada, under licence from the Minister of Health and only for research purposes. In addition to providing a detailed research plan, no parts of the plants can be

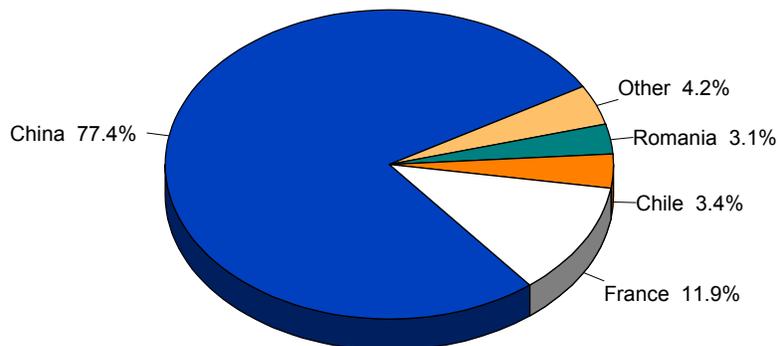
sold and monitoring expenses must be paid by the farmers. In 1995, seven groups were granted licenses, including efforts between private industry, the government and academia. Bill C8 has recently made hemp fibre and stalks legal and commercial production is expected in spring 1998.

Historically, US hemp production virtually stopped at the end of the 19th century due to foreign competition (particularly from Manila hemp, which is not cannabis) and the demise of sailing ships (which utilized hemp for rope and sailcloth). Perhaps the final death knell for US hemp production was the 1937 Marijuana Tax Act which levied a transfer tax of \$1.00 per ounce on all hemp transactions. Production restrictions were eased during World War II after supplies of Manila hemp from the Philippines were cut-off. Production languished until the 1950s, when once again hemp production was outlawed. Currently, it is illegal to produce any variety of cannabis sativa L. In the US except under certain permitted scientific conditions (discussed later).

World hempseed production, for both oil and for seedstock, has fallen by half since the early 1960s and appears to have stabilized at around 33,000 metric tons per year. China was responsible for the production surge in the mid-1980s and has dominated this market for years, with over 75% world market share. France (which dominates low-THC seedstock production), is also a significant producer of hempseed.



World Market Share: Hempseed Production (1996)

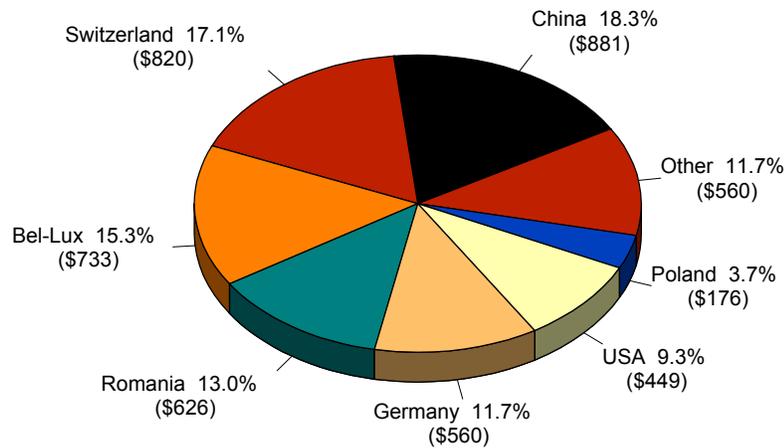


World Trade

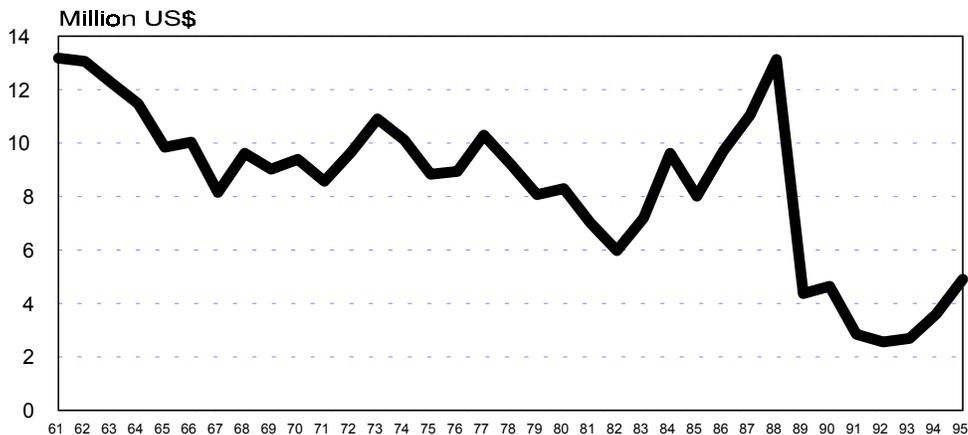
The principal suppliers of hemp to the world include China (where hemp cultivation has never been illegal and labor costs are low for both harvesting and processing) and Europe (primarily Switzerland, Belgium-Luxembourg, Romania and Germany). Similar to production trends, world hemp exports have declined over the years, falling from over US\$12 mil in the early 1960s to slightly less than US\$5 mil in 1996 (after accounting for inflation, a very large drop in real terms). (The surge in world hemp fiber exports during the mid-1980s was due to tremendous export increases from the USSR.) The last three years have demonstrated some global export growth potential.

The US exported around \$100,000 of hemp fibre on average for each of the last five years. Given that industrial hemp production is essentially banned in the US, this must be re-exports. In 1995, the US exported about \$452,000 of hemp fibre and tow, of which \$250,000 went to Japan that year and thus far is an anomaly.

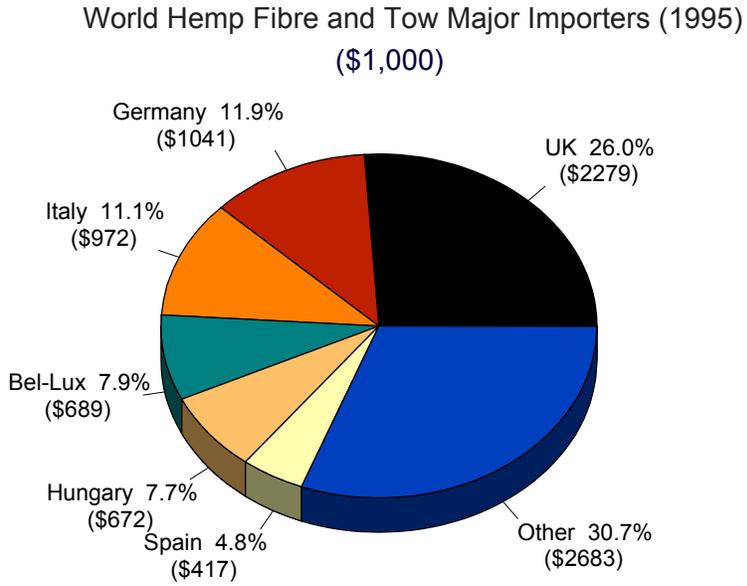
World Hemp Fibre and Tow Major Exporters (1995)
(\$1,000)



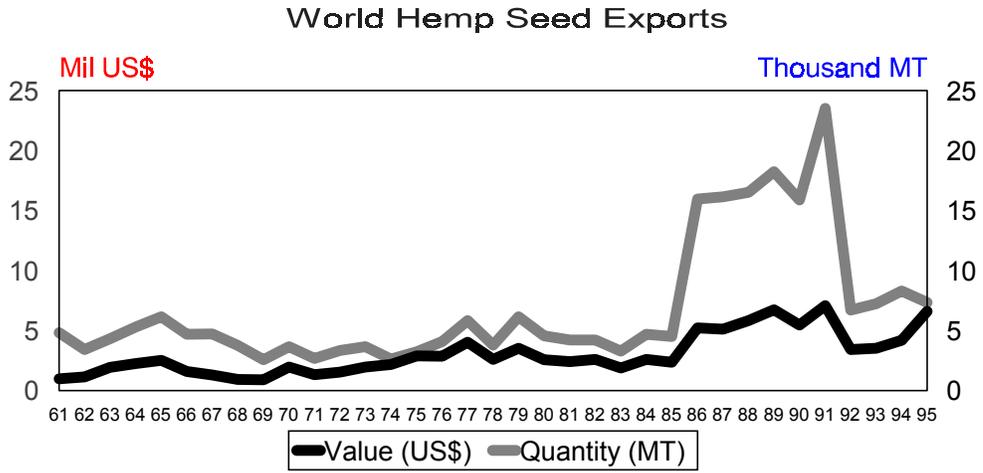
World Hemp Fibre and Tow Exports



On the import side, major world buyers include the United Kingdom, Germany, Italy and Belgium-Luxembourg. Given the growth in the hemp processing industry, the members of the EU (with a 70% world import market share), appear to be importing raw hemp from Eastern Europe and the FSU for further processing in western Europe. (Note: Unlike exports, import statistics are measured using CIF (cost of the goods, insurance and freight) values of the product when it arrives at the port of entry. Thus, transportation costs can be a significant portion of import values, particularly for bulky products.)



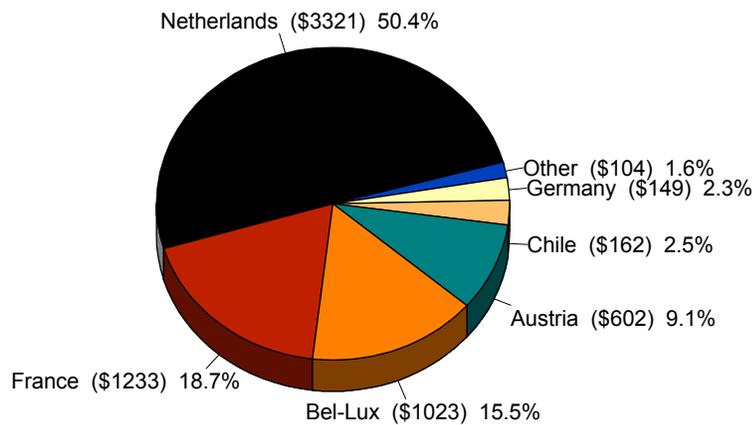
The world hempseed market has been somewhat volatile over the last ten years, particularly in the late 1980s as world exports surged in quantity and (to a lesser extent) value. Significantly, as world production swelled in 1986 (again, due to production in China), export volume increased and prices per metric ton fell dramatically. As world export prices dropped from about 56 cents/kg to 34 cents/kg, it wasn't until 1989 that production fell significantly (assumedly in response to lower world prices), followed by a fall in world exports in 1992 (as can be seen below).



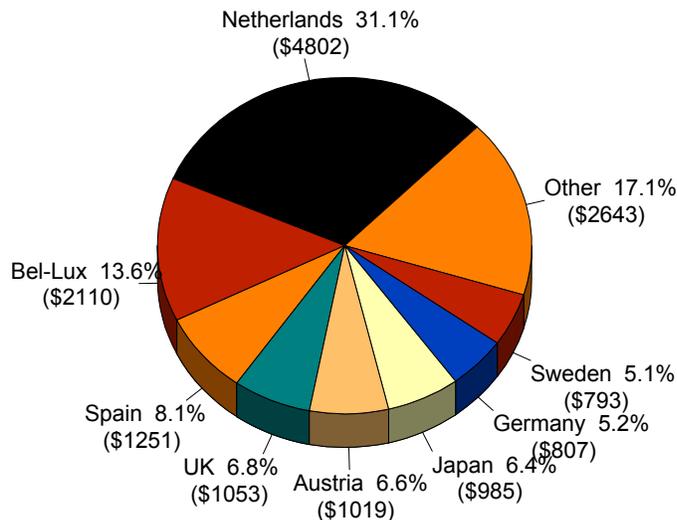
In 1995, world hempseed exports totaled 7,345 metric tons (worth \$6.6 mil). This compares with over 43 million metric tons of total oilseed trade last year, which is dominated by soybean, palm, rape and sunflower seed.

Major world hempseed exporters include the European Union (in particular the Netherlands, with a 50% market share, France, Belgium-Luxembourg and Austria) and Chile. As noted earlier, France is the primary supplier of low-THC industrial hempseed varieties to the world market. Importers also include the European Union (again, the Netherlands with dominant market share). While hemp production in the Netherlands is negligible, the Dutch have long been renowned for their role in global trade and logistics management, thus their dominant position in hempseed trade.

World Hemp Seed Major Exporters (1995)
(\$1,000)



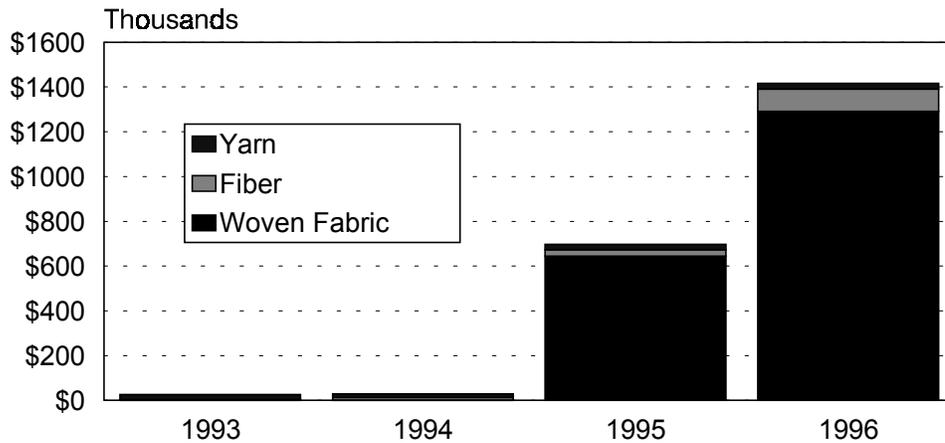
World Hemp Seed Major Importers (1995)
(\$1,000)



US Imports

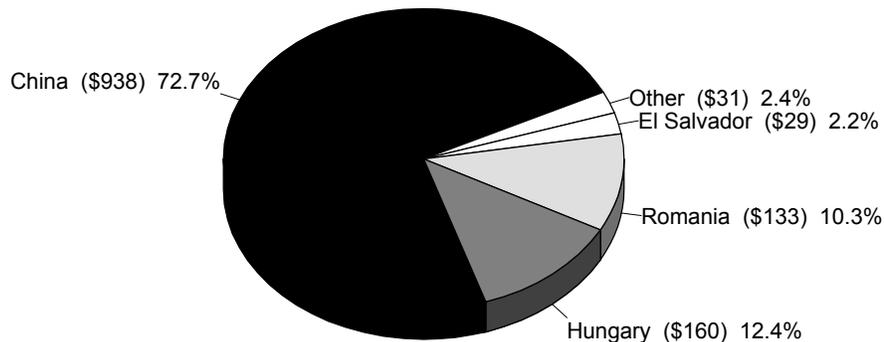
It is legal to import industrial hemp into the United States. In general, US hemp imports have grown significantly in percentage terms over the last few years, but remain negligible in absolute value. In 1996, the US imported a total of \$1.4 mil in hemp and hemp products, including woven fabrics made of hemp (\$1.29 mil); raw or processed hemp (\$100,000); and yarn (\$25,000). (All US trade statistics are reported at customs value.) In 1993 and 1994, woven hemp imports were non-existent (or, the hemp content was minimal). Importantly, the world UN/FAO data previously discussed does not include woven fabrics; but instead focuses on raw and semi-processed fiber and seed. For this discussion, we will also examine US hemp fabric imports.

US Industrial Hemp Imports (1993-96)



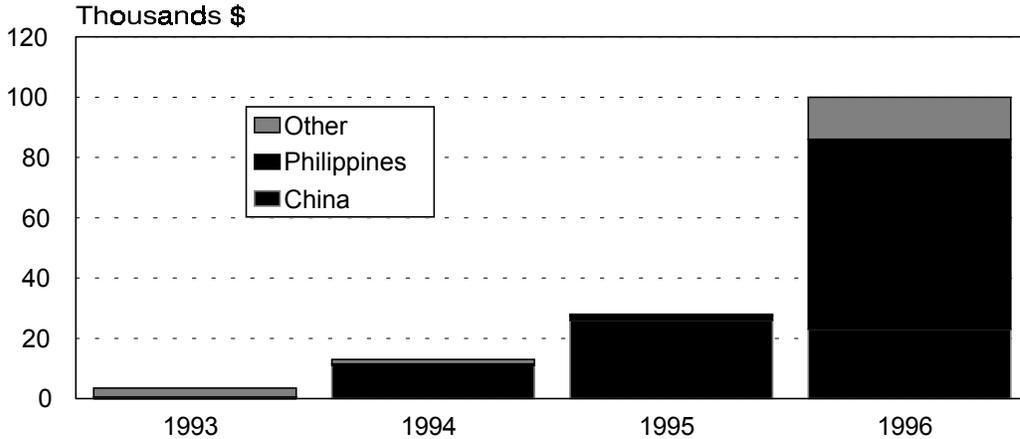
Almost three-fourths of all US imported hemp fabric in 1996 came from China, with Romania and Hungary also significant suppliers. Many woven hemp products imported into the US (such as hats, clothing and shoes) are actually a blend of many fibers including flax, cotton and linen. The recent increase in woven hemp imports reflects a current fad by US (particularly young) consumers. Although US hemp fabric imports have grown significantly larger in percentage terms, they are still very small in absolute value.

Woven Fabrics of Other Vegetable Textile Fibers: True Hemp
1996 US Import Market Share (\$1,000)



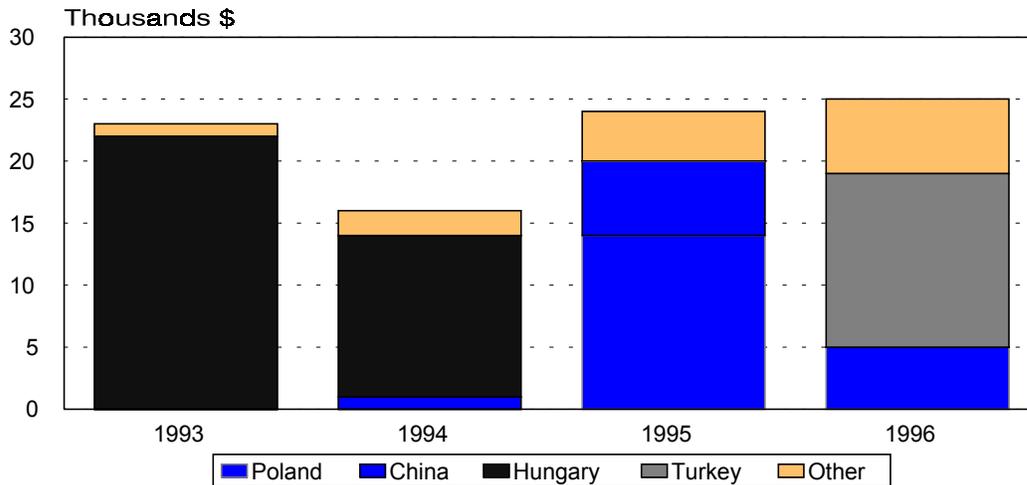
China and the Philippines are the largest suppliers of raw or processed hemp (not spun) to the US, with over 80% of the market. Other players include Belgium, Switzerland and other parts of the European Union. Although US raw hemp imports are small they have grown significantly percentage-wise over the past few years, reaching \$100,000 last year.

**True Hemp, Raw or Processed But Not Spun
US Imports 1993-1996**



Annual US hemp yarn imports have averaged \$22,000 the last four years. Major suppliers include Poland, China, Hungary and parts of the European Union. (In the last few years, raw Hungarian hemp supplies may have been diverted to the EU for processing, before being re-exported to the US.)

**Yarn of other Vegetable Textile Fibers:
True Hemp: US Imports 1993-1996**



Small amounts of hempseed and oil are imported into the US, but these amounts are lumped together with other minor seed sources and are not reported separately.

VII. POLITICAL ENVIRONMENT

International

Current domestic US law does not distinguish between industrial hemp and marijuana, although this could be construed as inconsistent with US international policy. International treaties signed by the US state that hemp with less than 0.3% THC shall be considered industrial hemp and not marijuana. Further Article 28: Control of Cannabis, of the Single Convention on Narcotic Drugs (1961) under the United Nations (signed by the US) states that “This Convention shall not apply to the cultivation of the cannabis plant exclusively for industrial purposes (fibre and seed) of horticultural purposes.

Both NAFTA and GATT trade agreements recognize hemp as a “valid agricultural crop”. With the exception of the US, all members of the G7 permit industrial hemp cultivation.

United States

State Efforts

Several US state legislatures debated hemp bills last year, proposing legislation to permit industrial hemp to be grown for research purposes. Given that this year is a non-election year, some hemp proponents are optimistic for more success at the state level. Political activity regarding industrial hemp production in Kentucky will be discussed subsequently.

Vermont passed legislation in 1996 permitting the analysis of market economic conditions affecting the development of an industrial hemp industry in Vermont and the analysis of agronomic conditions required for hemp production. But, Vermont stopped short of legalizing the cultivation of industrial hemp for experimental purposes. After passing both the House (by a margin of 108 to 33) and the Senate, the Governor chose to ignore the bill and by default it passed into law. The University of Vermont also conducted a survey of consumer attitudes towards hemp production and hemp products, but poor survey design renders the findings questionable.

Supporters in Colorado have been some of the most vigorous in promoting industrial hemp production. Hemp production has been endorsed by the Colorado Farm Bureau and the University of Colorado is exploring the possibility of industrial hemp production research. Several companies (such as International Paper, Masonite and Inland Container Corporation) have expressed interest in hemp as an alternative fiber source. The state also has an active grassroots support group, the Colorado Hemp Initiative Project (CO-HIP), which supports a web site with extensive hemp information. Despite three years of proposed legislation, Colorado pro-hemp supporters have yet to succeed.

In the spring of 1996, the Industrial Hemp Production Act was introduced into the Colorado state

legislature, which would allow for the regulated cultivation of industrial (low-THC) hemp by Colorado farmers. In 1996, production would be limited to 40 acres for agricultural, commercial and scientific research, with that amount increasing in subsequent years. Despite wide-spread support, the legislation failed. After passing the Colorado Senate by a margin of 18 to 15, the bill failed in the House of Representatives after heavy lobbying by 12 state and federal police agencies including the Drug Enforcement Agency.

Hawaii has recently passed a resolution to look into the viability of hemp as an economic crop and both Missouri and North Dakota are debating similar legislation.

The Navajo Indian Reservation worked with the Coalition for Hemp Awareness to coordinate the first planting of an industrial hemp crop on their reservation in northern Arizona. Last spring, a Justice of the Peace for the Arizona State Court of Appeals and the president of the Wide Ruins Community Chapter, planted 80 pounds of seeds on 2 hectares. Although current tribal law bans THC, the nation's full tribal council met last July to ascertain whether tribal law should be modified to permit the cultivation of industrial hemp. This is a very interesting case in that Indian nations are semi-sovereign in the US.

USDA White Paper

In 1995 the US Department of Agriculture released a 3.5 page white paper *Industrial Hemp and Other Alternatives for Small-Scale Tobacco Producers*, jointly produced by the Agricultural Research Service and Economic Research Service for the Under Secretary for Research, Education and Economics. The paper acknowledges that there are few alternative crops that can provide high returns comparable to tobacco. The paper also notes that European research has not established the profitability of commercial industrial hemp production, but acknowledges that “few estimates are available for modern production and processing costs and the market potential is uncertain”.

The paper indicates several constraints to industrial hemp production in the US:

- Crop and fiber yields must increase to bring down costs
- Research is needed to develop modern hemp fiber harvesting and processing methods
- Uses for co-products need to be found to make processing operations profitable
- “Any effort to legalize hemp production for paper or specialty textiles could encounter stiff Congressional and Administration opposition.”
- All hemp production is strictly regulated and “DEA’s interpretation of these matters discourages any attempt to conduct field trails at a reasonable cost...it would be virtually impossible to collect useful, realistic agronomic or economic information about hemp production”.
- Unless economic viability is proven, “hemp fabrics and paper uses will likely remain a very small niche market which is satisfied by imports”.

(An interesting side note: In 1994, USDA permitted 16,000 hemp plants be grown for research purposes in southern California on USDA land. Four months later USDA rescinded and ordered the crop seized and be plowed under by California law enforcement officials.)

American Farm Bureau

In January 1996, at their annual convention, the American Farm Bureau unanimously passed a resolution which read:

“We recommend that American Farm Bureau Federation encourage research into the viability and economic potential of industrial hemp production in the United States. *We further recommend that such research includes planting test plots in the United States using modern agricultural techniques.*”

However, during their annual meeting in January 1997, AFB struck the text in italics which recommended test plots. Research into industrial hemp production has also been endorsed by the Kentucky Farm Bureau and the Colorado Farm Bureau. It was thought by many hemp proponents that this endorsement would assist state efforts in legalizing research efforts and add credibility to the industrial hemp movement. It is not clear what, if any, impact these resolutions have had, thus far.

Drug Enforcement Agency

The DEA is adamantly opposed to industrial hemp production for the following reasons:

- It is too difficult to distinguish “legitimate” industrial hemp from illicit cannabis with higher narcotic concentration.
- It has been suggested that industrial hemp advocates have a hidden agenda of favoring the legalization of marijuana.

Cannabis sativa L. (including cannabis indica) is classified as a schedule 1. Controlled Substance (regardless of it’s narcotic or THC content) and all hemp production in the US is strictly regulated (as vested in the Attorney General and carried out by DEA). Permits to grow cannabis are restricted to researchers and police analytical laboratories and permit holders must maintain strict security requirements (including complete fencing, 24-hour guards, an alarm system and limited, controlled access) and detailed records concerning stored or cultivated cannabis.

The University of Mississippi has been under contract for several years to maintain industrial hemp and marijuana test plots for the US government.

Kentucky

Governor's Task Force on Hemp and Related Fibers

In 1994, then-Governor Brereton Jones appointed a task force to look into the viability of industrial hemp as a cash crop. The task force, comprised of government officials (including the Kentucky Department of Agriculture and the Drug Enforcement Agency), university representatives, Kentucky Farm Bureau and private farmers, disbanded after two meetings.

Findings of the Task Force include:

- Most analysts predict long-term growth in world demand for fibrous materials.
- Although Kentucky has a history of hemp production, this advantage has diminished. For hemp to become a large scale crop, significant research must be done in varietal selection, crop management practices, harvesting technology and other agronomic aspects.
- Significant investment is needed for research and development of harvesting and processing technology.
- The current market for hemp is limited to specialty uses, although paper applications and use as building materials could create a “very large but relatively low value market. Crop prices above \$60/ton would probably be required to interest most producers; this price might preclude extensive competition in this market.”
- Legal issues remain the greatest obstacle to industrial hemp production, both at the state and at the federal level. Further progress on agronomic research, infrastructure needs and marketing is moot until the legal issues are resolved.

The Final Report also included some price and profitability projections for hemp as compared with other crops. This information is included in a subsequent section of this report.

Kentucky Attitudinal Survey

In Spring 1995, the Kentucky Hemp Growers Cooperative Association, Inc. contracted with the University of Kentucky Survey Research Center to conduct a survey of Kentucky residents' current opinions towards industrial hemp in general and their position regarding possible legislation to license Kentucky farmers to grow hemp as a cash crop.

Over three-fourths (77%) of the respondents favored legislation to license Kentucky farmers to grow industrial hemp as a cash crop. In terms of a profile of those who support such legislation, only three characteristics were statistically significant: 1) Those who understand the difference between industrial hemp and marijuana; 2) Those who feel positive about the condition of Kentucky's economy; and 3) Men slightly favored the suggested legislation over women (80% to 74%). Interestingly, other factors such as religious preference, education, race, income, and political identity were not statistically significant as to whether a respondent supported such legislation or not. The survey center also suggested that an educational program would be

necessary to inform all citizens of the difference between industrial hemp and narcotic varieties, to support such legislation if it were actually proposed.

A similar survey conducted in Vermont in May of 1996 by the Center for Rural Studies, University of Vermont, had very similar findings. Of those surveyed, 77% of Vermonters support changing laws so that farmers can grow hemp. As noted previously, other findings from this survey are somewhat suspect.

Lexington Herald-Leader

The Lexington-Herald Leader has followed the hemp “debate” fairly closely. In an editorial dated April 15, 1996, the LH-L encouraged Governor Patton “to resurrect the Hemp and Related Fibers Task Force, name members who have at least some vision of the future and open minds to new crop development, and ask them to report to him before the 1998 legislature convenes”.

Louisville Courier-Journal

In an editorial dated July 11, 1996, The Louisville Courier-Journal editorial board nominated “researchers at the University of Kentucky’s College of Agriculture to take logical steps that the task force should have suggested: Find varieties of hemp that would thrive here. Determine what the crop yield would be. Poll the fiber industry to see whether the companies would be willing to buy hemp. Gather hard statistics on the sale of hemp elsewhere in the world.”

First Annual Industrial Hemp Conference

The conference, an invitation-only affair, was held in Lexington, KY on May 31, 1996 and attracted about 120 people, including hemp growers and processors from seven countries. Speakers addressed a variety of cultivation, processing and legal issues surrounding industrial hemp. (The designation “First” has been debated.)

Kentucky Proposed Legislation

Kentucky State Senator Metcalf has proposed legislation that would require the University of Kentucky to conduct agronomic and marketing research into industrial hemp. This legislation has not gone to the House Agriculture committee as of yet.

VIII. Costs of Production and Price Data

Industrial hemp production must be profitable from an economic standpoint, regardless of the political environment, to truly be a viable alternative crop. Hemp must compete with other agricultural crops and with other fiber and oil substitutes (such as wood, cotton, flax, and other seed oils). There exists some fairly good production cost data for other countries, but less than complete profit data. Given that the US lacks both adequate production test sites and a commercial processing market, other country’s experiences become germane. This leads to a

certain degree of variability in both cost and profit estimates. It is reasonable to assert that production costs should be approximately similar across geographic regions (given the minimal agronomic conditions and chemical applications that are required). However, the lack of processing facilities and other infrastructure necessary for a viable commercial hemp market in the US makes demand and profit projections extremely speculative.

Factors such as the availability of government production and processing subsidies; the relative profitability of other production alternatives; the costs of transportation to processing centers; and legal constraints may be more influential in determining production location advantage. US producers are at a disadvantage in each of these areas. Currently, hemp growers must compete with substantial production subsidies in the European Union (approximately half the value of the crop) and in parts of Eastern Europe. Labor costs for both harvesting and processing are significantly lower in many regions outside of the US. Harvested hemp is very bulky and minimizing transport distance between processing centers (at least first stage) is advantageous. If growing licenses or permits are required, there may be additional costs associated with production and/or processing. Security and THC-testing costs must also be acknowledged. Hempseed crushing facilities and oil producing equipment are rare. Many have suggested that significant amounts of investment is required (for example, by some of the large paper companies) to upgrade the harvesting and processing technology to truly revitalize not only the US hemp market but the world market as well.

Despite these caveats, production costs estimates and world price data are presented below as a starting point to evaluate the economic feasibility of producing industrial hemp in the US.

Production Cost Estimates

Production cost estimates vary considerably depending on a complex array of factors: producing seed and/or fiber; seed cost; seed varietal selection and yield estimates; transportation costs and access to processing facilities; and licensing and/or security costs. A researcher in Canada has estimated break-even prices for industrial hemp fiber and seed production and the following section relies heavily on his work (D. Marcus).

The choice of raising industrial hemp for seed and/or for fiber impacts seed varietal selection, planting density, and yield. Certified seed, the most expensive production cost item, imported into Canada costs about US\$1971 per ton, of which roughly half is transportation costs from Europe (viable seeds are not currently available in Canada or the US and most certified seed containing 0.3%THC or less comes from France). It is reasonable to assume that this cost estimate would also apply to US producers. Further, since no varieties have been specifically adapted to North American production, yields may be slightly less than average, particularly during early years of commercial production.

The following chart indicates break-even prices for hemp fiber production, covering all costs of production (fixed and variable).

Price Required for Farm Gate Break-Even: Hemp Fiber (whole stalk) (for various expected yields per acre)				
	2.5 t/ac	3 t/ac	3.5 t/ac	4 t/ac
Seeding rate @55 kg/ha	\$78.28 /ton	\$65.23 /ton	\$55.91 /ton	\$48.91 /ton
Seeding rate @70 kg/ha	\$83.21 /ton	\$69.34 /ton	\$59.44 /ton	\$52.01 /ton

Note: Prices are in US\$ per ton and are break-even at the farm gate (thus, do not include any transportation costs). Yields estimates vary due to ranges in dry mass yield per acre and bast fiber yield per ton. After a few years of cultivation experience and the development of seed varieties adapted for North America, yields may increase. Licensing fees and security costs such as fencing, additional recording keeping and THC-level testing fees are not included.

Production cost estimates for industrial hempseed production were similarly calculated:

Price Required for Farm Gate Break-Even: Hemp Seed (US\$/bu) (for various expected yields per acre)			
	14.3 bu/ac	19 bu/ac	23.8 bu/ac
Seeding rate @15 kg/ha	\$12.21 /bu	\$9.19 /bu	\$7.35 /bu

Note: All prices are in US\$ per bushel and are break-even at the farm gate (thus, do not include any transportation costs). Yields estimates vary due to ranges in seed yields as well as oil content. Jeyasingam reports average yields of 19.24 bu/ac. After a few years of cultivation experience and the development of seed varieties for North America, yields may increase. Licensing fees and security costs such as fencing, additional recording keeping and THC-level testing costs are not included.

Break-even prices have also been calculated for the simultaneous production of both hempseed and fiber. Marcus asserts that this production choice is essential: “If hemp were grown only for seed OR whole stalk, it would likely generate negative returns even in best case scenarios.” This is refuted by some agronomists who claim that varieties that are designed for optimal fiber production are not the same as those bred for their oil producing capacity and quality; production of both seed and fiber from the same plant results in inferior production of each. Consequently, economic and agronomic production decisions may not meet the same objectives.

Assuming the following range of prices received for hempseed (using comparables from flaxseed and canola), break-even prices are given below for “leftover” stalk assuming varying seed and stalk yields:

Break-Even Price for Stalk When Growing Seed and Fiber (US\$/ton)				
Price/bushel (for hempseed)	Low/Low: 14.3bu/2.5t	Low/Med: 14.3bu/3.0t	Med/Low: 19bu/2.5t	Med/Med: 19bu/3.0t
\$3.67	\$48.82/t	\$40.68/t	\$41.91/t	\$34.93/t
\$4.41	\$44.62/t	\$37.18/t	\$36.32/t	\$30.27/t
\$5.15	\$40.41/t	\$33.68/t	\$30.74/t	\$25.61/t
\$5.88	\$36.21/t	\$30.17/t	\$25.15/t	\$20.96/t

Note: All prices are in US\$ per ton. Yields reflect bushels (seed) and tons (bast fiber). Given that the assumed market price for hempseed is below the break-even price noted in the table above, additional stalk revenue is required to reach the break-even point. It may also be difficult to reach these yields given that the planting density for growing fiber (55-70 kg/ha) is significantly greater than the density needed for seed production (15 kg/ha). Also, differences in quality in both oil and fiber must be compensated for through price.

Gordon Reichert, of the Market Analysis Division of Agriculture & Agri-Food Canada, also claims hempseed runs about CN\$2,700/ton (US\$1971/ton) and fertilizer costs are comparable to spring wheat (\$35-40/ac, with generally no pesticides or herbicides required). He further notes that half the cost of importing certified seed is transportation costs from Europe. The existence of a certified hempseed industry in North America would significantly alter this scenario.

Australian farmers estimate that it costs US\$240/ton to grow and harvest hemp, including irrigation and storage costs. The following section looks more closely at market prices, to follow the link to purported profitability.

World Prices

Several people have attempted to calculate the market price for various hemp products (such as bast fibers for textiles and paper, oils, biomass, building materials and so forth) as an indicator of profitability for hemp farmers. It is this authors contention that such information is faulty since:

- Price information becomes anecdotal, and heavily relies on local processing and buying conditions.
- Farmers will most likely be raw commodity suppliers and wholesale and retail prices are more a function of processing costs and not raw commodity procurement costs.
- The US hemp processing market is currently non-existent. Short-term production decisions must be made on the basis of world prices for raw products.

Thus, this paper only discusses world prices for raw hemp fiber and seed. The average price of

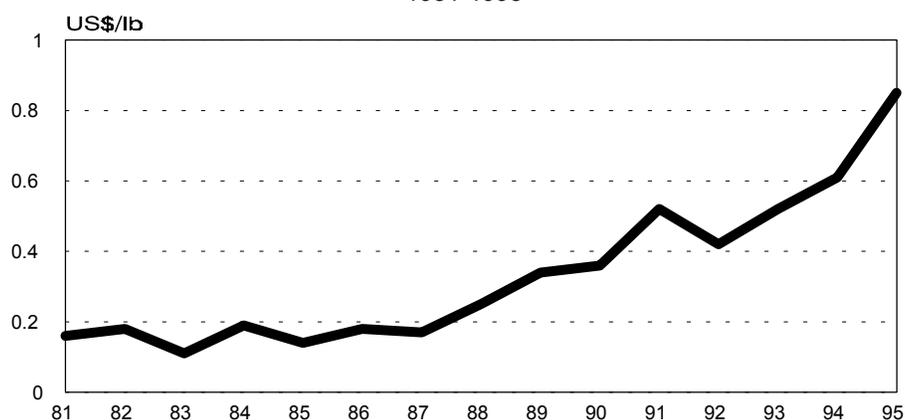
hemp fiber and tow (the by-products of fiber separation) traded on the world market was \$1882/mt or \$1.88/kg in 1995. However, substantial variation exists amongst countries. For the major suppliers, average export prices are as follows:

Average Hemp Fiber and Tow Export Prices (1995, US\$)			
Country	Price/lb	Price/kg	Price/mt
Switzerland	\$8.09	\$17.83	\$17,826
Germany	\$6.87	\$15.14	\$15,135
Italy	\$3.40	\$7.50	\$7,500
Belgium-Luxembourg	\$2.58	\$5.68	\$5,682
China	\$1.58	\$3.48	\$3,482
United States	\$0.67	\$1.49	\$1,487
Poland	\$0.42	\$0.92	\$917
Romania	\$0.32	\$0.70	\$695
Croatia	\$0.15	\$0.33	\$334
Hungary	\$0.07	\$0.15	\$148
World Average	\$0.85	\$1.88	\$1,882

All countries are instructed to supply trade statistics using similar procedures. Prices are FOB (free-on-board), and only include the price of the commodity and transportation costs to move the commodity from the point of production to the point of exit from the country. Reported import prices include insurance and freight, thus are not utilized here. However, the variation in export prices appears to reflect more than just transportation costs to the port and quality differentials. One obvious explanation could be that prices are also reflecting differences in partial processing the hemp fiber has undergone.

Notably, world export prices have grown considerably in the last six years, presumably due to the growth in consumer demand for finished hemp products. Although these export prices do include transportation costs to the point of exit from the country, hemp prices have clearly grown faster than the rate of inflation. It is another question as to whether these prices can be sustained. These higher prices may have spurred the recent growth in hemp fiber exports observed in the first half of the 1990s.

World Hemp Fibre and Tow Export Prices
1981-1995



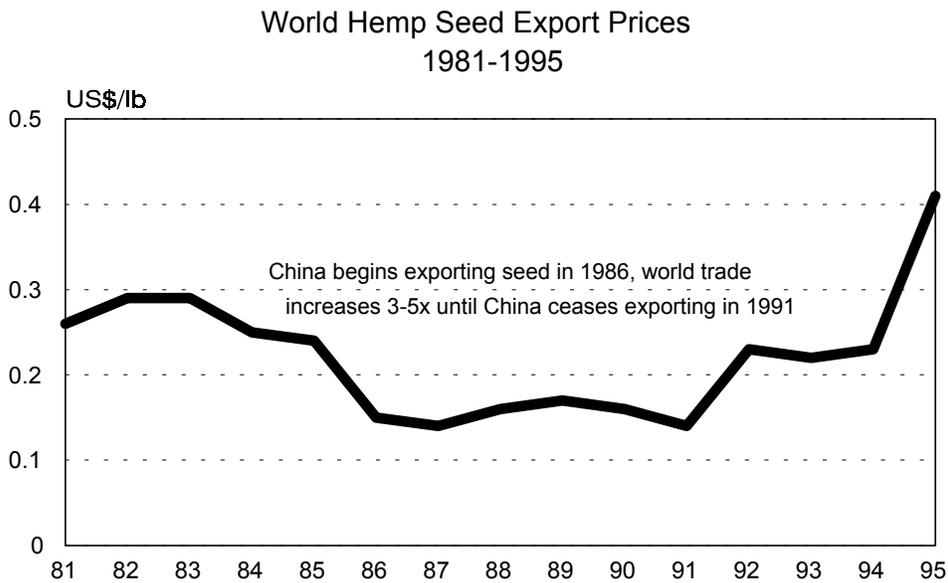
Potential US hemp producers must also compete with imported hemp. The US import price for industrial hemp (processed but not spun, “customs value”) was \$1.75/lb in 1996. Import prices have trended downward somewhat over the last few years: \$4.71/kg or \$4,710/mt in 1994; \$4.26/kg in 1995; and 3.85/kg in 1996. Raw hemp imports averaged \$72 cents/lb in 1996. (Customs values are best to compare with world export prices.)

Using CIF values (which includes the price of the good, shipping costs and insurance to deliver the product to a US port of entry), imported hemp prices averaged \$1.91/lb in 1996 (\$5.07/kg in 1994; \$5.12/kg in 1995; and \$4.20/kg in 1996). (CIF import values are best for evaluating what US farmers would have to compete for the domestic market.)

World hempseed export prices have been somewhat volatile over the last 10 years as discussed earlier. Average prices have ranged from 30 cents/kg in 1991 to 90 cents/kg in 1995. It would be very difficult for many farmers to weather this kind of price fluctuation. Again, much of the downward pressure on price appeared to be a result of excess world production from 1986-1990. This may have important implications for significant increases in world production in the future. Prices per bushel in the following table were converted using an average of 46 pounds of hempseed per bushel.

Average Hemp Seed Export Prices for Major World Suppliers (1995)				
Country	Price/bu	Price/lb	Price/kg	Price/mt
Netherlands	\$16.10	\$0.35	\$0.78	\$783
Belgium-Luxembourg	\$17.02	\$0.37	\$0.81	\$811
France	\$22.08	\$0.48	\$1.05	\$1,046
Germany	\$11.04	\$0.24	\$0.53	\$534
World Average	\$18.86	\$0.41	\$0.90	\$898

The volatility in hemp seed export prices can be seen in the graph below. China entered the world hemp seed market in 1986, tripling world trade and depressing world prices by half. In 1991, China ceased exporting hempseed and prices nearly doubled in 1992. In 1995, world export volume fell by 13%, while seed export prices almost doubled from 23 cts/lb in 1994 to 41 cts/lb last year. It is very possible that the surge in interest in industrial hemp has increased the demand for seed stock for planting purposes, thereby raising export values (rather than an increase in world hempseed demand for crushing purposes.)



In addition to UN/FAO data, other sources have reported observed hemp prices. In an attempt to summarize reported prices, the following table was compiled. Hemp fiber prices are exceedingly difficult to compare, due in large part to the wide-variety of semi-processing that can be done in the field and after. Consequently, yields may vary considerably due to the degree of processing or retting in the field.

Average world price includes some degree of storage, assemblage, transportation and perhaps grading costs to move the raw product from the point of production to the point of exit from the country. Given the bulkiness of hemp fiber, transportation costs are significant and extreme variability persists in country-specific export prices.

Many western European countries do some partial-processing prior to export to minimize transportation costs, hence their higher export values. Prices for EU producers include a government subsidy of approximately US\$100/ton for hemp.

Estimated Hemp Prices and Revenue from Various Sources (US\$)					
Commodity	US\$/unit	Est Yield	Est. Revenue	Notes	Source
Fiber	\$1137 / ton \$1882 /ton			Avg. World Price - '94 '95	8
Whole Stalk	\$49-78 /ton	2.5-4 ton/ac	\$123-312 /ac	break-even price; bast fiber yield	7
Raw Stalk	\$44-55 /ton	2.8-6 ton/ac	\$124-331 /ac	defoliated chopped stalk	6
Whole stalks	\$200 /ton			Air-dry, min. price	1
Fiber Hemp	\$100 /ton	8 tons/ac	\$800/ac		2
Dry Stems	\$125 /ton			16% moist; 1994	4
Raw Fibers	\$566-647 /ton	.36-1 t/ac	\$204-673/ac	textile and cordage	6
Dry Fibers	\$800 /ton	1.1-1.4 t/ac		20% moist; 94/5*	5
Bast Fibers	\$630 /ton			Air-dry, min. price	1
Hurds	\$44-55 /ton	2.8-4.8 t/ac	\$124-265 /ac	pulp and paper; '94	6
Dry Hurds	\$40 /ton	4.2-5.7 t/ac	\$168-228 /ac	20% moist; 94/5*	5
Seed	23 cts/lb 41 cts/lb			Avg. World Price - '94 '95	8
Seed	\$272-331 /ton (12-15 cts/lb)	.16-.38 t/ac (353-838 lbs/ac)	\$44-126 /ac	oil and feed	6
Seed	16-27 cts/lb	658-1095 lbs/ac	\$105-296 /ac	break-even price; seeding 15kg/ac	7
Seed	40 cents/lb	2000 lbs/ac	\$800 /ac	seeding rate 10kg/ac	2
Seed	43 cents/lb	2000 lbs/ac	\$860 /ac		3
Seed(certified)	55 cents/lb	557 lbs/ac	\$306 /ac	French yield and export price	8
Seed(certified)	60 cents/lb	2000 lbs/ac	\$1200/ac	seeding rate 10kg/ac	2

Source:

- 1/ Dutch research (assumed to include \$100 /ton CAP subsidy)
- 2/ Kentucky Hemp Growers Association
- 3/ KY Task Force Marketing Committee

- 4/ Jeyasingam
- 5/ Hemp Textiles International (based on availability and use of an in-field decorticator to separate the bast fibers from the hurds)
- 6/ Agriculture and Agri-Food Canada, Policy Branch
- 7/ D. Marcus (Marcus' break-even price for seed using an average of 46 lbs of hempseed per bu.)
- 8/ Food and Agriculture Organization, United Nations

Despite these yield estimates and the wide-variety of reported price and revenue information, a clear consensus on industrial hemp profitability in the US is difficult to obtain:

- *Cost and yield data is unavailable for US hemp production.* Crop estimates, particularly yield assumptions, may vary according to the stage of legalization. That is, yields in the US may be lower initially until varietal selection, farmer know-how and seedstock quality and availability increase. The development of a domestic hemp seedstock industry (which produced certified seed well-adapted to the US) would significantly reduce production costs and possibly improve yields (although this is not a certainty).
- *The cost of legalization and regulation is difficult to incorporate into the production cost and profit estimates.* None of the estimates above include costs associated with regulation, crop security, and THC-testing (some or all of which may be required).
- *Variations in hemp value-added processing makes direct price comparisons extremely difficult* (eg., price differences for raw stalk versus fiber versus pulp). It is not clear how much value-adding should be done in the field versus at local processing centers.
- *The US lacks any significant hemp processing facilities, leading to low and uncertain prices for raw hemp.* Obviously, potential hemp manufacturers would be hesitant to invest in domestic hemp processing facilities unless a large and reliable supply of local hemp was available. In the near-term, US farmers may have to sell raw fiber and seed on the world market until domestic processing facilities are established.
- *Very little has been done in the way of consumer studies to project hemp sales into the future.* Total wholesale and retail revenues from manufactured hemp products was expected to reach a little over \$20 mil last year. Although this is a large increase percentage-wise, it is not clear if this merely reflects a fad or indicates some longer-term purchasing power. (The \$20 mil estimate seems high to the author, given near non-existent domestic production and processing capacity and imports of less than \$1 mil last year.)
- *It is near impossible to estimate future hemp demand from the paper, wood products, and building industries.* It is important to note that in countries where hemp production is (and in some cases has always been) legal, these sectors have not developed on their own. If these industries are critically examining alternative sources, they do not appear to be

putting “much stock” into hemp as measured by their investment dollars. Of course, relative prices, thus profitability, frequently changes over time. Industrial hemp could become increasingly attractive to companies as a renewable resource in the future.

- *The hempseed market is less clearly defined in terms of end-uses and relative profitability compared to other oilseed crops.* Again, the US does not have any oil crushing facilities designed for hempseed, although current facilities could be altered if the demand warranted such investment. The relative costs of hempseed oil has not encouraged the development of very many other specially-adapted crushing facilities around the world.
- *Price uncertainty and variability increase in thin markets where the volume of trading is relatively low (particularly in relationship to substitutes).* As noted earlier, the world market for hemp fiber and seed has continued to contract and is relatively small in absolute terms. Direct contracting may be an attractive alternative to guarantee both price and quantity for both parties.
- *How much of a production increase can the market bear, without significantly depressing world prices?* Perhaps the greatest area of price uncertainty is the effect that legalization of industrial hemp production in the US would have on prices. That is, what would happen to hemp prices if, for example, hemp production *was* legalized in the US? One angle to approach this question is to look at the impact of Chinese production on world prices. China is the largest producer of hempseed (with over 70% of world production), and one of the largest hemp fiber producers (sharing that role with India in recent years). In 1984-86, China doubled her hempseed production. For the next six years, world prices averaged \$334/mt, compared with \$564/mt over the previous 6 year period. Although less dramatic, similar world price impacts were felt in the hemp fiber market during this same time period.

The current US hemp import market is a little more than \$1 mil and three-fourths of that is value-added hemp products. Despite the current fad for products made from hemp, legalized hemp production in the US would very likely depress US hemp prices, particularly in the short-run, and may even have a dampening effect on world prices, given the current state of world hemp processing technology and capacity. The slight upturn in world prices last year may be signaling excess demand or room for production expansion. This is viewed by some as the classic chicken and egg argument of the need for a cheap reliable supply of raw material before a processing industry is developed and vice-versa.

Any price, thus profit projections, for future industrial hemp production must take into account the effect of changes in both production and demand on world prices.

Profitability of Hemp Versus Other Crops

There have been some attempts to calculate the profitability of hemp versus other crops. It is not surprising that those entities that strongly favor legalization of industrial hemp production have,

in general, the most favorable profit margins and multipliers effects. The following table is from Marcus' research. Although these estimates were for Canada, they should reflect similar conditions in the US:

Expected Profitability of Hemp for Seed and Stalk vs. Other Crops (US\$)						
	Canola (Ontario)	Grain Corn*	Spring Wheat*	Low P/Y Hemp	Average Hemp	High P/Y Hemp
Avg Yield (bu/ac)	33	109 (105)	41 (40)	14.3bu/ac; +2.5 t/ac	19bu/ac; +2.75 t/ac	23.8bu/ac; +3 t/ac
Avg Price (\$/bu)	\$4.63	\$2.10 (\$2.44)	\$2.64 (\$3.82)	\$5.51/bu; \$40.44/t	\$6.16/bu; \$45.96/t	\$6.80/bu; \$51.47/t
Total Revenue	152.21	229.22 (256.20)	108.23 (152.80)	179.96	248.13	316.29
Total Costs	122.46	204.26 (145+80)	103.23 (110+65)	174.63	174.63	174.63
Return (\$/ac)	30.40	24.96 (136-56)	5.00 (60-39)	5.33	73.49	141.65

* The numbers in parentheses reflect expected profitability estimates for grain corn and soft red winter wheat production in Kentucky (all other estimates are from Marcus' Canadian research). Average prices reflect the 1990-95 marketing years. Total costs reflect cash costs and land costs (for example, total cash costs of grain production are \$145 per acre; land costs are \$80 per acre). (It is assumed that the Canadian estimates include land costs, given that it is a component of fixed costs, although land costs were not specifically mentioned.) Returns per acre reflect the difference between including land costs or not and a US government deficiency payment of \$25/ac for corn and \$17/ac for wheat. Deficiency payments are subject to change in the future.

Again, profitability estimates do not take into account licensing or growing fees and costs of providing security for the crop (all of which would lower the return per acre). However, returns could also be greater in subsequent years as seed costs come down (assuming certified seed no longer had to be imported) and varietal selection improved.

It is extremely important to note that Marcus assumes that the grower would raise hemp for both fiber and seed simultaneously and that "If hemp were grown only for seed or stalk, it would likely generate negative returns even in best case scenarios". However, as discussed earlier, seeding rates (thus costs) vary significantly for fiber versus seed production and the production of one will diminish the quality and production of the other. Obviously, this is not sufficient information to draw definitive conclusions regarding hemp profitability in North America.

Other US sources provide estimates of returns to hemp production, although no explicit production costs and price information is provided. Production returns provided in the Governor's (Kentucky) Task Force on Hemp and Related Fibers are shown below:

Estimates of Net Returns per Acre for Ky Crops	
Tobacco	\$1,050
Tomatoes for Processing	775
Wheat (+Def Payment) and Soybeans*	175
Soybeans	100
Average of Existing Crops	175
Corn (+Def Payment)	75
Hay and Silage	100
Fiber Hemp - low fiber price / yield	-200
Fiber Hemp - high fiber price / yield	500

* double cropping

Relative profitability is an extremely important concept in comparing production alternatives. Further, expected profitability over time is germane and price stability is a key factor in defining risk. Finally, supply expansion in a contracting market will depress price as was discussed earlier in relation to Chinese overproduction in the 1980s.

IX. CONCLUSIONS

Industrial hemp can be grown with little or none of the psychoactive properties of marijuana by utilizing low-THC varieties. However, most seedstock in the world has been bred for European and Asian production. The development of a US-based industrial hemp seedstock industry may improve yields (if varieties were engineered for North American production) and lower seed costs. However, this is not guaranteed.

Many have argued the merits of hemp fiber and oil -- superior fiber length and strength, excellent oil quality for both industrial and feed uses, and a myriad of other applications. Despite these claims, world production has steadily fallen; dramatically since the early 1980s. Declines in production may be signaling that hemp profits are also on the decline -- either absolutely and/or relative to other production alternatives. Industrial hemp faces significant competition from other natural fibers (cotton comprises 98% of the natural cellulose textile fiber market), oils (particularly soy) and a multitude of synthetics. Specialty pulp fibers are limited to less than 5% of normal demand of other major grades of paper.

Hemp processing technology remains antiquated. However, new innovative fiber separation techniques are being tested, particularly in western Europe. Given that US hemp production is essentially non-existent, if production was legalized, farmers would be limited to selling bulk production until (and if) a US hemp processing industry was established. The domestic market for hemp is relatively small (\$100,000 of raw or processed hemp, 1996) and is comprised primarily of value-added products (\$1.3 mil of hemp fabrics and products, 1996). The lack of processing facilities and other infrastructure necessary for a viable commercial hemp market in the US makes demand and profit projections extremely speculative. The US retail hemp market was projected to be \$23.3 mil last year. (It would be interesting to find out the farm-value of hemp fiber in a pair of jeans.) If legal constraints were lifted today, growers would primarily be bulk suppliers to a limited domestic market, at least in the short-run.

Potential US industrial hemp growers would compete with many low-cost producers (China, the FSU and Eastern Europe) where labor costs remain low. The European Union continues to subsidize industrial hemp at the rate of \$100/ton (approximately half the market price). Despite these subsidies, hemp production in France (which has always been legal) has not grown in recent years, and newly legalized production in the Netherlands, England and Germany remains negligible. Canada and Australia have both recently authorized limited hemp production. It is not reasonable to believe that the US would subsidize hemp production.

Further, many of the multinationals purportedly interested in hemp production (Weyerhaeuser, Masonite, International Paper and Inland Container Corporation) are not confined to the US for investment opportunities. Multinationals have the capacity to invest in production and processing facilities all around the world. Non-existent US industrial hemp production does not impede their investment elsewhere. It is notable that foreign investment in hemp processing facilities in China and Europe are small. It is logical to assume that these decisions were based on prudent business sense.

US hemp farmers would face considerable world price variability. When world hempseed production surged in the 1980s, prices fell below the break-even price required for production (as estimated from Canadian research). US hemp fiber import prices averaged \$3.85/kg in 1996, also below the break-even price projected by Canadian research. If the profit margin collapses, or remains risky, alternative crops are increasingly attractive.

If industrial hemp production was permitted in the US, it is reasonable to assume that production would be relatively low in early years (the EU experience bears this out). Commodity prices can be more volatile in thin (low volume) markets, creating more market risk than US farmers might be willing to bear. Contract production would alleviate some of that risk. *Any price, thus profit projections, for industrial hemp production must take into account the effect of changes in both production and demand on world price.*

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