Cannabis Farming

The Potential of Hemp in Indiana's Agricultural Landscape

Honors Thesis

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Abstract

The Cannabis industry is not a new feature in world markets. Its existence has been noted in history dating back several thousand years before the start of the Common Era. In the past century however, this industry has been one of controversy and ongoing legal battles and debates. The recent growth of legitimate cannabis markets suggests that the cultivation of the plant has the potential to provide a significant boost to the economy. This paper deals with the cost and profit potentials associated with the cultivation of industrial hemp. An assessment of the worldwide hemp markets suggests a potential for a new market for Indiana farmers as an alternative to current practices. Using data collected from various studies done by national agriculture organizations of several countries, the research will present an estimated balance sheet for an average sized Indiana hemp grower. The results suggest that a high yield will be required to provide an economic incentive for farmers to introduce hemp into their agriculture practices. The current state of the industrial hemp industry will make it difficult for large scale farms to have incentives to switch production. However, additional investment and research could lead to a competitive alternative to current products in various industries.

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Chapter 1

1.1 Introduction

Cannabis is currently the 3rd most recreationally used drug in the United States, trailing behind alcohol and tobacco. Research suggests that federal prohibition costs taxpayers an estimated $10 billion annually. On top of this, as most criminology figures show crime falling to record lows, drug related arrests continue to rise. Marijuana arrests amount to an average of 750,000 nationwide. Despite these figures, 30% of America's population lives under decriminalization laws, 19 states have medical marijuana laws, and two states have passed laws legalizing marijuana. (NORML, 2014) In addition, Gallup polls [Figure 1], show that the U.S. population is now historically leaning towards legalization with over 50% being for and 39% against as of 2013. This is a sharp increase since in 1969 only 12% favored legalization and 40% in 2009. For the most part the federal government's stance on cannabis has not changed. The drug is still considered a Schedule I substance, the most dangerous classification. On all government websites the official statement is that marijuana has no medical benefits, harmful side effects, and a high tendency for abuse. (DEA, 2014) Despite this position, the government seems to be unable or unwilling to stop the recent legal changes that have happened, and continue to happen, among the states. The government has quietly allowed the relaxation of state laws and as of early 2014 allowed banks to lend money to businesses involved in legal cannabis production. Although the industry is stuck in what can be called a legal limbo, the trends, polls, referendums, and legal changes that have taken place suggest that the coming of a national, legal cannabis industry is likely. With this new market also comes a new agricultural commodity that has not been grown by farmers in over fifty years.

Most important of all of these trends, and the topic of this thesis, is that as of 2014 the pace of the legalization process has reached Indiana. The state's government passed a bill allowing farmers to apply for permits to grow industrial hemp, which is what this paper focuses on. This non-narcotic strain of cannabis is intended solely for agricultural and industrial purposes, has a wide range of uses, and has historically been cultivated by Indiana farmers until the introduction of the Marijuana Tax Act of 1937.

1.2 Significance of Industrial Hemp

Although the legal battles that have swept the states over cannabis have affected hemp it would be wrong to place it in the same sphere as medicinal and recreation cannabis. Hemp is a variety of the Cannabis sativa plant that is grown for its seed and fiber contents. It cannot be used for medicinal or recreational purposes as it has only 1 to 3 % THC (Tetrahydrocannabinol) content. (Clarke, 2013) Its uses do include the making of paper, food, textiles, specialty plastics, hygiene products, construction material, livestock feed and bedding, and oils [Table 1]. Research studies suggest that, with sufficient investment, hemp may develop to become an environmentally sound, economical alternative to the existing crops and ingredients currently used by the mentioned industries. (Robbins, 2013)

1.3 Research Question

Although hemp has a wide array of uses, its illegality in the world markets has significantly reduced innovation and research. The plant, and the production capabilities needed to develop the products mentioned previously, has been forgotten in the United States and demand worldwide remains low. This research will focus on the potential profits and costs of growing industrial hemp

in Indiana in the current environment. How much of an economic incentive will farmers have to grow hemp compared to the incentives of crops currently available?

1.4 Research Design

This paper will first show a list of fiber hemp yields, ranging from the lowest recorded in the United States to the highest. The table will show the contribution margin and net return associated with those yields to provide an idea of how much farmers would need to produce in order to make a desired level of profit. The next part of the research will assume the average documented yield recorded in the United States and create a balance sheet for a hemp producing 254 acre farm. Because of a lack of research or history of stable markets assumptions had to be made for certain aspects of the table which I will discuss. Finally, the contribution margins of hemp fiber and hemp seed will be compared to the contribution margins of the crops in the 2014 Purdue Crop Cost & Return Guide.

1.5 Outline

This paper is organized into four chapters. The current chapter has dealt with the current status of cannabis in the United States, the potential of industrial hemp, and the significance to Indiana farmers. Chapter 2 will deal with the history of hemp in the world and, more specifically, in the United States. Chapter 3 will present the data analysis of hemp cultivation. It will show projected worldwide demand as well as a balance sheet and income statement for a sample farm growing the crop. Chapter 4 will compare the results with the trends and profitability of the major crops currently grown in Indiana. Finally Chapter 5 will provide an assessment of the results and suggestions for further research.

Chapter 2

Background

2.1 History of Hemp

Cannabis belongs to the family *Cannabaceae*. Within that family there are three main strains: *Cannabis indica, Cannabis ruderalia,* and *Cannabis sativa*. *Cannabis sativa* is the most widespread out of the three, much taller, and is naturally found in lowland regions. This strain's common name is hemp and it is the one that is the subject of this paper. The term "weed" commonly used for all types of marijuana has developed from cannabis's adaptability and ability to grow in every environment. There are archeological and historical records of cannabis's existence in every part of the world where vegetation exists. This has made the exact origins of cannabis hard to pinpoint. The agreed upon origin is in Northern India, Nepal, Tibet, and in general the south/southeastern regions surrounding the Himalayan mountain range. The earliest recorded cultivation by humans is around 4000 BC in China. In most cultures around the globe it has been used as medicine, added to food, smoked for pleasure, and burned as incense in religious ceremonies. Hemp was considered important for the making of clothes, paper, rope, and oils. In 1563 Queen Elizabeth I of England decreed that land owners must grow hemp on a certain percentage of their land or pay a fine of £5. In 1611 the colony of Virginia made the growing of hemp mandatory for farmers. (Clarke, 2013)

By the early 1900s however the attitude towards the cannabis plant began to change. Much like the move to remove alcohol, cannabis use and growth was discouraged. In 1911 the Commonwealth of Massachusetts became the first state to ban cannabis. In 1937 the Marijuana Tax Act placed a tax on the sale of cannabis that effectively ended its presence in general

pharmacopeia and agriculture. Hemp saw a slight revitalization in the 1940s with the onset of World War II. President Roosevelt signed an executive order that allowed emergency hemp production for a time in order to make various supplies for the war effort. As the war concluded however, the ban was reinstated. In the late 1960s, President Nixon declares the first War on Drugs campaign. The United States government creates the Drug Enforcement Administration in 1970, and the government's position on cannabis has remained largely the same since then. (PBS, 2014)

The 1990s saw the birth of new interest in cannabis. California was the first state to pass medical cannabis laws in 1996 and the National Organization to Reform Marijuana Laws was founded the following year. Now, 18 years later, as a national campaign to reform marijuana laws gains ground, the ban on industrial hemp is once again being looked at. In the early months of 2014 the federal government made its first concession to the reform movement by allowing banks to loan money to businesses involved in legal cannabis. So far fifteen states have passed legislation allowing farmers to receive permits for growing hemp and in 2014 Indiana passed a similar law. This law has timely coincided with the writing of this paper and has emphasized the significance of industrial hemp that has been mentioned previously. (NORML, 2014)

2.2 Hemp Cultivation

Hemp cultivation was detailed in the Oregon State University Study. The hemp plant is an annually growing plant that matures to form a woody stem that is hollow in most varieties. Its height varies from 1 to 6 meters and typically grows as a long central stem that lacks any branches or foliage except at the top, forming a sort of canopy. The seeds are smooth, round, and typically brown or gray with a typical diameter between 2 to 4 millimeters. It is an adaptable plant capable of living in a wide range of environments. Its optimum habitat is a temperate zone with

temperatures ranging from 60 to 80 degrees Fahrenheit although it can endure a wider range of temperatures. Optimally it prefers well drained soil, especially in its early stages, with low clay content.

When planting hemp it is best if started with winter or fall plowing and followed by planting in the spring after freezing weather has passed. Because of its canopy and height research papers have found that herbicides are not need or used in very small amounts. Also, insects or disease problems have not been shown to be significant although some varieties can be prone to certain types of diseases.

When harvesting, the best quality fiber is gathered after plants have finished flowering but not before the seeds have matured. The technology that best fits harvesting hemp has limited capacity per day. In Europe, a forage chopper tractor is used on hemp production farms. Research into contemporary technology is not particularly strong and in some countries harvesting by hand remains a preferred method. For the most part hemp is treated much like hay when it is harvested. (Ehrensing, 1998)

2.3 Global Demand Trends

There is no official estimate of the value of U.S. sales of hemp products. According to the Hemp Industries Association that number was around $500 million in 2012. For the most part however this study does not take into account all retailers which sell hemp products. For example Whole Foods Market, a seller of hemp based foods, is not included in that figure. A recent study done at the University of Kentucky (2013) showed that world fiber production has been falling. The production of hemp seed seems to have more potential as production in 2011 has returned to levels that were recorded in the early 1960s. It is difficult to pinpoint the demand for the market

however. For over fifty years there has been little to no progress or research by the federal government into hemp or hemp based products that are imported. Because the politics over hemp and cannabis as a whole remains a mixed and contentious issue in the United States, not many studies have been funded on the state of the hemp market environment.

Only in the past decade has research into the market potential of hemp in the U.S. started to develop. As mentioned in the previous paragraph, the production of hemp seed is seeing a general upward trend, despite large fluctuations in demand. Certain studies, such as those done by the Universities of Oregon (1998) and Kentucky (2013), show the potential in using hemp as a rotational crop. The research suggests that, in the products that can be made from hemp, the crop may develop as a more environmentally friendly alternative to the current practices. Research is also optimistic that, given time and research, it may develop economically as well, given its relatively low input and management requirements.

In the current global markets, China is the single biggest producer of hemp. In the 1960's global production of fiber was measured at 300,000 metric tons. In the early 2000's that number fell to only around 50,000. Although these numbers show a drastic decrease in global demand it is important to note that for most western countries industrial hemp was under prohibition for over 50 years. During that time China was essentially the only producer of hemp products. Certain signs show that hemp demand may be slowly rising.

Chapter 3

Profit Comparison

3.1 Set-up of the Net Returns

This paper uses research done by Oregon State University as well as the USDA "Potential U.S. Production and Processing" article and the 2013 University of Kentucky paper in order to assess and assume the various variable costs associated with hemp production. The general structure tries to mirror the one used by the 2014 Purdue Crop Costs Guide in order to make a better comparison.

The net returns assessment establishes a hypothetical 254 acre farm in Indiana, located on average productivity soil. 254 acres is the average farm size in Indiana determined by the USDA (2006). The hemp fiber yield is configured to be the average recorded yield from research studies done in the United States since the 1900s. It is important to note that fiber is measured in tons/acre. For hemp seed, which is measured in lbs/acre, the expected yield is 900lbs/acre established by research done by the University of Kentucky. The research used average producing soil. Market harvest prices for hemp tend to fluctuate frequently and generally have a wide range. The Kentucky research stated that they assumed $75/ton general market price for fiber and $0.70/lbs market price for hemp seed. In France, hemp fiber sells for about $200/ton. It is important to note however that certain European Union states have been giving subsidies to hemp growing farmers. In France, prices have been artificially propped up.

Fertilizer dryer fuel prices were the same as prices used for corn in the 2014 Crop Cost Guide because in general, corn is similar to hemp in those categories. Pesticide was used in negligible amount or not at all in most research conducted on hemp growth, so it was not

considered as a cost. Machinery Use was a label that consisted of several parts, specifically the cost of a forage chopper, the cost of raking, and the cost of bailing. The forage chopper was priced at $3.00/ either ton for fiber or lbs for seed. Raking cost $1.50 per equal units as the forage chopper variable. Bailing was priced at $9.80 per equal units as the forage chopper as well. These numbers were derived from the Oregon State Study (1998) as the machinery is different than the one used to plant and harvest other crops in the industry. The Insurance/Misc. variable consisted of general overhead, machine insurance, tool rental, and other minor costs incurred during production. In order to be in line with the type of machinery used, the Oregon State Study was used for these costs. The prices for the permit and the permit minimum were taken from the recommended amount stated by the Kentucky hemp industry legislation. Permit pricing and issuing is a topic of debate in many states where hemp has been legalized or considered.

For Fixed Costs, I calculated a total cost of $58,166.00 for the 254 acres of land. This was calculated by the $229/acre land rent cost for average productivity soil stated in a USDA report on Indiana farm land rent. Depreciation consisted of the Machinery & Equipment and Irrigation System variables. They cost $68.00 and $44.00 respectively. These costs were also derived from the Oregon State University research because of the need for consistency among machinery costs. Since the machinery is unique, the Machinery Use and Depreciation costs were linked.

3.2 Net Returns and Break-Even Point

The most typical forms of production of hemp are focused on either producing hemp fiber or producing hemp seed. In some countries, such as France, techniques for the production of both fiber and seed on the same field have been used. For the most part, farmers globally tend to specialize in either hemp or seed production and in these specialized scenarios a generally higher

yield of fiber or seed is produced. TABLE 2 shows the detailed breakdown of the variables used to determine the net return of the two products. With an expected yield of 5.8 tons/acre priced at $75/acre the contribution margin for fiber was only $22.25/acre. When applied to the 254 acre farm assumed earlier the net return for fiber was $-54,046.50. Hemp seed fared better. With the expected 900 lbs/acre yield priced at $0.70/lbs. the contribution margin was $320.96/acre. When applied to the 254 acre farm the net return for hemp seed was $21,825.84. Table 3 shows, all variables remaining equal, the various yields for hemp fiber for the farm and the projected contribution margins and net returns associated with them. The range of yields start at the lowest recorded yield of fiber in the United States and project incrementally until the highest recorded yield of 12.5 tons/acre. If yield is rounded to the nearest integer, a farmer with a 254 acre farm must be able to attain a yield of at least 9 tons/acre to receive a positive net return. A close examination of the projected net returns showed that in order to break even a farmer must receive a yield of about 8.64 tons/acre of fiber. If however the farm was able to attain the upper yields of 12.5 it can see strong contribution margins of $524.75/ton and net returns of $73,588.50. This is assuming that the market demand for hemp fiber will grow. Such an assumption would be questionable however. Looking at Figure 2, world hemp fiber production has been falling consistently and sharply since the 1960's and does not seem to be ending the trend.

3.3 2014 Predicted Crop Cost & Return

To compare the results calculated in the previous section, this paper will use the 2014 Purdue Crop Cost & Return Guide. Table 4 shows the part of the guide relevant for the comparison. The numbers represent 2013 estimates for average productivity soil. The five categories examined by the guide are Continuous Corn, Rotation Corn, Rotation Beans, Wheat, and DC Beans. The expected contribution margins are $277.40, $345.40, $395.40, $253.00, and $240.80 respectively.

Comparing that to the margins of hemp fiber, at the average recorded yield fiber is significantly less profitable per acre than all 5 crop categories. Based on contribution margins, in order for fiber to be considered, from an economic standpoint, farmers would have to reach expected yields of 9 or 10 tons/acre at minimum. Hemp seed fares a little better. Its projected contribution of $337.43 is comparable to the margins of Rotational Corn and Beans. This adds to the prediction of the Oregon Study saying that hemp may have a potential as a rotational crop. Figure 2 does cast some doubt as to the future of fiber, and although the demand for hemp seed has been on the rise since the start of the 2000s, the demand is inconsistent and is possibly on a downward trend since roughly 2010.

Chapter 4

Summary

4.1 Summary of Results

The comparison of contribution margins suggests that, in its current state, hemp is a considerably risky venture for farmers. From the point of view of basic profits alone, hemp seed looks like a feasible option. Fiber on the other hand does not. Hemp fiber needs a guarantee of significantly above average yields in order to be economically feasible. The net returns and contribution margins are a small part of the overall decision however. At its current state, the global market has significant fluctuations in both supply and demand. A study done by Ernest Small and David Marcus at the Department of Horticulture at Purdue University in 2002 showed that the hemp fiber demand total for the European Union in 1999 was only 26,821 tons. The fact that there are no consistent official figures that account for the global hemp industry would make farmers uneasy in approaching such a venture. With demand figures such as the ones suggested by the Purdue study however, even the yields necessary to attain a profit would not be enough for hemp fiber to be economically feasible on a large scale.

Another important aspect is the lack of research into improving harvesting practices, yields, and production costs. Ever since cannabis was removed from the legal markets research into hemp has stalled. Looking back to Table 1, hemp is shown to have potential in paper production. Research suggests that it may be an environmentally sound replacement to the current methods of producing paper and may significantly cut down the progress of deforestation. However the production of paper has for many decades been focused on the refinement of this method while

developing hemp paper has not. At its current state hemp fibers cannot be produced in a way that would be an economically feasible alternative.

Another crucial factor is the law. In many states hemp remains illegal to produce. The recent sweep of cannabis reform makes some members of the United States population uneasy. As the various cannabis industries develop, the government keeps to the laws that were enacted at the initiation of the War on Drugs during the Nixon Administration. (PBS, 2014) From a legal standpoint, participating in any part of the cannabis industry is a federal offense, regardless of whatever laws a particular state may have. The federal government's quiet permission to allow the states to produce hemp is a very recent development. Furthermore, the likelihood that the U.S. government will offer subsidies to farmers for hemp production is highly unlikely. Farmers feel uneasy with switching to a product that is in such a murky area both legally and economically even if the future prospects looks promising.

Finally, the public must be educated about this industry. Many people do not see a difference between the different strains of cannabis. For some, hemp will appear as an attempt to mass produce marijuana for recreational purposes, abusing and taking advantage of laws much like the medical cannabis industry in California. Others may attempt to steal the plant for personal consumption from farmlands not realizing its difference from the *Indica* plant. This difference is crucial as it takes away any drug effect of the other strain. The public must be informed of those differences and the many positive uses and products hemp fiber and seed can provide. Such a campaign would require funding, either from private or public sources. Because of the government's passive stance, and the DEA's continued support for prohibition (McKay, 2013), public funding seems unlikely in the near future.

4.2 Future Research

The state of the hemp industry suggest lots of potential in the future. Hemp is a relatively low maintenance crop that can produce profits for farmers. As Table 1 shows, hemp has a wide variety of already documented uses. It is also important to remember that these uses have been underutilized on a global scale and research into hemp use has been severely underfunded. The current state of global hemp markets predominantly demand hemp seed for human and livestock consumption. Most of this use is in Asia, where long cultural traditions have unimpeded the use of hemp throughout the ages. Hemp fiber has seen a drop in demand as production techniques of substitute crops and products have advanced. Overall hemp has potential, and history has shown that hemp has been a valuable crop for the majority of recorded human civilization all across the world. More research is needed however. It is quite possible that hemp is a product of a time long past, replaced by cheaper, more efficient materials. It is also quite possible that decades of prohibition have inhibited the growth of an industry that can provide environmentally and economically sound, healthy alternatives to the agriculture sector.

Figure 1

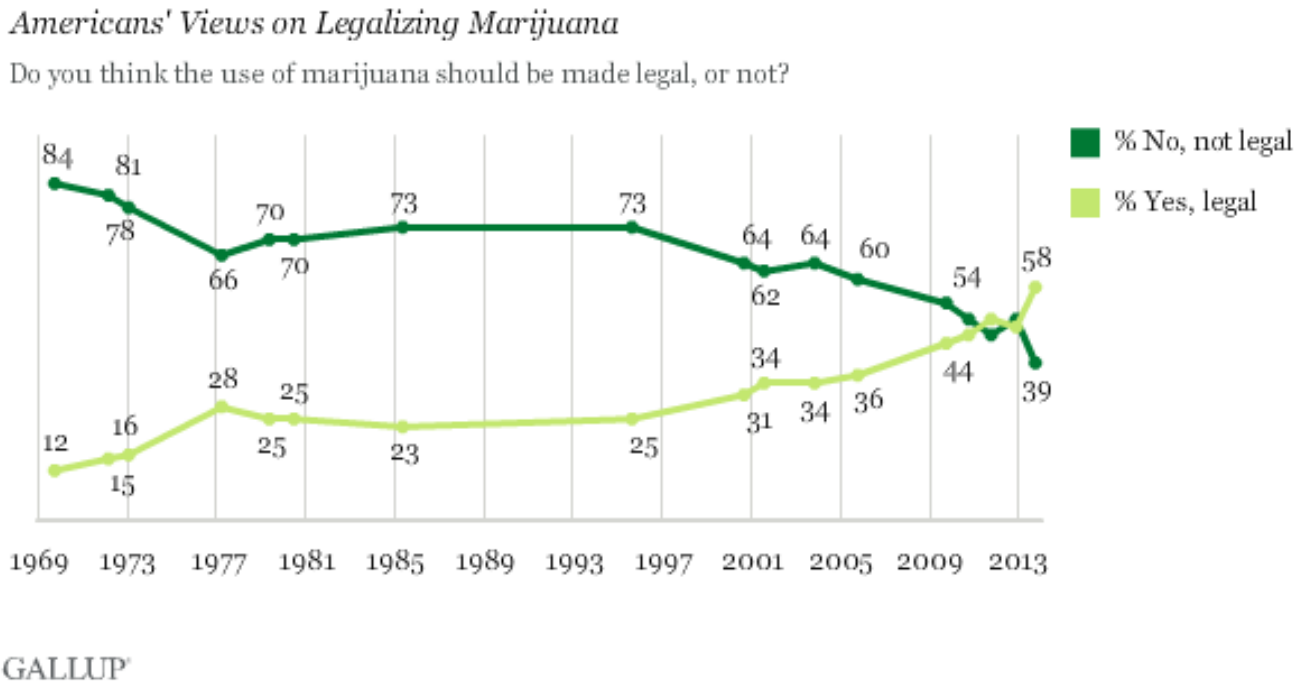
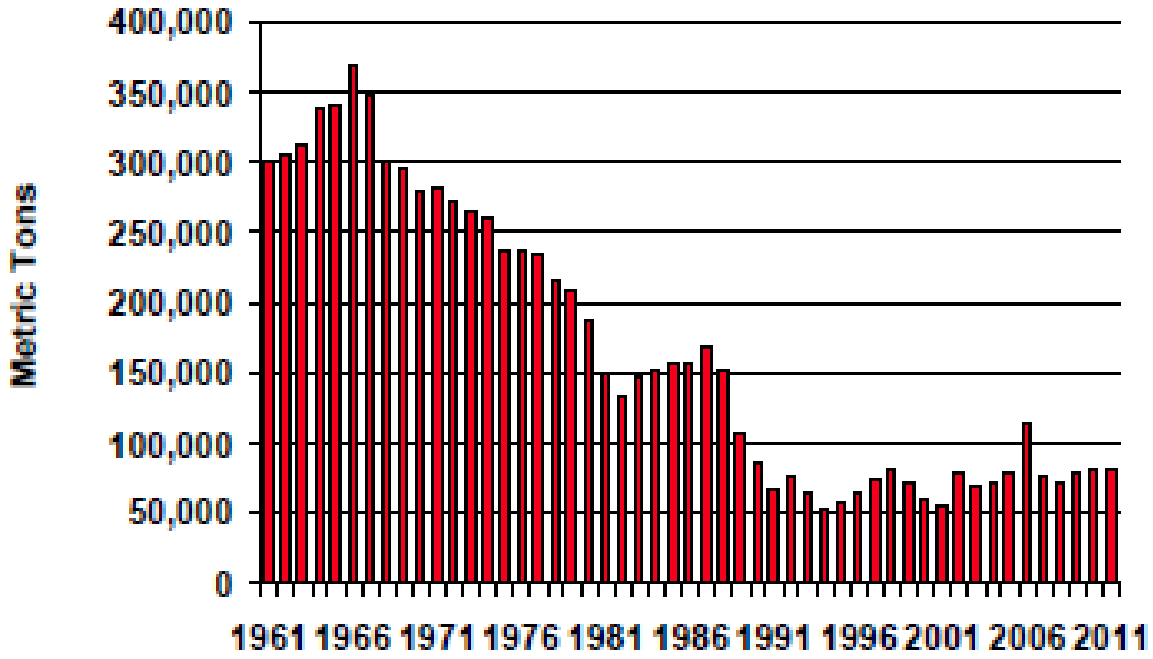
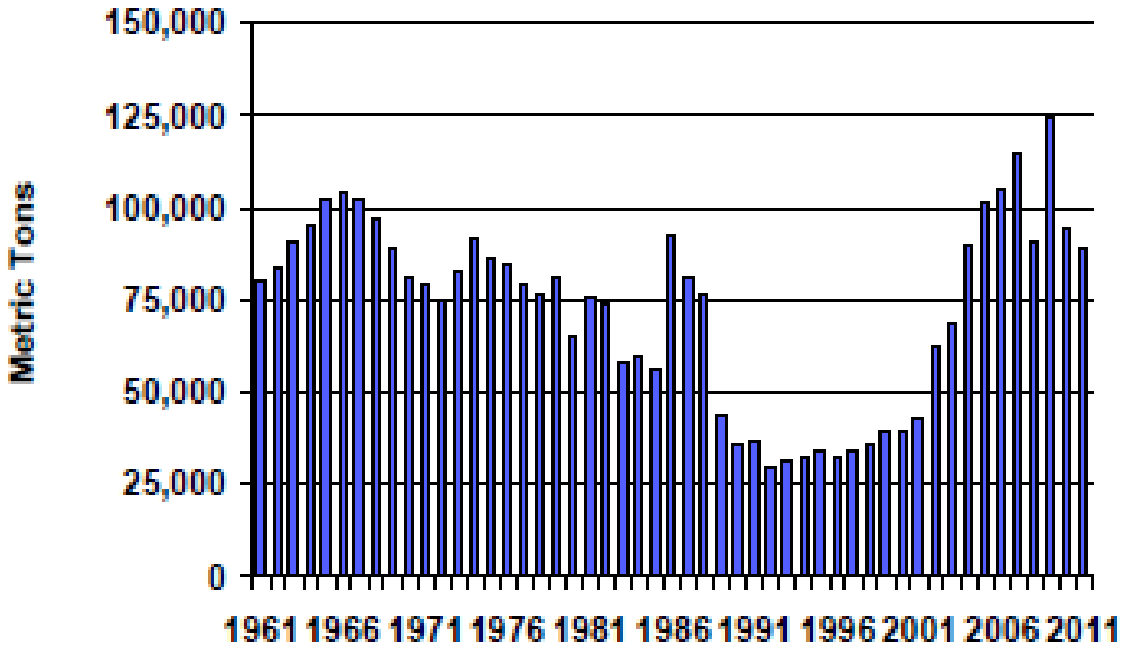

Americans' Views on Legalizing Marijuana
Do you think the use of marijuana should be made legal, or not?
% No, not legal
% Yes, legal
84
81
78
66
70
70
73
73
64
62
64
60
54
58
39
12
16
15
28
25
25
23
25
31
34
34
36
44
1969
1973
1977
1981
1985
1989
1993
1997
2001
2005
2009
2013
GALLUP

Figure 2: World Hemp Fiber Production



Source: FAOSTAT

Figure 3: World Hemp Seed Production



Source: FAOSTAT

Table 1

Table 1

TABLE 2

Cannabis: a plant of many uses.

Plant parts used	Use category	Material type or other benefits
Stem bark	Cordage	Long cellulose fibers
Stem fiber	Cordage and woven textiles, building materials	Long cellulose fibers, concrete reinforcement
Stems (wood and bark)	Paper	Long and short cellulose fibers
Stem wood w/o bark	Building materials, animal bedding	Chip board, concrete matrix
All parts: Primarily female flowers and seeds	Medicinal	Herbal remedies, pharmaceuticals, nutraceuticals
Female flowers and associated resin glands	Recreational drugs	Marijuana (*ganja*), hashish (*charas*)
Seeds, seed oil	Human food	Proteins and essential fatty acids, essential fatty acids (*omega*-3 and *omega*-6)
Seeds, seed cake, foliage	Animal feed	Proteins and essential fatty acids, proteins and trace fatty acids, vegetable mass
Seed oil	Industrial feedstock	Oil used in paint and plastic manufacture
Stem wood w/o bark, seed oil	Fuel	Heat, light
All parts: Primarily bark, seeds, and female flowers	Ritual and social	Social activities employing various plant parts such as healing and life cycle rituals and inebriation
Populations	Environmental	Erosion control and CO_2 fixation
The plant, people, and their interplay	Aesthetic	Intrinsic beauty of the plant
The genus	Educational	Iconic example of an economic plant and its ancient human relationships

Source: *Cannabis: Evolution and Ethno-botany*, *(Clarke, 2013)*

Table 2

Industrial Hemp Net Returns			
		Fiber	**Seed**
Expected Yield/Acre	1*	5.80	900.00
Harvest price	2*	$75.00	$0.70
Market Revenue		$435.00	$630.00
Less Variable Costs			
Fertilizer		$153.00	$153.00
Seed		$34.00	$20.00
Pesticides		N/A	N/A
Dryer fuel		$14.23	$14.23
Machinery Use	3*	$82.94	$82.94
Repairs		$15.00	$17.60
Hauling		$15.00	$3.00
Interest		$29.78	$4.24
Insurance/Misc.	4*	$63.80	$4.00
Permit		$5.00	$5.00
Total		$412.75	$309.04
Contribution Margin (Revenue-Variable Costs)		$22.25	$320.96
Acreage		254	254
Fixed Costs			
Land Rent		$229.00	$229.00
Land Rent Cost		$58,166.00	$58,166.00
Depreciation	5*	$112.00	$112.00
Permit Min.		$150.00	$150.00
Permit Costs		$1,270.00	$1,270.00
Total Fixed Costs		$59,698.00	$59,698.00
Net Return		**($54,046.50)**	$21,825.84

1* Fiber measure in tons/acre. Seed measured in lbs/acre
2* Prices determined from University of Kentucky (2013) study and comparison of European prices
3* includes: Forage chopper ($3.00/variable), Raking ($1.50/variable), Bailing ($9.80/variable)
4*variables include: general overhead, machine insurance, tool rental, etc.
5* Includes: Machinery & Equipment ($68.00) and Irrigation System ($44.00)

Table 3

Hemp Fiber Margins and Net Returns		
Yields (tons/acre)	**Con. Margins ($/acre)**	**Net Return ($)**
3	**(187.75)**	**(107,386.50)**
4	**(112.75)**	**(88,336.60)**
5	**(37.75)**	**(69,286.50)**
6	37.25	**(50,236.50)**
7	112.25	**(31,186.50)**
8	187.25	**(12,136.50)**
9	262.25	6,913.50
10	337.25	25,963.50
11	412.25	45,013.50
12.5	524.75	73,588.50
Breakeven	~8.64 Tons/Acre	

Table 4

2014 Purdue Crop Cost & Return Guide September 2013 Estimates for Average Productivity Soil					
	Cont. Corn	**Rot. Corn**	**Rot. Beans**	**Wheat**	**DC Beans**
Expected Yield/Acre:	153	163	54	70	38
Harvest price:	$4.80	$4.80	$11.60	$6.30	$11.60
Market Revenue:	$734.40	$782.40	$626.40	$441.00	$440.80
Less Variable Costs:					
Fertilizer	$153.00	$138.00	$61.00	$82.00	$45.00
Seed	$122.00	$122.00	$73.00	$44.00	$84.00
Pesticides	$44.00	$44.00	$28.00	$12.00	$27.00
Dryer fuel	$30.00	$24.00	N/A	N/A	$4.00
Machinery Fuel	$26.00	$26.00	$16.00	$16.00	$11.00
Repairs	$22.00	$22.00	$18.00	$18.00	$15.00
Hauling	$15.00	$16.00	$5.00	$7.00	$4.00
Interest	$13.00	$12.00	$7.00	$6.00	$6.00
Insurance/Misc.	$32.00	$33.00	$23.00	$3.00	$4.00
Total VC:	$457.00	$437.00	$231.00	$188.00	$200.00
Contribution Margin:	$277.40	$345.40	$395.40	$253.00	$240.80

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