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An Assessment of Economic Considerations for Industrial Hemp Production

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Abstract:

The Farm Bill now allows for the legal production and research of industrial hemp as long as it meets the standards outlined in the Farm Bill. The bill passed by the House of Representatives states, "To amend the Controlled Substances Act to exclude industrial hemp from the definition of marihuana, and for other purposes" (House of Representatives, Bill 525). Prior to the passing of this bill, farmers were not allowed to produce industrial hemp. Industrial hemp is defined as, "the plant Cannabis sativa L. and any part of such plant, whether growing or not, with a delta-9 tetrahydrocannabinol concentration of not more than 0.3 percent on a dry weight basis" (qtd. in Johnson). Although it has a wide range of uses (upwards of 25,000 products use hemp), due to its very recent legalization for widespread production, there is a lack of updated information regarding the economic feasibility of hemp production by the private agricultural sector.

First, through an extensive search of existing legal, political and economic literature information was gathered to construct an enterprise budget for industrial hemp. This constructed enterprise budget was then used to compare an industrial hemp crop in Arkansas to the rest of the crops that are produced in Arkansas. This was done using a constrained linear programming model that optimizes farming acres in all 75 counties of Arkansas to examine the best (most profitable) crop for each acre.

When industrial hemp was introduced in the model, the total amount of acres farmed increased by 2.8% - 4.4%, the statewide profit increased by 0.3% -18.2%, and rice was the only crop that increased in acreage by 5% when industrial hemp was introduced.

Analyzing cost and potential returns using the enterprise budget and the results from the comparison with other commercial Arkansas crops in the constrained linear programming model, industrial hemp looks to be a promising crop. There are still hurdles to overcome, however. The lack of clearance by the DEA and the absence of hemp processing facilities in the United States are clear roadblocks to hemp production. Once the DEA consistently grants permits for hemp production, there needs to be research gathered for optimal locations of processing facilities and target markets for hemp goods.

Keywords: hemp, production, economics, market, budgets, Arkansas, crops

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Introduction

The omnibus agriculture Farm Bill, passed in 2014, opened up new opportunities for producers in America. Prior to this, only universities could grow industrial hemp for research purposes. The Farm Bill now allows for the legal production of industrial hemp for research purposes as long as it meets the standards outlined in the Farm Bill. The bill passed by the House of Representatives states, “To amend the Controlled Substances Act to exclude industrial hemp from the definition of marihuana, and for other purposes” (House of Representatives, Bill 525). The 2014 Farm Bill also established a statutory definition of “industrial hemp” as “the plant Cannabis sativa L. and any part of such plant, whether growing or not, with a delta--- 9 tetrahydrocannabinol concentration of not more than 0.3 percent on a dry weight basis” (Johnson, 2015).

Currently there is limited information, particularly in Arkansas, regarding the economic feasibility of production and marketing of industrial hemp as a commodity. Furthermore, there is confusion regarding the laws surrounding industrial hemp. There is no central location where interested parties can access summaries of existing economic, legal and political information surrounding industrial hemp.

The overarching goal of this thesis is to provide Arkansans and others with information needed to critically assess the feasibility of hemp production within the state. Two objectives will be fulfilled to reach this goal: 1) use information collected from an extensive literature review and the Mississippi State Budget Generator (MSBG) to create a production budget for hemp within the state of Arkansas; and 2) based on this budget, identify which regions of the state will most likely benefit from the production of hemp.

Literature Review

Historically, industrial hemp has played an important role in America. It was first brought to New England in 1645 then it spread throughout the colonies and later the states. The plant was grown for both seeds and fiber, with one of the main fiber customers being the United States navy. As time went on, and technology, such as the cotton gin and steam powered boats was introduced, the market demand for industrial hemp decreased. This continued until the Marijuana Tax Act of 1937, which gave the National Government more control over who could grow industrial hemp and penalties associated with not complying with the law surrounding industrial hemp. This legislation was not specifically targeted at industrial hemp; rather, it was concerned with all forms of cannabis, which is the family industrial hemp is classified under. This further decreased the production of industrial hemp, until the government temporarily lifted the restrictions on producing industrial hemp for fiber in order to fill the shortages created by World War II. The penalties from the Marijuana Tax Act were then reinstated after the war, so the production of hemp declined again (Fortenbery and Bennett, 2001).

The most recent legislation, HB 1778 (2017), by the State of Arkansas is intended to allow for the further research of the economic power of an industrial hemp crop and commercialization of the hemp products to advance the state agricultural sector. This bill calls for the combined efforts of the State Plant Board, the State Department of Agriculture, the University of Arkansas, and the Cooperative Extension Service to create an in-depth research analysis of an industrial hemp crop and market in Arkansas. This bill allows for the growth, development of an Arkansas specific seed, licenses process, produce renewable energy, and research the potential of Arkansas grown hemp in the world market.

Impressions of Hemp Production over Time

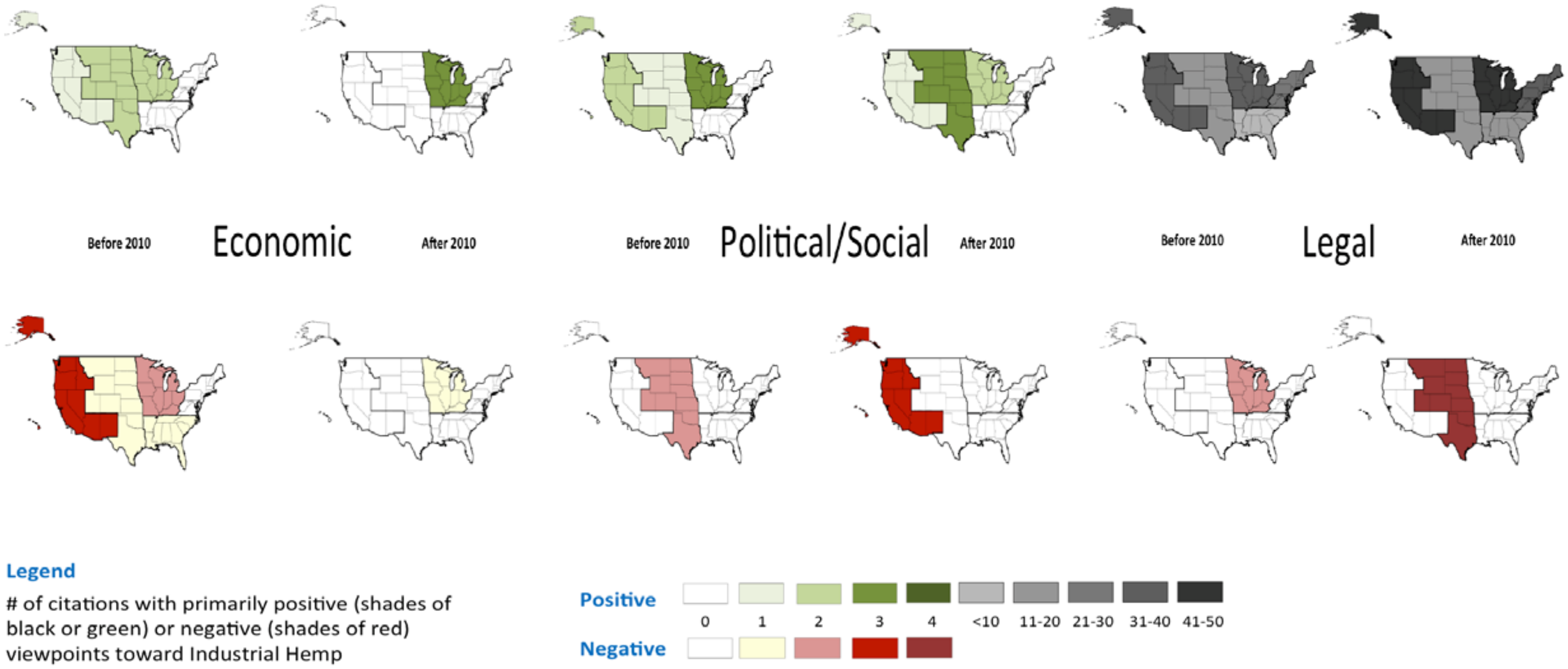
A literature review was conducted to examine the political/social, legal and economic considerations surrounding hemp production over time. Sources were divided into two categories – those created before 2010 and those in 2010 and later. The year 2010 was chosen specifically because this was during the time when the current Farm Bill was under construction and industrial hemp was being examined as a potential commercial enterprise. A total of 379 sources were found (see Table 1). Of these sources, the most were found concerning legal aspects of industrial hemp. While more recent sources of information were found concerning legal aspects of industrial hemp, sources were generally more dated for the economic and social/political aspects of hemp.

Table 1. Industrial Hemp Citations found in Literature Review

Category	Number of Sources Created Before 2010	Number of Sources Created in 2010 or After	Total Number of Sources
Social/Political	14	19	33
Economic	25	8	33
Legal	138	175	313
Total	177	202	379

Number of Citations Found Regarding Industrial Hemp

Figure 1. Positive and Negative Reactions to Industrial Hemp by Economic, Political/Social, and Legal Aspects



Economic, Political/Social, and Legislative Positive/Negative Industrial Hemp Production Outlook Maps

These sources were reviewed to determine whether they looked at hemp production favorably (positive) or whether they focused on challenges or obstacles associated with hemp production (negative). As shown in in Figure 1, there were more negative sources that were found under the Political/Social and Legal categories in the after 2010 section. This corresponds with the same amount of positive sources that were found in the before 2010 and after 2010 in the Political/Social category. While more negative sources were found in the after 2010 section of the Legal category, there was also a large increase in the amount of positive sources that were found after 2010. There was also a dramatic decrease in the amount of negative sources found in the after 2010 section for the Economic category as opposed to the prior to 2010 section. This was mirrored by one less positive source in the after 2010 section to the Economic category.

It is interesting to see the relationship between the positive versus negative outlooks on industrial hemp during the same time periods. The economic sources showed a mainly balanced amount of positive and negative research in the same geographical areas. The South region was the only region on the map in the prior to 2010 section that did not have a corresponding positive source to go along with the negative. The Midwest region had both positive and negative research in the after 2010 category.

The political social map shows a more favorable industrial hemp stance in both the prior to 2010 and after 2010 sections. The negative research seems to be more concentrated in the plains area in the prior to 2010 section and in the Pacific West area after 2010.

The legal map shows the heavily positive areas with multiple legislative sources in each region. Both the Mid-West and the Pacific West areas increased in their amount of legislation and held the highest amount of legislative resources in both the prior to 2010 section and the post 2010 section. There were a few negative legislative sources in the Mid-West area in the prior to 2010 section and a few in the Plains area during the post 2010 section.

Best Practices for Industrial Hemp Production

A review of the literature revealed different recommendations for the production of hemp. There are differences in the recommended inputs such as the type and amount of fertilizers, the range of growing degree days, and the amount of water needed. Industrial hemp requires 90-135 pounds of Nitrogen, 45 pounds of phosphorus, and 80 pounds per acre of liquid fertilizer (Bócsca and Karus, 1998). On a per unit of yield basis, the minimum and maximum quantities for the production of one metric ton of hemp stalks per hectare are: 33-44 pounds nitrogen, 9-11 pounds P2O5 phosphate, and 33-44 pounds K2O potassium oxide (Bócsca and Karus, 1998). In general, hemp is a hearty plant that can be grown across a large range of climates and ecosystems that allows it to positively respond to a wide range of inputs (Boulic, Allegret, and Arnaud, 2013). Industrial hemp grows best with the dial soil acidity between 5.8 and 6.0 pH but can range between 6 and 8 for optimal results (Boulic, Allegret, and Arnaud, 2013). Hemp generally does not do well in light soils, marginal soils low in organic matter, or soils that are poorly drained. The best soil for fiber hemp soils are dark black and brown loess soils (Bócsca and Karus, 1998). These soils are naturally present in Arkansas but not in large amounts.

Industrial hemp requires a certain amount of time to grow and reach a harvestable maturity. This is measured in Growing Degree Days (GDD), which is the sum of days with average temperatures above over the entire growing period. In order to achieve average maturity, “the entire vegetative cycle requires between 2500 (4532ºF) and 3000ºC (5432ºF) days” (Boulic, Allegret, Arnaud 2013). In order for the plants to reach a technical maturity it requires 3,400-3,600 °F GDD and for the seedlings to develop it takes 4,900-5,400 °F GDD. Hemp seeds begin to germinate when the ground temperature reach 34 to 36 °F. Seeds sprout in 8-12 days at 46-50 °F. Hemp can survive a frost down to 23 °F. Hemp specifically grows best between 66-77 °F.

Industrial hemp seeding can easily be accomplished by the machinery and implements already used on most row crop farms. Crop seeding could occur after the soil temperature reaches 45 °F (Boulic, Allegret, and Arnaud, 2013). Farmers are to use a seed drill and seed at a depth of 2-3 cm (Boulic, Allegret, and Arnaud, 2013). The seeds can even be sown up to 5 cm deep and deeper in light soils (Benhaim, 2010).

Industrial hemp does not tolerate standing water for extended periods of time, but it requires about 30 inches of water during the growing season with 3 to 4 inches of rainfall during the growing months (Roulac, 1997). Industrial hemp requires 20 to 28 inches of water to reach maximum growing requirements, with 10 to 14 inches falling in the vegetative period. Hemp requires 80-130 gallons of water for the production of 2.2 pounds of dry matter. Their roots can grow from 6.5-10 feet if not hindered, this aids the plant in getting more water. If water is left standing for one or two days then the plants will die. After industrial hemp is harvested, it is imperative to dry the hemp crop to 8 to 9 percent moisture after harvest to protect from unnecessary shrinkage during storage (Fine, 2014).

As earlier stated, industrial hemp is a hearty crop and can be grown across a wide range of environments. Further, yield potential of hemp is linked to corn. Hence, land that yields a strong corn crop, will also produce a strong hemp crop. Some of the contributing factors are that hemp crops thrive in well drained soil with proper fertilization (Roulac, 1997). This information, along with the study by Russell, Dalsted, Tranel, & Young (2015), is key to the crop production budget generated by the constrained linear programming model used in part two of this research.

Methods

This research was conducted in two parts. First, as described above, a literature search for all existing economic, legal and political information regarding industrial hemp in the US was undertaken. Using relevant resources found in the research/opinion database as well as additional enterprise budgeting development information, a spreadsheet based industry hemp production budget relevant to producers in Arkansas was created. For example, information from Kaiser, Cassady, and Ernst (2015), Barta, Bjœrnsson, and Kreuger (2013), Cochran, Moore, and Windham (2000), and Bocsa and Karus (1998) among others was used to identify best management practices for hemp production. Then information from the Mississippi State Budget Generator (Laughlin and Spurlock, 2014) and University of Arkansas Cooperative Extension Service enterprise budgets (Flanders et al., 2015) was used to calculate default estimates of costs for those production practices. This information was compiled in a user-friendly spreadsheet. Producers and other users have access to an approximate industrial hemp enterprise budget based on the default information. All dollar values were converted to 2016 real prices. Budgeting categories include revenues (yields and output prices), fixed costs (such as machinery, and capital recovery charges), and variable costs (such as fuel usage, labor needs, fertilizer, pesticides, and seeds). The finished budget includes a breakdown of expected yields for fiber and seeds, expected variable and fixed costs, breakeven prices, and expected revenue.

The Mississippi State Budget Generator is then used to provide the technical data concerning costs, application rate, and efficiency to the production processes that were determined to be necessary from the literature review. The most current (2016) row crop budget and input cost data were downloaded from the Department of Agricultural Economics website at Mississippi State University. These data include information on tractor and implement costs such as fuel, labor, repair and maintenance, efficiency, and total cost of ownership (purchase price, percentage salvage value, lifetime repair and maintenance %, useful life, and annual use) fertilizer use and twine for wrapping the bales.

These inputs were combined in the form of the Industrial hemp enterprise budget. This is shown in Table 2. All of the seedbed preparation, planting, and harvesting is outlined, along with the month of completion and the cost of the input. This was the same enterprise budget that the constrained linear model used.

This model uses information from the website of the University of Arkansas Division of Agriculture (Flanders et al., 2015). That is, it uses the most current data from all counties in the state of Arkansas showing how each crop is produced. Expert opinion from local extension and research personnel allowed determination of what production practices to use by USDA NASS district in the state. The market price and yield for each crop were 5 year real averages along with USDA NASS reported county level yields.

Table 2. Total Specified Expenses for Industrial Hemp

Operation/ Operating Input	Size	Units	Month	Amount	Cost in $ per Unit	Total Cost
Soil Testing and Lime			Apr			
Custom soil test	Custom	acre		1	0.60	0.60
Custom lime applied	Custom	t/acre		0.5	44.00	22.00
Seedbed Preparation, Fertilizer and Planting			Apr			
Custom Fertilizer		$/acre		1	7.00	7.00
Urea (46-0-0)		lbs		235	0.17	38.76
Phosphate (0-45-0)		lbs		62	0.19	11.77
Potash (0-0-60)		lbs		180	0.15	27.43
Disk & Incorporate	32'	acre		2	9.15	18.30
Grain Drill	30'	acre		1	11.05	11.05
Seed		lbs		70	1.00	70.00
					Subtotal	184.31
Harvest			Oct			
Combine	25'	acre		1	23.65	23.65
Grain Cart	1000bu	acre		1	1.77	1.77
Disc Mower	10'	acre		1	9.06	9.06
Hay Rake	8.5'	acre		2	5.78	11.56
Large Hay Square Baler	4' x 8'	acre		1	41.25	41.25
Sisal Twine		$/bale		**3.08**	1.00	3.08
Large Square Bale Stacker	16 bales	acre		1.0	4.98	4.98
					Subtotal	95.35
Operating Interest				1	4.75%	5.72
Total Specified Expenses						**307.98**

Estimated Total Specified Expenses for Hemp Fiber and Seed Production Using 2016 Input costs, Arkansas.

The model compares each crop to all other crops produced in a county to assess relative profitability and thereby determines what amount of each crop to grow given historical irrigation and land use constraints. This means the model considers what grows well in the county and the expected yield of the crop in the county. The constrained model maximizes Arkansas's producer returns on crop land above total specified expenses (NR) to 15 crop, hay, pasture and Hemp land use choices in 75 counties as follows:

$$\max_{x} NR = \sum_{i=1}^{75} \sum_{j=1}^{15} (p_j \cdot y_{ij} - c_{ij}) \cdot x_{ij}$$

Subject to

$$xmin_{ij} \leq \quad x_{ij} \leq xmax_{ij}$$

$$iacresmin_i \leq \sum\sum x_{ij} \leq iacresmax_i \quad \forall\, irrigated\ x$$

$$acresmin_i \leq \sum\sum x_{ij} \leq acresmax_i$$

where

p_j – 5 yr avg Arkansas prices for different commodities except Hemp (NASS)

y_{ij} – most recent 5yr avg. county crop yields

c_{ij} – UAEX county and crop specific 2016 total specified costs

$x_{min/maxij}$ – NASS reported min and max county acres by crop since 2000

$iacres_{min/maxi}$ – 1987-2012 census based county irrigation acreage restrictions

$acres_{min/maxi}$ – 1987-2012 census based county total harvested acreage restrictions

Note that hemp acreage is restricted to 25% of harvestable acreage to account for likely crop rotation restrictions. That is, growing industrial hemp continuously is likely to lead to pest and disease pressures as well as a likely price response from competing commodities.

With hemp yields indexed to dryland corn yields, cost of production was modified for the tractor running the baler, twine use and hauling equipment in the crop model to reflect yield-based changes in harvest cost per acre that were related to time spent per acre. Hence, at low yields per acre, twine use per acre would decline as would equipment charges as less time would be needed to harvest an acre when compared to a higher-yielding acre. As a result, harvest cost per acre was affected by changes in yield as field speed of harvesting equipment declines with higher yields and thereby raises labor, fuel and equipment charges per acre. Tractors and implements used for planting and fertilizer applications represent pre-harvest costs that are not affected by yield, however. As such, fertilizer application levels were not adjusted for anticipated yield. These changes in the cost by county as indexed by non-irrigated corn yield thereby drive model outcomes along with changes in hemp fiber price.

In the model, hemp price is modified by selecting from $25 to $75 per ton of fiber and seed price is held constant at $0.33/lb for seed. The average industrial hemp price per lb of fiber was $0.82 CDN in 2014 for the Alberta Canada providence (Alberta Agriculture and Forestry, 2015) which is a price for processed fiber. By the same token, USDA ERS (2000) published a report in 2000 indicating a range of $50 to $125 per ton of fiber sold on farm ranging in yield from 3 to 7 tons per acre.

Industrial hemp seed was much more valuable and reached prices of up to $1.23 per pound with the 2011 average price being between $0.90 and $1.00 per pound (Hanson, 2015). Alberta Agriculture used a seed price of $0.74 CDN in 2015 whereas, USDA ERS (2000) used a range of seed prices from $0.30 to $0.55 per lb in their sensitivity analysis.

Hemp seed and fiber are assumed to be sold free on board (F.O.B.) farm site in the linear programming model as all other crops are treated in the same fashion. As such, the prices modeled for fiber and hemp were lower than in the above-mentioned studies as no marketing, transportation, storage or processing costs were accounted for. At the same time, profitability estimates per acre are returns to management and land for production activities on farm that exclude potential gains from storage, transport and marketing.

Expected yields for industrial hemp are not well known for Arkansas. Based on the literature that suggests land suitable for corn production will likely be suitable for hemp production (Russell et al., 2015), the constrained linear programming model was modified to grow industrial hemp only on land in counties that grew corn. With a baseline yield expectation of hemp at 3.08 tons/acre of fiber and 700 lbs of seed, fiber yield was indexed to corn yield. Hence, if a particular county had non-irrigated corn yields of 75 bu/acre compared to a 90 bu/acre state level yield, that county's yield expectation for hemp fiber was estimated at 75/90*3.08 tons/acre or 2.57 tons/acre with harvesting costs adjusted for lesser than average yield. This yield compares to a range of 3 to 7 dry tons of fiber and 500 to 1000 lbs of hemp seed in the USDA ERS study. Russel et al. (2015) list a range of 2.2 to 3.9 ton of fiber along with seed yields of 520 to 910 lbs per acre in their study when contemplating a dual harvest system. Higher fiber and seed yields are attainable when targeting only fiber or seed, respectively.

While non-irrigated Arkansas corn yields were not available from NASS, expert opinion and historical yield differences between irrigated and non-irrigated corn in Kansas were used to adjust irrigated corn yields that are reported for Arkansas to arrive at non-irrigated corn yield to use in the constrained model. These changes in the yield impact the cost and relative profitability of industrial hemp on a county by county basis and thereby affect its competitiveness in relation to other crops.

Results

The constrained linear programming model was run using the fiber prices of \$25/ton to \$75/ton in \$10 increments to compare the changing allocation of crop acreage by county in Arkansas. At \$45 per ton of fiber, for example, relative profitability and cost of production for all crops analyzed is shown in Table 3. At \$45/ton for fiber most row crops demonstrated better returns than non-irrigated industrial hemp. Note, however, that the average profit per acre shown in the Table is not the same in each county as differences in yield are present. Hence as the price of hemp rises, lowest yielding and thereby least-profitable acreage of competing crops are diverted to industrial hemp production.

These changes in crop acreage due to hemp fiber price changes as well as total agricultural production returns to row crop production including pasture rent and hay can be found in Table 4. Note that yields for all crops did not vary except spatially and that prices for all other crops were held constant. Also note that the price of hemp seed was held constant as it proved less volatile historically than fiber prices. These model runs thus provide a spatial assessment of supply response to fiber prices as shown in Figure 2 using the modeling assumptions presented above.

These maps of counties in Arkansas show the amount of industrial hemp grown in each county at different price levels of industrial hemp. When industrial hemp is introduced at $25/ton fiber, it is first farmed in the river valley, central, timberlands, and the delta regions of Arkansas. As the price of hemp fiber increases there is more change in the Arkansas Delta region than anywhere else in the state. Only the easternmost counties in the Ozark region produce industrial hemp. No industrial hemp is produced in the Quachitas region of Arkansas as that region is not adapted to corn production (a necessary condition for growers to consider industrial hemp production in this model).

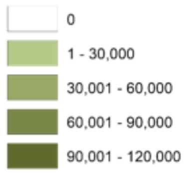
Table 3: Average Cost Of Production by 2016 Prices and 11-15 NASS Avg. Prices

Crop	Price	Unit	Avg. Yield	TSE	Avg. Profit
Rice	11.80	cwt	70	528.32	295.95
Cotton	0.75				
Irrigated		lb	1182	735.68	152.67
Non-irrigated		lb	982	612.82	125.04
Corn	4.84				
Irrigated		bu	168	546.74	266.89
Non-irrigated		bu	86	426.12	(10.83)
Soybean	11.64				
Irrigated		bu	43	408.51	87.09
Non-irrigated		bu	28	355.03	(29.52)
Double cropped		bu	33	414.81	(30.90)
Sorghum	4.68				
Irrigated		bu	99	348.16	114.91
Non-irrigated		bu	81	269.69	107.59
Wheat	6.11	bu	56	275.14	68.94
Hay	63.42	ton	2.07	125.60	5.94
Pasture Cash Rent	18.50	acre	1.17	77.45	18.50
Low-input Hay	50.74	ton	1.61	76.56	5.26
Dry Industrial Hemp	**45.00**	ton	**3.08**	**307.98**	**61.63**

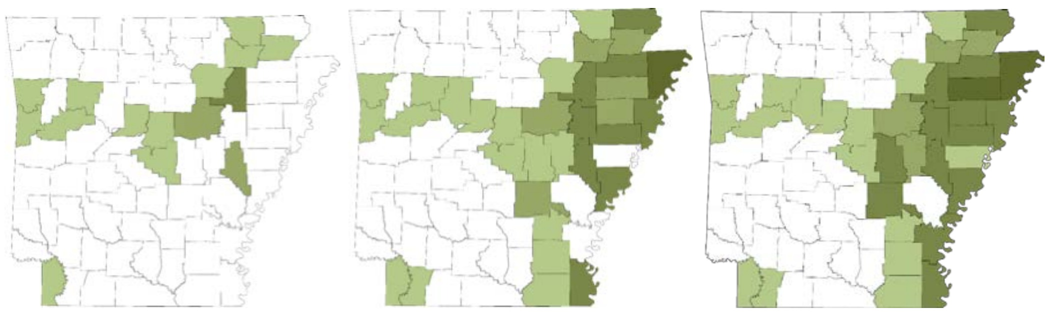
Avg. Cost of Production (TSE) and Estimated Profitability per Acre by Crop for Model Run using $45/t for Hemp Fiber. 2016 Cost of Production and Avg. of 2011-15 Crop Commodity Prices. Cost and Yield varies by County.

Figure 2. Hemp Production By County at Various Fiber Prices

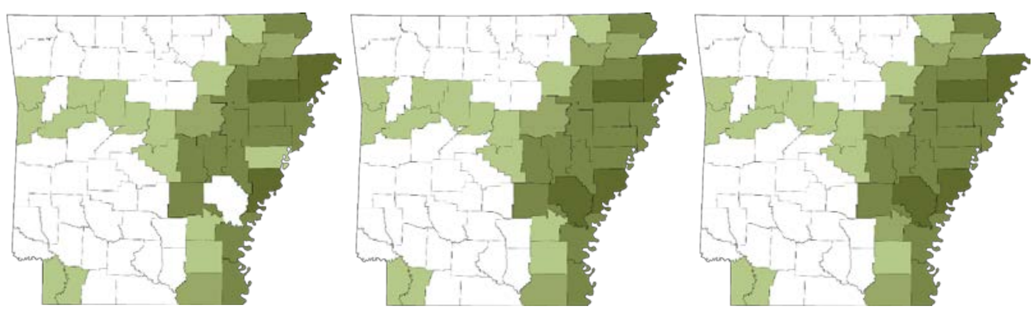
Legend:
Number of Acres
Produced



Hemp Fiber Price $25 T | Hemp Fiber Price $35 T | Hemp Fiber Price $45 T



Hemp Fiber Price $55 T | Hemp Fiber Price $65 T | Hemp Fiber Price $75 T



Hemp acreage by county at Hemp Fiber prices ranging from $25 to $75/t and Seed Price of $0.33/lb. Seed yield is 700 lbs/acre. Fiber yield averages to 3.08 t/acre once indexed to non-irrigated corn yield when PH = $45/t.

Table 4: Crop Production Change in AR After Introduction of Industrial Hemp

	Baseline	% Change		
Hemp Fiber Price	**$0**	**$25**	**$45**	**$65**
State Profit (000's $/yr)	1,002,522	0.3%	7.9%	18.2%
Acres (000s)				
Rice	1,560	0.0%	5.0%	5.0%
Cotton				
Irr	313	0.0%	0.0%	0.0%
Non-irrigated	29	-7.2%	-53.8%	-53.8%
Corn	870	-0.4%	-1.3%	-1.3%
Soybean				
Irr	1,422	-0.1%	-26.3%	-30.6%
Non-irrigated	336	0.0%	-38.2%	-38.2%
Double cropped	175	-12.9%	-12.9%	-12.9%
Sorghum				
Irr	81	0.0%	-13.1%	-13.1%
Non-irrigated	42	0.0%	-7.0%	-7.0%
Wheat	943	-1.1%	-15.0%	-31.2%
Hay	1,252	-2.2%	-5.9%	-5.9%
Pasture	3,914	0.0%	0.0%	0.0%
Low-input Hay	640	-3.7%	-64.5%	-64.5%
Dry Industrial Hemp				
(000s of acres)	-	326	1,585	1,800
Total Harvested	7,821	2.8%	4.4%	4.4%
Total Irrigated	4,391	-0.6%	-7.7%	-9.1%

Estimated Changes to Arkansas State Agricultural Profitability as Modeled with the introduction of Industrial Hemp at Varying Hemp Fiber Prices. Hemp Seed Price was held constant at $0.33/lb.

All changes in crop acreage due to the introduction of industrial hemp resulted in a decrease of acreage allocated to the other crops except an increase of 5% of rice acreage after the initial $25/ton hemp fiber price. Irrigated cotton and pasture acres were the only non-affected crops by dry land industrial hemp. The largest percentage decreases in crop acreage occurred in non-irrigated cotton, non-irrigated soybeans, irrigated soybeans, and low-input hay acreage. Each of those crops decreased by more than 25% after the $25 ton fiber price. The highest percentage change in crop acreage allocation at $25 ton of hemp fiber came from -12.9% change in Soybean double cropped acreage. The total amount of acres harvested increased with the introduction of hemp, while the total amount of irrigated acres decreased with the introduction of hemp. This made sense as industrial hemp was grown under non-irrigated conditions.

Discussion

The main issues facing acceptance of industrial hemp to the political and social aspect of this topic is from the education level of the average American concerning industrial hemp. There is a strong resistance from certain interest groups, such as various sheriffs' associations, due to the history of industrial hemp having been a schedule one narcotic. There is also the issue of the DEA not granting permits to farmers that apply to have an industrial hemp cultivation license.

The main issues facing industrial hemp in the legal aspect comes from the current wording of the national regulation requiring the DEA to issue permits to potential industrial hemp cultivators. States also have legal issues because they have not established regulations concerning cultivation of industrial hemp. Some states have not passed legislation to conduct research to determine the practicality of industrial hemp in the specific state.

The main issues facing industrial hemp in the economic aspect comes from a combination of factors. The equipment currently in use by farmers would have to be adapted and the technology advanced to more efficiently cultivate industrial hemp. This comes from industrial hemp not being produced in the United States in recent years and the technology not being updated from the times that it was last produced. Seeing as there are no industrial hemp processing factories in the United States, this adds transportation cost to the producer, farmer, and the end consumers for getting the raw materials from the farm to the closest processor. This makes industrial hemp less competitive and possibly infeasible for farmers in Arkansas or any farmer far away from a processor.

The regions in the United States, as a whole, that are in the best position to move forward would be in the Mid-West and the Plains Area. The main contributing factor to their being able to move forward with cultivating industrial hemp would be their proximity to Canada. This will allow them to get their raw materials to industrial hemp factories for a lower cost. They will also be able to purchase seed and industrial hemp harvesting equipment for a lower cost due to the proximity. There is a history of industrial hemp cultivation in these areas. The two states that stand out in these areas with a strong history of industrial hemp cultivation are Kentucky and North Dakota. This would mean less resistance from the citizens of this state and a more willing farming population. There has also been favorable research conducted encouraging industrial hemp cultivation in these areas.

The main issues facing the South would be the potential profitability of industrial hemp in each of the states. The South would not be able to import industrial hemp seed as cheaply as the regions to the North. There has also been research conducted that does not give as favorable an outlook on the industrial hemp cultivation in the South as it does in the North due to soil conditions. Industrial hemp can still grow in the South but growing conditions would not be as optimal as in the Northern areas.

The challenges associated with industrial hemp are formidable. Throughout this process, the only thing that was considered during this research has been to the gate of the farm. This is because there are currently no industrial hemp processing facilities in the US.

The Canadian hemp market has had difficulties with markets being flooded and scarce from year to year. Hence, it is not well established.

The opportunities for the South and the state of Arkansas in general, are that they have a unique opportunity to capture the US hemp market on the processing and retailing side as a market pioneer. This would be a highly diversified market offering producers access to a potentially large market. The quantity of sources and research that has been conducted concerning the practicality of industrial hemp is encouraging.

The main economic issues facing the South would be the potential profitability of industrial hemp in each of the states. The South would not be able to import industrial hemp seed as cheaply as the regions to the North. There has also been research conducted that does not give as favorable of an outlook on the industrial hemp cultivation in the South as it does in the North due to soil conditions. This would affect the competitiveness of the potential profit to be gained from this crop. The Southern Region shares the same barrier of the DEA being unwilling to grant farmers permits to allow for industrial hemp cultivation. The Southern region has not comparatively produced as much legislation concerning industrial hemp. This could be from a disinterest in the Southern region, or this could be from some other unknown reason.

Conclusion

The estimated enterprise industrial hemp enterprise budget for the state of Arkansas shows the true competitive nature of the plant when evenly compared to other commodities. Industrial hemp not only competes with other crops, it is grown over many other competing enterprises. When industrial hemp was introduced to the constrained linear model, only two crops did not change, only one crop was grown more, and the rest were grown less in order to divert more acres for industrial hemp. This was because the land was more profitable to the farmer when used to produce industrial hemp. This was true for every hemp fiber price, and when compared to the other crops five-year average yields and price, not just the 2016 crop information. This is very encouraging information that leads to a very positive outlook on industrial hemp as a competitive cash crop in the state of Arkansas.

Due to the potential profit to be gained from an Industrial hemp crop at the farm gate, the next step would be to research the market for a processing facility and everything that should be considered after the farm gate. This would include factors such as the storage and transportation costs, and the possibility of trading industrial hemp futures and options.

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