FEASIBILITY OF INDUSTRIAL HEMP PRODUCTION IN ARKANSAS

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INTRODUCTION

This report regarding the uses and economic benefits of industrial hemp is being compiled in response to Senate Resolution 13 as passed by the State of Arkansas 82nd General Assembly Regular Session, 1999.

There is an enormous amount of literature written on hemp production both pro and con. Those authors in favor of legalized production indicate superior fiber length and strength, excellent oil quality, and many other applications. Despite these reports, world hemp acreage has steadily declined since the early 1980's and is dominated by low-cost producers. Hemp fiber production is only one-fourth the volume of the early 1960's with India, China, and the Former Soviet Union producing about 70 percent of the world supply. Hemp seed production has fallen by 50 percent during this time period with China alone producing 70 percent of the world supply (Vantreese, 1997).

In 1988 the European Economic Community established subsidy payments for the production of hemp seed in EC countries (Anon., 1988). In 1989 the EC established direct subsidies for hemp fiber production (Anon., 1989). Despite these subsidies of approximately $400/acre, no major increases in EC hemp production have occurred and production there remains negligible. Similarly, world hemp fiber exports have fallen from more than $14 million in the early 1960's to currently less than $5 million (Vantreese, 1997).

Industrial hemp is currently legally produced in 22 countries with Canada being the closest and is recognized as a legal crop in both the NAFTA and GATT agreements. The main obstacles for legalization of industrial hemp appear to be: 1) law enforcement officials are concerned about the regulation, 2) no domestic facilities currently exist to process hemp stalks, 3) there is a lack of current production and processing technology, and 4) lack of research on the production potential and quality aspects of the crop (Kraenzel, et. al.).

The report will attempt to compile information on the environmental benefits, agronomic considerations, harvest methods, seed production, and economic returns to industrial hemp production.

ENVIRONMENTAL CONCERNS

Many people have thought that industrial hemp would be the miracle crop that would protect the environment and produce a visible, economic crop for farmers. It is a faulty assumption that hemp is different from other crops in that it will require no pesticides and fertilizers and that the industry developed from its production will be less harmful to the environment than those now being grown.

In Arkansas, much of the hemp grown would be produced on less productive soils as has been the case with most of the other alternative crops grown here. This would necessitate two things which are no different than with any other crop and is certainly the case with Kenaf, a crop which is produced in much the same manner.

Pre-emergence herbicides would be needed to control such weed pest as crabgrass and other early competitors as is evident with Kenaf production.

Hemp for ideal production is a heavy user of plant nutrients hence no reduction in the use of commercial fertilizers would be realized over other competitive crops.

Much of the sandy loam and loamy soils of Arkansas are infested with root knot nematode and other nematode pest which will attack hemp.

Cultural, biological and chemical means would have to be developed to efficiently grow hemp in these areas.

There are no processing plants within the borders of the United States. Plants would have to be constructed and put on line. This would necessitate new permits being obtained and environmental impact assessments made. To this point, producers of Kenaf, a similar crop, have had difficulty obtaining permits for a processing plant in Texas. The hemp processing plants, of which it takes two to complete the process, are no less polluting facilities than those for Kenaf or other fiber crops.

Hemp at this point in other countries has few disease and insect pests. Other crops which are now grown on a large scale once were free of most major pests, however, as more and more of the crop was produced, the incidence of disease and insect problems continued to rise with production. There are no reasons to believe that hemp is any different.

These problems would have to be addressed by research in breeding, genetics, agronomic properties, and if necessary chemical control.

ADAPTATION CONSIDERATIONS

It should be noted for purposes of this discussion that industrial hemp has never been grown in Arkansas as a commercial crop. No research exists for this State on varieties, production methods, and other agronomic and production parameters needed for sound assessment of this crop as a profitable alternative for Arkansas producers.

Climatic Requirements

Hemp is well adapted to the temperate zone and will grow under a wide range of environmental conditions. Hemp grows best when mean daily temperatures are between 13˚ and 22˚ C (60˚ - 80˚F), but will endure colder and warmer conditions. Hemp grows quite well at relatively low temperatures, and young seedlings will tolerate some exposure to frost. The best fiber producing hemp varieties require about 4 months without killing frost to produce fiber and about 5.5 months to mature seed (Dewey, 1913.).

Moisture

Hemp requires abundant moisture throughout the growing season, particularly while young plants are becoming established especially during the first six weeks of growth (Dewey, 1913). After plants are well rooted, they can endure drier conditions, however, severe drought hastens maturity and produces dwarfed plants. Studies in Europe indicate that hemp requires 20-28 inches of available moisture for optimum yield, and that 10-14 inches of moisture should be available during the vegetative growth state. These amounts include both precipitation and available soil moisture. In Europe, hemp yield is strongly dependent on the amount of rainfall during June and July (Bocsa and Karus, 1998). Crop water use will, of course, vary depending on local soil, climatic, and cultural conditions.

AGRONOMIC CONSIDERATIONS

Most information on agronomic practices for hemp production in the Unites States is from crop production produced prior to and during the 1940's. Several Extension publications were produced prior to and during World War II to educate growers about producing hemp (Robinson, 1935a: Wilsie et al., 1942; Hackleman and Domingo, 1943; Wilsie et al., 1944). As with most other agricultural crops, the technology employed to produce hemp and the timing and nature of cultural operations will be highly dependent on the end product for which the crop is produced. Hemp grown for high quality textile fiber may be handled much differently than hemp grown for paper or particleboard production. Hemp seed production for planting seed or oil is usually a specialized activity carried out on fields designated for seed production.

Hemp Varieties

As with any crop, the genetic background of hemp can have profound effects on crop productivity. Early European varieties of hemp were selections from indigenous populations and generally were grouped into northern and southern types (Hoffman, 1961). Northern hemp is characterized by rapid early growth, early flowering, strong branching, and high seed yield. Southern types tend to be slow-growing, tall, late flowering, and have high yield and fiber quality and poor seed yield (Van der Werf, 1991). Selections from Asian hemp landraces and wild populations have also provided the basis for new hemp varieties (De Meijer, 1995).

No information on modern varieties or production practices are available for industrial hemp for the State of Arkansas or, for that matter, for the United States as a whole.

Soils

Although hemp can be grown on a variety of soil types, it does best on loose, well-drained loam soils with high fertility and abundant organic matter (Dempsey, 1975, Van der Werf, 1991). Hemp should not be grown on poor soils (Robinson, 1952). Repeated attempts to cultivate hemp on heavy, low-lying soils have demonstrated that, while these soils may produce some large hemp plants, it is practically impossible to raise a good, even stand of hemp stalks that produce high quality fiber. "In Texas good crops of hemp have been produced on rich dark prairie soil, but on upland soils, subject to drought, the crop has proved a failure" (Dewey, 1901). "Fertile clay loam or silt loam soils, neutral or slightly alkaline, are best for hemp. It will not grow well in acid sandy soils, heavy clay, gumbo soils, or gravelly soils that dry out quickly. All of these soil types exist in Arkansas.

Optimum soil pH for hemp production ranges from 5.8 to 6.0 (Bocsa and Karus, 1998).

Seedbed Preparation and Planting

Hemp should be planted on well prepared land. The best crops are produced when fall or winter plowing is followed by preparation of a good seedbed in the spring. Fertilizer is generally applied as a broadcast treatment just prior to final seedbed preparation (Dempsey, 1975). No records of banded fertilizer application or minimum-tillage planting of hemp have been found.

Optimum seeding dates vary with local climatic conditions, but are generally as early as possible after the danger of hard freezes has passed.

In past years, hemp was broadcast, seeded and harrowed in. Most hemp is now planted with seed drills using row spacings from 3 to 7 inches. Optimum seedling depth is 3/4 to 1 1/4 inches. Historical seeding rate recommendations vary widely from 36 to 125 pounds/acre (Dempsey, 1975). Current recommended seeding rates in western Europe range from 45 to 63 pounds/acre (Kozlowski et al., 1995; Low, 1995).

Fertilizer

In addition to deep soils and adequate moisture, hemp requires high levels of nutrients to produce high biomass yields. Even the earliest investigators in the United States and Europe noted that only soils maintained in a high state of fertility produced good crops of hemp (Anonl., 1890; Dewey, 1901 and 1913; Dempsey, 1975; Van der Werf, 1991).

Hemp responds well to nitrogen fertilization, has some response to phosphorus and little response to potash.

It is popularly believed that hemp does require little or no fertilization for productive yields. This assumption is false. Over a wide range of soil and environmental conditions, hemp has been shown to require liberal fertilization for maximum production. Although nutrient uptake by hemp is high, a substantial portion of withdrawn nutrients are returned to the soil as leaves and roots, since only the stems are removed from the field. If the crop is retted in the field, nearly all soluble nutrients are washed into the soil during retting (Dewey, 1913). This process in all likelihood would not be practiced today.

Uniform stem size is desirable for industrial processing of hemp as well as for mechanical harvesting, and stem uniformity is affected by nitrogen fertilization.

Weed Control

When grown under favorable conditions, hemp is very competitive with weeds and no herbicides are generally used in fiber hemp production. However, in many areas, a pre-emergence herbicide would be necessary due to pressure from grasses such as crabgrass. Many authors have commented on the exceptional ability of hemp to suppress weed populations (Dewey, 1901 and 1913; Robinson, 1935; Dempsey, 1975, Van der Werf, 1991). Weed suppression with minimal pesticide use is potentially one of the greatest agronomic and environmental benefits of growing hemp in rotation with other crops. Thick stands of hemp have been reported to suppress aggressive weed species, however several climbing weeds have sometimes caused harvesting problems with hemp including black bindweed (*Polygonum convolvulus* L.), vetch (*Vicia* sp.), and morning glory (*Convolvulus sepium* L.)(Dempsey, 1975). Morning glory is a particular problem in hemp seed production because its seed is the same size as hemp and is very difficult to separate by screening (Robinson, 1935a). These weeds would out of necessity need to be controlled in hemp. At present, there are no labeled pesticides in this country or state for hemp production.

Insects, Diseases, and Other Pests

Insect and disease pests have generally not been considered agriculturally significant problems in the production of industrial hemp, and pesticides are not commonly used in hemp production. This does not mean that hemp is free of pests or that there is no potential for pest problems with hemp production.

Significant insect damage to hemp fields is apparently rare at this time despite reports of nearly 300 insect pests associated with the crop. Most serious among these are the European corn borer (*Ostrinia nubilalis*) and the hemp borer (*Grapholita delineana*).

Although a number of plant diseases have been reported on hemp, major disease outbreaks are uncommon.

Several species of nematodes are known to infest hemp including the southern root knot nematode, *Meloidogyne incognita* (McPartland, 1996a), and, more rarely, the northern root knot nematode, *Meloidogyne hapla* Chitwood (Norton, 1966). Both species of these nematodes are found on a large number of acres in Arkansas especially soybean and cotton ground.

Birds feed voraciously on *Cannabis* seeds. Many bird species have been reported as pests in hemp, and their feeding can lead to substantial crop losses (McPartland, 1996). Birds are a major problem in grain crops in Arkansas.

Although hemp is comparatively free of major pests, introduction of new crops to Arkansas and their increased production can and may result in unforeseen pest problems. High-density planting, increased fertilizer use, and irrigation have often increased incidence of pest problems in other crops, and such problems should be anticipated with intensive hemp production.

Harvest

When grown for the highest quality fiber, hemp is harvested when the staminate plants have finished flowering, but before seed has matured. Early in this century and during World War II, horse or tractor drawn harvester-spreaders were used to cut hemp stems and lay them in windrows on the ground for field retting. A second machine was later used to gather and tie field dried stem bundles for pickup and delivery to the mill.

A similar harvest system is still found in Europe using more modern, specialized equipment. These systems are designed to maintain the parallel alignment of hemp stems throughout harvest and processing in order to maximize the recovery of long textile fibers from the stems. Because it maintains the alignment of hemp stalks during handling, this equipment has limited harvest capacity per day. Additional innovation in harvesting equipment and practices is still needed to improve the efficiency of long fiber production.

It is possible to harvest unretted stalks using modified forage or sugar cane harvesting equipment as has been done for Kenaf (Wood et al., 1978; Quick et al., 1980). Recent harvests in western Europe have used conventional forage harvesters to chop and windrow hemp for field retting. Once retting is complete, the crop is treated much like a hay crop. After turning with hay rakes or tedders and field drying, the crop is harvested with large round or square balers.

Another option is cutting and using a cotton module maker to compact large quantities of hemp into a large module. These practices favor fast harvest but appreciably lower the quality of long fiber in the plant.

Time of harvest in Arkansas is an unknown and will depend on time of planting, cultural practices, density of planting, and end product use.

RETTING

If hemp fibers are to be made into cordage, textiles, or high quality industrial products, the fibers must be separated from the stalk. Retting is a microbial process which breaks the chemical bonds that hold the bast fiber bundles together. This partial rotting of the stem allows easy separation of individual fiber strands and the woody core and is common to all bast fibers used in high quality textiles, including hemp. Without retting, hemp fibers tend to break if stems are bent or broken (Robinson, 1935). Since it is a biological process, retting requires both available moisture and temperatures warm enough for microbial action to occur. The two traditional types of retting include water retting, in which plant stems are immersed in water (river, ponds, or tanks), and field or dew retting, in which the crop is spread in the field where rain and dew provide the moisture for retting.

Water retting produces fiber of greater uniformity and higher quality than can be produced by field retting, but is very labor and capital intensive. In addition, water retting requires large volumes of high quality water that must be cleaned before discharge after the retting process is complete (Fuller et al., 1946b). The vast majority of hemp fiber currently used in textiles is water retted in China or Hungary. Water retting has been largely abandoned in countries where labor is expensive or environmental regulations are enforced.

Yield

Yield is one of the most important considerations in assessing the feasibility of any crop, and also one of the more complex. Reported yields for hemp vary widely, and some care must be taken when studying yield figures.

Researchers from many countries have reported wide variations in hemp yield. In the United States, farmers' dry stem yields ranged from 2 tons/acre to 12.5 tons/acre, but averaged 5 tons/acre under good conditions (Dewey, 1913).

Transport and Storage

Unprocessed hemp biomass, like agricultural residues or other fiber crops, is very bulky material, and the costs of transportation and storage are a major consideration in the large-scale use of these products, regardless of their end use. The low density of stem core material from bast fiber crops, including hemp, is a major factor limiting their utilization in pulping. An inexpensive method of increasing their density is required to reduce transportation costs and ease handling in the mill (Wood, 1981). Storage is a major consideration. Cost for comparable materials is from $13 - $15 per ton. No production facilities exist short of Canada to process raw materials into usable products.

Transportation to Canada for processing, could become prohibitive and would be necessary while local processing and transportation infrastructure were developed.

Seed Production

Since hemp grown for fiber is usually harvested before the female plants flower, production of planting seed or oilseed involve somewhat different crop management. In general, hemp seed production requires a warmer climate and a five to six week longer growing season than hemp fiber production to allow time for seed maturation (Bocsa and Karus, 1998). Historically, hemp seed planted for fiber production in the U.S. Midwest was produced primarily in Kentucky.

Hemp seed production fields are planted on much wider row spacing and at much lower seeding rates than fiber production fields to encourage development of large, branching plants that seed heavily (Dempsey, 1975). Row spacing wider than 16 inches promotes branching and increases seed yield, particularly during drought conditions. At low plant densities common in seed fields, the hemp crop may not suppress weed growth, and cultivation or herbicides are often used to control weeds in traditional European hemp seed production. Tall, heavily branched hemp plants are difficult to harvest with conventional combines, and in many countries hemp planting seed is still harvested by hand. Maximum expected seed yield using these practices is 893 lb/ac. In Europe the hemp stalks left after seed crop harvest are either burned or chopped and then worked into the soil in countries where field burning is prohibited (Bocsa and Karus, 1998).

Seed production in the United States at present is at best non existent. Depending on varieties developed for other parts of the world, without research and testing for local conditions is at best a dangerous venture.

Hemp planted for seed is handled differently than hemp for fiber. It is spaced wider both between rows and in the row. This condition would allow competition from weeds to develop and some type of weed control would be necessary for maximum production, however, these cost could be offset by lower seed cost.

The only way to reliably determine the potential for industrial hemp production in Arkansas and in the United States is as has been done with other crops and that is through research and field testing over several years at multiple locations and under commercial production conditions.

ECONOMICS OF HEMP PRODUCTION

While there is great interest in the potential of expanding hemp production in the United States, there is also tremendous uncertainty about the economics of doing so. The commercial production of industrial hemp is restricted in the United States so solid information about the farm level costs of production, yields and overall profitability are unavailable. Projections must be derived from experiences in other countries and price observations in thin markets. This section will briefly summarize the potential uses of industrial hemp, describe global production and U.S. import flows of hemp products, discuss the price uncertainty associated with thin markets, compare previous studies that estimated farm level net returns, review possible constraints to hemp processing and finally, detail the conclusions of a recent, comprehensive study of the market potential of industrial hemp conducted by the Economic Research Service of the USDA.

Uses

While the actual use of hemp products in the United States is quite limited, there are a number of potential uses that could be developed. Kraenzel et. al. identify nine different classes of potential uses and estimate that there may be as many as 25,000 different hemp products. These classes and typical products are displayed in Table 1. The wide range of products makes it difficult to identify all of the competing commodities, raw materials and products, but a few that are obvious include: cotton, lumber, fossil fuels, plastics, jute, flax, abaca, kenaf, poppy seeds, and sesame seeds.

The most commonly mentioned uses in the literature appear to be paper, particle board, plastic, animal bedding, food oils, fuels, paints & varnishes, lubricants and snack foods (Kraenzel et al.; Marcus; The Boulder Hemp Initiative Project; Thompson, Berger and Allen; Vantreese). Hemp textile production has been based in Asia and central Europe where many countries have long histories of fabric production for domestic clothing. In Italy, Hungary and some adjacent countries, relatively fine yarns and soft fabrics resembling flax are produced, but usually are more expensive than natural and synthetic fiber blends due to the large amount of hand labor involved (Oregon Natural Resources Council).

Global Production Trends

The global production trends for hemp fiber and tow for 1961 to 1997 are presented in Figure 1. As can be seen, acreage peaked in the late 60's and has been decreasing ever since. The distribution of hemp fiber production for 1997 is displayed in Figure 2. With the exception of France and Spain, the major producers are in Asia. It is estimated that worldwide 250,000 acres of industrial hemp was grown in 1997 (Kraenzel et al.) with retail sales valued at $75 million. This acreage can be contrasted with various projections for the U.S. market at between 2,500 and 250,000 acres (Kraenzel et. al.; Thompson, et al., ERS, USDA; The Boulder Hemp Initiative Project). Total production figures follow a similar trend. World production of fiber fell from 400,000 metric tons in 1960 to about 100,000 metric tons in 1996. Seed production has declined from over 100 million metric tons in 1965 to just over 36,000 metric tons in 1997 (Kraenzel et al.).

Demand Uncertainty in Thin Markets

It is often difficult to accurately assess the market potential for products that have historically been traded in thin markets. Market prices are determined by the interaction of supply and demand which can in turn be influenced in the short run by government policies and production subsidies. It is not uncommon that markets without significant barriers to entry can experience abrupt changes in market prices as short run profits may entice substantial production expansion, increasing supply, lowering prices, creating excess capacity and transforming profits into losses. In these cases, success is often dependent upon demand growing at a faster rate than the increase in supply. Initial government subsidies may either help to establish an infant industry or disguise the true limited nature of the market potential. Asset fixity which results when investments in production capacity have limited alternative uses can further complicate the situation and prolong excess capacity and low market prices. The recent history of alternative agricultural markets are populated with examples of the risks associated with thin markets (i.e. Poinsettias, emus, organic mesclun; ERS, USDA). Prospective investors in these markets, both private and public, should assess the market potential and the inherent price risks that will greatly influence the relative profitability. Preliminary reports from Ontario, Canada indicate that in 1999 a major increase in the acreage of industrial hemp (to 35,000 acres) generated an excess supply that overwhelmed the local market (ERS, USDA).

Estimates of Demand and Size of Market

The market demand for industrial hemp in the U.S. is quite uncertain. While many potential uses have been identified, current commercial use is very limited. With legal restrictions on the production of industrial hemp, the best estimates of market potential may be derived from an examination of the import levels of raw hemp and hemp products. As reported by the Economic Research Service, current import levels do not suggest that there exists a large national market for hemp products in the United States. Obviously, market prices do matter and relative changes in the prices of competing materials and products could easily alter these conclusions. Nevertheless, the following assessments are most enlightening.

U. S. imports of raw hemp increased from 500 lbs in 1994 to 1.5 million lbs in first nine months of 1999. Hemp yarn imports were reported as 625,000 lbs in 1997. The ERS study has converted these figures to estimate the total hemp production necessary to displace all imports of hemp fiber, yarn, and fabric in 1999 and concluded that at an average yield of 1,550 lbs per acre, the entire amount could be produced on less than 2,000 acres.

If it were assumed that the hemp market expanded and was able to capture the entire market for its nearest competing textile fiber, linen, these numbers would increase. The hemp fiber necessary to replace the equivalent of all hemp and linen fiber, yarn and fabric imports form 1999 would be approximately 250,000 acres. The market for hemp food, products, oil and animal bedding materials is unknown at this time.

There are no import data available for hemp seed and oil products for the U.S.: however, 1998 imports of hemp seed into North America were estimated at 1,300 tons. At the average German yield of 1,000 lbs per acre, only 2,600 acres would be required to meet this entire demand.
The conclusion from the ERS study is that the size of the hemp market in the United States could likely be met by production from between 2,000 and 250,000 acres, with the greatest probability at the low end of the range. This compares to estimates from Thompson et. al. of 82,000 acres and the Boulder Hemp Initiative Project of 170,000 acres.

A Summary of State Reports on Farm Profitability

Without actual observations on U.S. production of industrial hemp, it is difficult to estimate accurately expected yields, costs of production and net returns for the farms that may grow the crop. Previous studies have attempted to do so, based upon experiences in other countries and/or similar crops routinely produced in the U.S.. The estimates from several studies are compared in Table 2. It should be noted that the costs of production range from $175 per acre to a high of over $600 per acre. Many of the differences are related to the exclusion from the lower estimates of such items as land rents, irrigation equipment charges, and other fixed costs. These estimates also do not include the costs associated with monitoring, licensing or regulating hemp production. While these costs might be borne by the public or the processors, they should still be included. Thompson et. al. reports Canadian farmers will pay annually $50 per acre for background checks and satellite coordinates for their hemp fields.

In addition to differences in the estimates for the costs of production, there are also discrepancies in yields and market prices selected by the various authors. Market prices for fiber ranged from a low of $45 per ton to a high of $200 per ton. The authors of the 1998 Kentucky study, Thompson et. al., concede that the price selected for fiber ($200/ton) was not one likely to be maintained in the long run as it reflected a premium provided by a Canadian contractor used to induce farmers to initially plant the crop. Some studies did conduct sensitivity analyses to determine the impact of various market prices of the projected profitability. The four most common production scenarios examined include fiber, seed, certified seed and combined fiber & seed. The net returns are obviously influenced by the estimates on the costs of production, yields and market prices. The net returns reported range from a loss $136 per acre to a gain of $606 per acre. It should be noted that even at the highest prices and yields if the standard Arkansas land rent of 25% of the crop and $50 per acre monitoring and licensing fees were applied to these net returns, almost all of the profit would be eliminated.

As indicated by the ERS report, the most comprehensive of the studies in the existing literature, hemp production appears to be profitable only at the highest ends of the estimated prices and yields. Coupled with the uncertainty about the thinness of the hemp market and the lack of reliable production data for the U.S., investors should carefully weigh the risks against the potential returns.

Processing

In addition to the uncertainties about the farm level profitability and overall size of the hemp market, ERS concludes that it is unclear if hemp can be economically processed in the U.S.. The technology of hemp processing has not advanced much in recent years and remains capital and labor intensive. While research is underway to streamline the processing, few technological advances have yet to occur. Labor costs in the U.S. might impede the ability to compete with established producers in countries such as China, Hungary, Poland and Romania. However, oilseed crushing facilities could accommodate hemp seed (ERS) and some lumber and paper mills could be remodeled to handle hemp materials (The Boulder Hemp Initiative Project).

Conclusions

The report from the Economic Research Service of the U.S. Department of Agriculture assesses the potential market for industrial hemp in the United States and concludes that it will be unlikely that markets will be able to sustain adequate profit margins for a large production sector to develop. While the range of acreage possibly required to meet market demand for hemp fiber, yarn and fabric extends from 2,000 to 250,000 acres, this reports suggests that the current potential is closer to the lower end. The demand for hemp seeds and flour will likely remain a niche market similar to those for poppy and sesame seeds. Demand for hemp oil may be constrained by processing and regulatory problems related to color, unsaturated fatty acid levels, shelf life and prices of competing materials (ERS).

KENAF PRODUCTION AND PRODUCT DEVELOPMENT

Development and commercialization of kenaf and various kenaf-based products in the United States have been ongoing since the 1940's. Research and development efforts, initiated by the U.S. Department of Agriculture (USDA) when U.S. jute imports were interrupted during World War II, received a boost in the 1950's when researchers identified kenaf as the most promising nonwood fiber for pulp and paper making. More recent USDA research and industry interest was triggered by high newsprint prices in the late 1970's.

Like jute and flax, kenaf stems consist of two distinct fibers. The outer bark of bast fibers comprises 30 to 40 percent of the total dry weight of the stalk. The inner core of short balsa-wood-like fibers accounts for the remainder. Many uses of kenaf have been identified including:

- Pulp, paper, and paperboard produced by wet processing;
- Fiberboard produced by dry processing using moldable fiber mats;
- Absorbing media;
- Packing materials;
- Composite products;
- Livestock forage and feed; and
- Traditional cordage uses.

Kenaf can be grown in many parts of the United States and the world, but it generally needs a long growing season to produce the necessary yield to make it a profitable crop. With a long growing season, like that found in the southern United States, kenaf can reach a height of 12 to 18 feet and produce 5 to 10 tons of dry fiber per acre annually. According to the American Kenaf Society (AKS), an estimated 6,000 acres of kenaf were grown in 1999. Primary production areas are Texas, Mississippi, Georgia, Delaware, and Louisiana. The AKS also reports that 1999 whole stalk prices ranged from $37 - $45 per ton, with fiber prices being higher depending on purity.

Several companies are currently producing and selling kenaf-based products. The AKS website (http://www.kenafsociety.org/) lists six companies operating in Georgia, Texas, Mississippi, Arkansas, and New Mexico. There may be other companies that are not AKS members that sell kenaf products.

A significant amount of research has been conducted on kenaf. The largest and most comprehensive U.S. research effort on kenaf is located at Mississippi State University (MSU). MSU has had over 20 scientists from more than 15 disciplines evaluating various aspects of kenaf, including product development. Much of the financial support was Federal funding provided through USDA's Agricultural Research Service, but this funding was reportedly being phased out in 1997. The types of research MSU staff have been conducting include:

- Varietal selection and breeding;
- Evaluating planting date, row spacing, plant density, and other yield determinants;
- Production practices;
- Control of nematodes and other kenaf pests;
- Fertility;
- Weed control;
- Plant desiccation for harvest;
- In-field separation of fibers;
- Economic analysis of fiber separation;
- Using kenaf as bedding for horses, broilers, and laboratory animals;
- Evaluating kenaf as an oil sorbent;
- Kenaf core as a bioremediation enhancer, a feedstock for composite materials, and a component in landscape and greenhouse bedding media; and
- Use as a textile fiber, including processing, fiber characteristics, and product development.

University of Delaware researchers have been evaluating kenaf as an alternative crop for their area. Farmers like to use kenaf in rotation with soybeans because it helps to break the life cycle of the soybean cyst nematode. In addition to on-going kenaf production research, scientists are conducting product development work such as using kenaf fibers in composite materials and kenaf core in cat litter, animal bedding, and as a growing medium for plants.

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Table 1 The Industrial Hemp Market

Agriculture:	Fertilizer; Certified Seed; Animal Products (Bedding, Feed)
Automotive:	Interior parts (Door panels, roofs, dashboards); Compression Molded Parts; Filters; Fuel; Grease
Construction Materials:	Paints; Varnishes; Putty; Packaging Material (Mats, Linerboards); Insulation; Composite Board; Plastics; Fiberglass Substitutes; Mortar
Food/Nutrition/Beverages:	Beer; Body Building Supplements; Cooking Oil; Margarine; Cheese; Health Food Snacks; Wheat Flour Supplement; Seeds
Furniture:	Carpet; Tapestries
Paper:	Fine; Specialty (Tea Bags, Coffee Filters; Carbon Tissues, Toilet Paper)
Personal Care:	Skin Care; Cosmetics; Soaps; Medicine; Shampoo; Lip Balm; Salves
Recycling:	Strengthening Additives
Textiles:	Clothing (Shoes, Shirts, Pants); Accessories (Necklaces, Bracelets)

Source: Kraenzel et al. Industrial Hemp as an Alternative Crop in North Dakota. Agriculture Econ Report No. 402, NDSU. 1998

Figure 1. Source: United Nations Food and Agriculture Organization, FAOSTAT Agricultural Data.

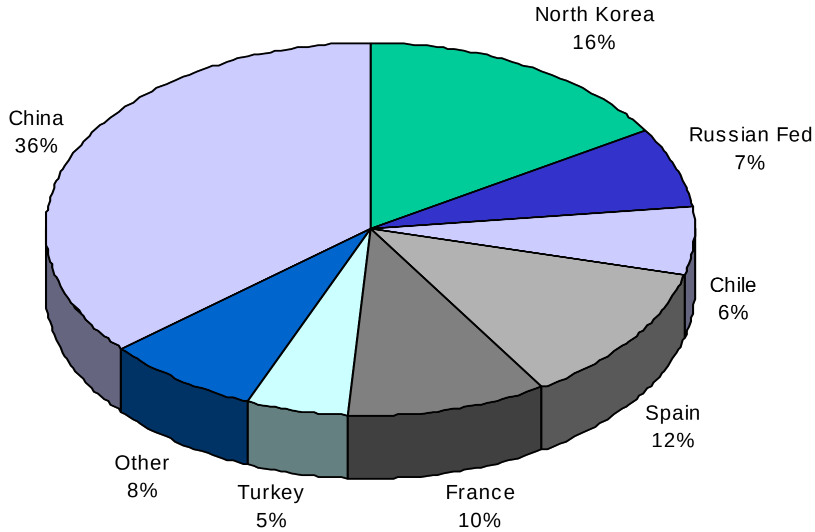

Figure 2. Source: United Nations Food and Agriculture Organization, FAOSTAT Agricultural Data.

Table 2 Comparison of Estimated Costs & Returns for Hemp from State Studies

	Yield	Price	Total Costs	Revenue	Net Returns
1995 KY					
Fiber	2.8 to 6.1 MT/A	$60 to 125/T	$286/A	$170 to 759/A	$-116 to 473/A
Seed	NA	NA	$196/A	$60 to 800/A	$-136 to 604/A
Certified Seed	NA	NA	$233/A	NA	NA
Oregon					
Fiber	5T/A	$75/T	$616/A	$375/A	$-241/A
1998 KY					
Fiber	3.4T/A	$200/T	$364/A	$680/A	$316/A
Seed	1069 lbs/A	$0.39/lb	$257/A	$477/A	$220/A
Certified Seed	700 lbs/A	$1.20/lb	$294/A	$900/A	$606/A
Fiber & Seed	700 lbs/A 2.25T/A	$0.39/lb $200/T	$403/A	$723/A	$320/A
North Dakota					
Fiber & Seed	14.3 to 23.8 bu/A 2.5 to 3T/A	$5.51 to $6.80/bu $40 to 52/T	$175/A	$180 to 316/A	$5 to 142/A

Source: ERS, USDA. Industrial Hemp in the U.S.: Status and Market Potential AGES00IE. 2000.

Table 3. **Estimated costs and returns per acre, Kenaf Production, Non-Irrigated, 2000**

ITEM	UNIT	PRICE	QUANTITY	AMOUNT	YOUR FARM
		dollars		dollars	
INCOME					
Kenaf	tons	40.00	4.0000	160.00	__________

TOTAL INCOME				160.00	
CROP SEED					
Kenaf Seed	pounds	6.00	6.0000	36.00	___________
CUSTOM WORK					
Cstm ap grd fert dry	acre	4.50	1.0000	4.50	__________
Cstm ap grd herbicid	acre	4.50	1.0000	4.50	___________
Cstm ap air fert	lb	0.05	150.0000	6.75	__________
Kenaf, Custom Harst	acre	25.00	1.0000	25.00	__________
Hauling - Kenaf	Ton	0.00	4.0000	0.00	__________
FERTILIZER & LIME					
10-20-20	lbs	0.09	300.0000	26.10	_______
46-0-0	lb	0.07	150.0000	10.35	_________
HERBICIDES					
Treflan 4EC	pint	3.75	1.5000	5.63	_________
OPERATOR LABOR					
Implements	hour	6.23	0.8045	5.01	_________
DIESEL FUEL					
Tractors	gal	0.60	6.5258	3.92	_________
REPAIR & MAINTENANCE					
Implements	acre	2.37	1.0000	2.37	_________
Tractors	acre	5.58	1.0000	7.34	_________
INTEREST ON OP. CAP	acre	7.34	1.0000	7.34	

TOTAL DIRECT EXPENSES				143.05	________
RETURNS ABOVE DIRECT EXPENSES				16.95	_______

FIXED EXPENSES					
Implements	acre	5.33	1.0000	5.33	______
Tractors	acre	9.38	1.0000	9.38	_____

TOTAL FIXED EXPENSES				14.71	________

TOTAL SPECIFIED EXPENSES				157.76	________
RETURNS ABOVE TOTAL SPECIFIED EXPENSES				2.24	

Table 4. Estimated resource use and costs for field operations, per acre Kenaf Production, Non-Irrigated, 2000.

						TRACTOR COST		EQUIP COST		ALLOC LABOR		OPERATING INPUT			
OPERATION/ OPERATING INPUT	SIZE/ UNIT	TRACTOR SIZE	PERF RATE	TIMES OVER	MTH	DIRECT	FIXED	DIRECT	FIXED	HOURS	COST	AMOUNT	PRICE	COST	TOTAL COST
						----------DOLLARS-----------				dollars		----------dollars----------			
Disk, medium cut	26.41'	180	0.082	1.00	Mar	1.39	1.38	0.44	1.77	0.098	0.61				4.99
Cstm ap grd fert dry	acre			1.00	Mar							1.0000	4.50	4.50	4.50
10-20-20	lbs											300.0000	0.09	26.10	26.10
Disk, medium cut	26.41'	180	0.082	1.00	Apr	1.39	1.39	0.44	1.17	0.098	0.61				4.99
Cstm ap grd herbic	acre			1.00	Apr							1.0000	4.50	4.50	4.50
Treflan 4 EC	pint											1.5000	3.75	5.63	5.63
Disk bedder, 8r@30"	20'	180	0.088	1.00	Apr	1.49	1.48	0.16	0.38	0.106	0.66				4.16
Bed conditioner	20'	180	0.069	1.00	Apr	1.10	1.04	0.22	0.54	0.083	0.52				3.42
Planter 8r@30"	20'	180	0.115	1.00	Apr	1.95	1.93	0.81	1.50	0.265	1.65				7.84
Kenas Seed	lbs											6.0000	6.00	36.00	36.00
Row cult 8r@30"	20'	180	0.129	1.00	May	2.19	2.17	0.30	0.57	0.155	0.96				6.18
Cstm ap air fert	lb			1.00	Jun							150.0000	0.05	6.75	6.75
46-0-0	lb											1.0000	0.07	10.35	10.35
Kenaf, Custm Harst	acre			1.00	Oct							1.0000	25.00	25.00	25.00
Hauling - Kenaf	Ton			1.00	Oct							4.0000	0.00	0.00	0.00
TOTALS						9.50	9.38	2.37	5.33	0.805	5.01			118.83	150.42
INTEREST ON OPERATING CAPITAL															7.34

UNALLOCATED LABOR												0.00
TOTAL SPECIFIED COST												157.76